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## V002

Signifikante Korrelation zwischen dem mittleren SUV-max von 68Ga-DOTATATE PET/CT und dem WHO-Grad des Meningeoms Significant Correlation Between Median SUV-max of 68Ga-DOTATATE PET/CT and WHO Grade of Meningioma

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## Objective

68Ga-DOTATATE PET/CT has been utilized for diagnosing meningioma and guiding postoperative radiotherapy. However, the relationship between clinicopathological characteristics and the semiquantitative indices of 68Ga-DOTATATE PET/CT remains unclear.

## Methods

We conducted a retrospective study at a single neurosurgical center. Semiquantitative indices of 68Ga-DOTATATE PET/CT, including maximum standardized uptake value (SUV-max), median standardized uptake value (SUV-median), mean standardized uptake value (SUV-mean), and metabolic tumor volume (MTV), were measured. The correlations between these parameters and clinicopathological characteristics were analyzed.

## Results

Eighty patients were retrospectively analyzed, including 45 with WHO grade 1 meningiomas, 33 with grade 2, and 2 with grade 3. The median SUV-max value was significantly higher in meningiomas with high WHO grade (P = 0.017), positive SSTR2a expression (P=0.023), and in male patients (P=0.002). An SUV-max > 15.55 was independently associated with higher WHO grade (P = 0.047). In contrast, SUV-median, SUV-mean, and MTV showed no significant differences across WHO grades. RNA expression of SSTR2 was significantly elevated in the SSTR2a-positive group and correlated positively with SUV-max, SUV-median, and SUV-mean. Furthermore, the high RNA scores risk group exhibited significantly higher SUV-max compared to the intermediate- and low-risk groups. Lastly, a nomogram incorporating SUV-max, gender, and surgical history demonstrated robust performance in preoperatively identifying patients at risk for high WHO grade based on 68Ga-DOTATATE PET/CT, offering potential utility in clinical practice.

## Conclusion

The median SUV-max of 68Ga-DOTATATE PET/CT was significantly higher in high grade and high RNA score risk groups. Of note, An SUV-max > 15.55 was independently associated with higher WHO grade.

## V003

## Dural Tail bei Meningeomen: Korrelation von MRT, PET/CT und neuropathologischen Befunden The Dural Tail in Meningiomas: Correlation of MRI, PET/CT, and neuropathological findings

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## Objective

In treatment planning, the dural tail sign of meningiomas on MRI is considered a tumor infiltration zone. However, histopathological studies show tumor infiltration in only ~50% of cases, suggesting it may also reflect reactive changes. PET imaging with somatostatin receptor-based tracers has shown greater sensitivity than MRI in differentiating tumor tissue from tumor-free areas in meningiomas, but its predictive value at the dural tail remains unclear.

This interim analysis of the prospective dural tail study correlates MRI and PET/CT findings of the dural tail with histopathological data.

## Methods

Patients >18 years with a newly diagnosed meningioma and MRI-detected dural tail, treated between 01/2023 and 12/2024, were screened for inclusion. Preoperative SIFATATE-PET/CT was conducted and only PET-enhancing tumors were included. A neuroradiologist labeled the dural tail, and nuclear medicine physicians and neurosurgeons identified biopsy sites on pre-fused images: PET+MRI+, PET-MRI+, and PET-MRI-. Navigated intraoperative samples were taken (**Figure 1**). PET+MRI- sites were not observed. Histopathological findings were correlated with imaging. DNA-methylome analysis and Maas et al. risk stratification (MS), was performed only on the main tumor sample.

## Results

20 patients (15 female; mean age 59.9±10.8 years) were analyzed.

Histology showed two WHO grade 2 (MS 5 and 1) and 18 WHO grade 1 meningiomas (MS 2 in 4 patients, MS 0 in 8 patients, n/a in 6 patients).

PET+MRT+, PET-MRT+ and PET-MRT- specimen were taken at an average distance to the tumor margin of 6.0±1.8, 11.2±2.8 and 15.5±3.9 mm, respectively.

In PET+MRT+, PET-MRT+ and PET-MRT- regions, 16/20 (80%), 9/20 (45%) and 3/20 (15%) specimens showed tumor cell infiltration, respectively.

No correlation was observed between presence of tumor cells in the dural tail specimens and WHO grade, MS or distance of samples to the tumor margin.

MRI-positive dural tail showed a sensitivity (specificity) of 89.2% (50.5%).

PET-positive dural tail showed a sensitivity(specificity) of 57.1% (86.7%).

Congruent PET and MRI results (PET+MRT+ or PET-MRT-) had a sensitivity (specificity) of 84.2% (79.0%) and a PPV (NPV) of 77.8% (85.1%).

### Conclusion

These preliminary results indicate that the combination of MRI and PET has the highest predictive value in detecting tumor infiltration of the dural tail. The final results of the prospective trail are pending as the study still recruits.

## Abb. 1



## V004

Wirksamkeit von Azacitidin in Meningeomen und explorative Analyse der zugrunde liegenden Mechanismen Efficacy of Azacytidine in meningiomas and explorative analyses of underlying molecular mechanisms

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### Objective

Meningiomas are treated by resection and/or radiotherapy. The treatment of multiple or higher grade meningiomas refractory to standard therapies still represents a therapeutic challenge. Effective drug therapies have not yet been established. Azacytidine (AZ), a DNA methyltransferase inhibitor, is successfully used in the treatment of leukemia and sarcomas, having both histological and genetic similarities to meningiomas. Efficacy of decitabine - a chemical analog of AZ – was demonstrated in a subset of primary meningioma cell lines. We therefore aim to investigate the efficacy of AZ on vitality and methylome in primary meningioma cell lines.

### Methods

Effects of AZ on cell viability and proliferation in primary meningioma cells were analyzed using a CellTiter-Glo Cell (CTG) Viability Assay and immunofluorescence staining of Ki67-expression. Immunofluorescence for DNA methyltransferases (DNMT-1 and DNMT3a/b) was used to investigate the molecular preconditions for efficacy. Furthermore, genome-wide DNA methylation analyses were performed.

### Results

72h after drug application of a single dosage of 10 $\mu$ M AZ, cell viability significantly decreased (p < 0.05) in 13 of 19 (68%) cell lines, while response to treatment measured by Ki-67 expression was found in 9 of 16 (56%) cases following 72h of AZ application. No significant correlations between the patients" age, sex, histological subtype, location of the paternal tumor and expression of Ki67, DNMT1, DNMT3a/b and AZ efficacy were found (p>0.05). AZ significantly reduced DNMT1 expression in 7 of 16 (44%) cell lines 72h after drug exposition, whereas a decrease in DNMT3a and 3b expression could be shown in 3 of 11 (27%) and 2 of 11 cell lines (18%). DNMT1 as well as DNMT3a/b expression were independent of both cell viability and cell proliferation. Methylation profiles of cells sensitive or resistant to AZ did not significantly differ, and no significant changes of the DNA methylation neither before nor after treatment was observed.

## Conclusion

Efficacy of AZ on both viability and proliferation was observed in primary meningioma cell lines. Compared to Decitabine, AZ showed improved efficacy and molecular impact was largely independent of DNMT expression and methylation profile. Next to inducing DNA demethylation and epigenetic reprogramming, the efficacy of AZ may be due to other molecular mechanisms of action.

## V005

Voxel-basierte Kartierung von Gehirn- und knocheninvasiven Meningeomen Voxel-based mapping of brain and bone invading meningioma

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## Objective

Most brain meningiomas are benign and have a good prognosis. However, sometimes they exhibit aggressive behavior, characterized by invasion of adjacent tissues. While brain invasion (BRAINinv) serves as an independent criterion for assigning WHO grade 2, bone invasion (BONEinv) does not influence WHO grading. The extent to which these invasive meningioma subtypes share a common physiopathological mechanism remains unclear. This study aims to compare the spatial distribution of BRAINinv and BONEinv meningiomas using voxel-based lesion symptom mapping (VLSM).

### Methods

Clinical parameters, including histological subtype, WHO grade, BRAINinv status, and extent of resection, along with MRI features such as tumor size, BONEinv status, and tumor location, were analyzed in a cohort of 542 meningioma patients. Multivariate stepwise linear regression was employed to identify significant predictors of BONEinv and BRAINinv. Subsequently, VLSM was performed to assess the spatial distribution of these predictors. Progression-free survival (PFS) was evaluated using the Kaplan-Meier method.

### Results

Among the 543 cases, 74 (14%) exhibited BRAINinv, while 152 (28%) showed evidence of BONEinv. Additionally, 50 cases (9%) demonstrated simultaneous invasion of both brain and bone tissues. WHO grade 2 and histological subtype were not significant predictors of BONEinv. VLSM revealed overlapping spatial profiles for BRAINinv and BONEinv meningiomas, with predominant clustering at the frontoparietal transition zone (FPTZ, corresponding to the coronal suture) and the sphenoid wing (correlation coefficient, r=0.71r = 0.71r=0.71, p<0.001p < 0.001p<0.001). BRAINinv was primarily associated with the FPTZ, whereas BONEinv was more frequently observed in the region of the sphenoid wing (Abb. 1). In contrast, WHO grade 2 and large-volume meningiomas predominantly clustered at the cerebral convexity. BRAINinv and WHO grade 2 meningiomas exhibited significantly shorter recurrence intervals (31  $\pm$  22 months and 34  $\pm$  24 months, respectively). No significant difference in PFS was observed between BONEinv and non-BONEinv meningiomas.

### Conclusion

BRAINinv and BONEinv meningiomas exhibit a shared spatial distribution in VLSM, with preferential localization at the FPTZ and sphenoid wing, suggesting a potential common pathophysiological mechanism. However, BONEinv meningiomas show a better prognosis than BRAINinv meningiomas.





## RC002

Langzeitergebnisse und molekulare Erkenntnisse bei strahleninduzierten Meningeomen: eine seltene, aber schwierige Entität

Long-term outcomes and molecular insights in radiation-induced meningiomas: a rare but challenging entity

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## Objective

Radiation-induced meningiomas (RIM) are rare tumors that typically arise decades after cranial irradiation, often following treatment for pediatric hematologic malignancies. These tumors exhibit higher recurrence rates and distinct molecular profiles compared to sporadic meningiomas.

### Methods

Our neurooncological center database was screened for patients with RIM. Patient demographics, medical history, radiation dosage, latency period, tumor characteristics (number, location, histology and grading), and treatment modalities were extracted and analyzed.

### Results

Fourteen patients (7 males, 7 females) with a mean age of  $44 \pm 12$  years were included in the study. The average follow-up period after initial tumor onset was  $4 \pm 3$  years. Most patients (n = 10) had undergone radiation therapy for leukemia, while other indications included lymphoma (n = 1), malignant histiocytosis (n = 1), Morbus Basedow (n = 1), and craniopharyngioma (n = 1). Thirteen patients received the radiation during childhood (mean age at exposure:  $8 \pm 6$  years) and 1 patient was irradiated at 36 years of age. RIM developed after latency periods ranging from 16 to 47 years (mean:  $31 \pm 9$  years). Multiple tumors were observed in 10 patients. Microsurgical resection was performed in 13 patients. During follow-up, 2 patients developed a new tumor within the radiation field, 5 experienced local recurrences and 4 showed progression of additional tumors. One patient died two years after surgery. Histological analysis revealed 6 CNS WHO grade 1 meningiomas and 8 WHO grade 2 meningiomas. These tumors exhibited a low growth rate, with a mean Ki-67 index of 5.7  $\pm$  4.4%. Molecular studies demonstrated loss of H3K27me3 in 4 out of 6 samples and no homozygous deletion of CDKN2A/B in 2 samples. Next-generation sequencing was performed on four samples, all of which demonstrated wild-type profiles for TERT.

## Conclusion

Despite their relatively low proliferative activity, RIM demonstrates high recurrence and progression rates. These findings highlight the importance of long-term monitoring and individualized management strategies.

## BO-01

Über traditionelle Prognosen hinaus: Integration von RAG-Enhanced AtlasGPT und ChatGPT 4.0 in die Vorhersage der Ergebnisse bei aneurysmatischer Subarachnoidalblutung Beyond Traditional Prognostics: Integrating RAG-Enhanced AtlasGPT and ChatGPT 4.0 into Aneurysmal Subarachnoid Hemorrhage Outcome Prediction

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## Objective

To assess the predictive accuracy of advanced AI language models in comparison with established clinical scales in prognosticating outcomes for patients with aneurysmal subarachnoid hemorrhage (aSAH).

## Methods

This retrospective cohort study included 82 patients suffering from aSAH. We evaluated the predictive efficacy of AtlasGPT and ChatGPT 4.0 by examining the area under the curve (AUC), sensitivity, specificity, and Youden's Index, in comparison to established clinical grading scales such as the World Federation of Neurological Surgeons (WFNS) scale, Simplified Endovascular Brain Edema Score (SEBES), and Fisher scale. This assessment focused on four endpoints: in-hospital mortality, need for decompressive hemicraniectomy, and functional outcomes at discharge and after 6-month follow-up.

## Results

In-hospital mortality occurred in 22% of the cohort, and 34.1% required decompressive hemicraniectomy during treatment. At hospital discharge, 28% of patients exhibited a favorable outcome (mRS  $\leq$ 2), which improved to 46.9% at the 6-month follow-up. Prognostication utilizing the WFNS grading scale for 30-day in-hospital survival revealed an AUC of 0.72 with 59.4% sensitivity and 83.3% specificity. AtlasGPT provided the highest diagnostic accuracy (AUC 0.80, 95% CI: 0.70-0.91) for predicting the need for decompressive hemicraniectomy, with 82.1% sensitivity and 77.8% specificity. Similarly, for discharge outcomes, the WFNS score and AtlasGPT demonstrated high prognostic values with AUCs of 0.74 and 0.75, respectively. Long-term functional outcome predictions were best indicated by the WFNS scale, with an AUC of 0.76.

## Conclusion

The study demonstrates the potential of integrating AI models such as AtlasGPT with clinical scales to enhance outcome prediction in aSAH patients. While established scales like WFNS remain reliable, AI language models show promise, particularly in predicting the necessity for surgical intervention and short-term functional outcomes.

## V006

## Klinischer Outcome des konservativen, endovaskulären und mikrochirurgischen Managements von rupturierten, intrakraniellen Riesenaneurysmen: Drei Jahre Follow-up des prospektiven, multinationalen Riesenaneurysmaregisters

## Clinical outcomes of conservative, endovascular and microsurgical management of ruptured giant intracranial aneurysms: three-year follow-up of the prospective, multinational Giant Intracranial Aneurysm Registry

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### Objective

Giant intracranial aneurysms (GIAs), defined as aneurysms of 25 mm or larger, are rare but pose significant challenges in managing ruptured cases due to their complexity and associated potential complications. The optimal treatment strategy for ruptured GIAs is not well established, with limited comparative data on conservative management versus endovascular (EVT) or microsurgical (SURG) treatment. This study aimed to evaluate the clinical course and outcomes of different management strategies for ruptured GIAs to inform evidence-based clinical decision-making.

### Methods

This prospective and retrospective multinational observational registry study included patients with ruptured GIAs treated in 37 neurovascular centers between 2003 and 2017. We investigated the clinical course of patients with unruptured GIAs under conservative management and after endovascular or microsurgical treatment over three years of follow-up. The trial is registered with ClinicalTrials.gov (NCT02066493).

### Results

We included 121 patients, while 21.5% of the patients underwent conservative management, 41.3% endovascular, and 37.2% microsurgical treatment. Overall survival was 3.8% in the CON group. The EVT group resulted in 51.1% survival, while the SURG group resulted in a survival rate of 53.3% after three years (p < 0.001). In the CON group, patients with favorable neurological outcomes (mRS 0-2) declined to 3.8% after three years compared to the time of discharge from index hospitalization. In the EVT group, favorable outcomes declined to 20.0%, while in the SURG group, 17.8% of patients had favorable outcomes (p < 0.001). Retreatment of the same aneurysm was experienced by 36.0% of the patients in the EVT group, whereas in the SURG group 0.0% of patients underwent retreatment (p < 0.001).

### Conclusion

Both SURG and EVT were associated with significantly improved survival and functional outcomes compared to CON management. For patients who are candidates for active treatment, EVT and SURG represent viable treatment options. While the proportion of patients achieving favorable outcomes was notable in both groups, the SURG group demonstrated significantly lower retreatment rates compared to the EVT group.

## V007

Die Sicherheit der schnellen, ventrikulären Stimulation in der Behandlung von cerebralen Aneurysmen durch Clipping bezüglich Gehirn und Herz

The safety of rapid ventricular pacing in the treatment of cerebral aneurysms by clip ligation regarding brain and heart

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## Objective

Rapid ventricular pacing (RVP) is a technique to reduce systolic blood pressure for a short period to facilitate clip ligation by consecutive softening the aneurysm. RVP can be used repetitively after a short recovery time. The aim of the study was to evaluate possible neurological and cardiac side effects of RVP during cerebrovascular surgery due to cerebral or cardiac ischemia.

## Methods

Data from patients who underwent RVP to clip ligation of ruptured and unruptured cerebral aneurysms were analyzed regarding pre- and postoperative serum values of creatine kinase (CK), brain natriuretic peptide (BNP) and troponine T (TPT), heart rhythm, electrocardiogram (ECG), and postoperative computertomography (CT) to rule out global cerebral ischemia.

## Results

In a total of 67 patients (age from 26-88 years) RVP (range 13-300 seconds) was performed. An immediate, controlled decrease of systolic arterial blood pressure (range 25-50 mm Hg) was achieved after initiation of RVP induced by heart beat modulation from 140-200 beats per minute. Systolic arterial blood pressure normalized immediately after RVP was finished. In two patients a self-limiting short phase of atrial fibrillation occurred. Postoperative CT scans did not show RVP-related brain ischemia. Serum values of CK, BNP, and TPT were transiently higher postoperatively than preoperatively. No myocardial infarction was detected.

## Conclusion

RVP, even after repetitive short maneuvers, proves to be a safe systolic blood pressure-lowering technique in the treatment of cerebral aneurysms by clip ligation at a low complication rate.

## V008

Rapid Ventricular Pacing im Clipping von zerebralen Aneurysmen: Institutioneller Arbeitsablauf und eine systematische Übersicht mit Single-Arm-Metaanalyse Rapid Ventricular Pacing in Clipping of Cerebral Aneurysms: Institutional workflow and a systematic review with single-arm meta-analysis

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## Objective

Rapid ventricular pacing (RVP) is suggested for the clipping of complex cerebral aneurysms to achieve temporary hypotension, thereby facilitating surgical interventions. However, the safety and efficacy of this approach in terms of cardiac and neurological outcomes remain under evaluation. This institutional series with systematic review and meta-analysis examine RVP"s impact on several key endpoints, including arrhythmia, mortality, complete obliteration of aneurysms, new neurological deficits, and myocardial damage as reflected by postoperative troponin T levels

### Methods

Data were extracted from institutional database and published studies investigating the use of RVP in both ruptured and unruptured aneurysms. Outcomes analyzed included postoperative arrhythmia, mortality, complete obliteration of aneurysms, pacing cycles, mean arterial pressure (MAP) during pacing, pacing rates, and postoperative troponin T levels. Pooled event rates and proportions were calculated using a common effect model, and heterogeneity across studies was assessed using I<sup>2</sup> statistics.

## Results

Among the 15 institutional cases, RVP-assisted aneurysm clipping resulted in stable neurological outcomes, no instances of cardiac complications, and a 94% rate of complete aneurysm obliteration. Pooling of institutional data with literature resulted in a total cohort of 141 patients. The pooled event rate for postoperative arrhythmia was low at 1% (95%-CI: 0.00–0.06), while mortality was similarly low at 0% (95%-CI: 0.00–0.04). Pooled aneurysm obliteration rate was high, with a pooled rate of 92% (95%-CI: 0.84–0.97). New neurological deficits were observed in 4% of cases (95%-CI: 0.00–0.09), and the mean postoperative troponin T level was 37.7 ng/L, indicating minimal myocardial injury. Mean pacing rates and cycles were 187.4 bpm and 6.5 cycles, respectively, with a mean MAP during pacing of 41.1 mmHg.

## Conclusion

The findings suggest that rapid ventricular pacing in cerebral aneurysm clipping is associated with a low risk of cardiac arrhythmia and myocardial injury, while facilitating high rates of complete aneurysm obliteration. This technique appears safe, with minimal impact on postoperative mortality and neurological outcomes.

## RC003

Der Einfluss zerebraler Kollateralkreisläufe auf das Infarktgeschehen bei posthämorrhagischen Gefäßspasmen unter Therapie mit intraarterieller Spasmolyse mittels Nimodipin The impact of cerebral collateral circulation on delayed cerebral ischemia in posthemorrhagic vasospasm treated with intraarterial nimodipine infusion

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## Objective

Despite elaborate countermeasures to treat and prevent posthemorrhagic vasospasm, delayed cerebral ischemia (DCI) remains a major complication after aneurysmal subarachnoidal hemorrhage (SAH). While endovascular rescue strategies provide excellent angiographic results, there is still a considerable discrepancy with the incidence of DCI. As observed in ischemic stroke, highly variable perfusion via cerebral collateral circulation (CC) can predict reperfusion, final infarct size, and outcome. We hypothesized that this phenomenon has implications for patients after SAH, as well, and subsequently investigated the effect of intraarterial nimodipine infusion on vasospasm and DCI with focus on the grade of CC.

## Methods

We reviewed 36 consecutive patients with vasospasm from SAH treated (repeatedly) with intraarterial nimodipine infusion in 2020 and 2021 (132 procedures). The angiographic response, grade of collateralization and infarction rate were classified using the pre- and postinterventional angiographic images and computed tomography scans.

## Results

Mean patient age was 62 years (range: 21-88 years). Fifteen patients (42%) presented with a poor clinical score (Hunt and Hess grade IV or V). Aneurysm location was at the anterior complex in 19 (53%), the internal carotid artery in 4 (11%), the medial cerebral artery in 10 (28%) and the posterior circulation in 3 (8%) patients. Aneurysm clipping was performed in 28 patients (78%), whereas 8 patients underwent endovascular coiling. Thirty-three patients (92%) exhibited high grade SAH (Fischer grade III or IV). There was a correlation between the grade of vasospasm and the necessity of repeat endovascular interventions (p=0,01 Fischer's exact test). While there was no significant correlation between response to endovascular treatment and infarction (p=0,2), a low grade of collateralization was a strong predictor of infarction (p<0,0001).

## Conclusion

CC might present a missing link in understanding the impact of vasospasm on the occurrence of DCI and explain the sometimes devastating clinical outcome despite excellent angiographic results.

## RC004

## Karotisstenosen im Rahmen von aneurysmatischen Subarachnoidalblutungen - Ein unterschätztes Risiko Carotid stenosis in aneurysmal subarachnoid hemorrhage – An underrated risk for cerebral infarctions

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## Objective

Aneurysmal subarachnoid hemorrhage (aSAH) is a devastating condition associated with complications such as cerebral vasospasm (CV), increased intracranial pressure (ICP), and delayed cerebral ischemia (DCI), significantly impacting patient outcomes. Extracranial internal carotid artery stenosis (ICAS) has been linked to impaired cerebral perfusion and ischemic events. However, its role in aSAH remains underexplored. This study investigates the impact of ICAS on post-aSAH ischemic events and neurological outcomes, with a focus on territorial patterns relative to ICAS severity.

## Methods

We conducted a retrospective analysis of 378 aSAH patients treated between 2004 and 2016 at a tertiary neurovascular center. Data included demographics, ICAS severity (assessed via the NASCET score), and outcomes measured by the modified Rankin Scale (mRS) at six months post-aSAH. Cerebral infarctions were analyzed by timing—early (ECI) or delayed (DCI)—and location (vascular territories). Binary logistic regression models, adjusted for confounders such as age, Fisher and WFNS grades, and CV severity, were used to assess associations between ICAS and outcomes. Subgroup analyses examined the effects of aspirin treatment on ICAS-related risks.

## Results

Among 378 patients (mean age: 55.82  $\pm$  13.82 years; 67.7% female), 72.6% had no ICAS, while 3.5% exhibited severe stenosis (NASCET > 20%). Higher NASCET scores significantly predicted infarctions in ICA (adjusted Odds Ratio (aOR) 1.03; 95% confidence interval (CI) 1.01-1.05; p<0.001), MCA (aOR 1.03; 95% CI 1.02-1.05; p<0.001), and ACA territories (aOR 1.04; 95% CI 1.01-1.07; p=0.004). ICAS correlated with increased DCI risk (aOR 1.03; 95% CI 1.01-1.05; p=0.013) but not ECI (aOR 1.01; 95% CI 0.99-1.03; p=0.270). Elevated ICAS was also associated with unfavorable outcomes (mRS 4–6; aOR 1.03; 95% CI 1.01-1.05; p=0.014), an effect diminished when controlling for infarction occurrence. In a subgroup, Aspirin intake diminished the impact of ICAS on the outcome (aOR 1.01; 95% CI 0.97-1.06; p=0.586) and DCI risk (aOR 0.99; 95% CI 0.93-1.05; p=0.685).

## Conclusion

ICAS independently predicts DCI, territorial cerebral infarctions, and poor neurological outcomes following aSAH, with risk increasing proportionally to ICAS severity. Aspirin appears to mitigate these risks, suggesting a potential therapeutic role. These findings highlight the importance of assessing and managing ICAS in aSAH to optimize patient outcomes.

## V009

Vorhersage der Shunt-Abhängigkeit nach aneurysmatischer Subarachnoidalblutung: eine multizentrische Validierungsstudie

Prediction of shunt-dependency after aneurysmal subarachnoid hemorrhage: a multicenter validation study

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## Objective

Several risk scores have been developed to predict shunt dependency after subarachnoid hemorrhage (SAH). However, the clinical utility of these tools remains limited due to the absence of external validation. In this multicenter pooled analysis, we aimed to assess the predictive accuracy of existing post-SAH shunt risk scores using two long-term observational SAH cohorts.

### Methods

We compiled a validation cohort by pooling consecutive SAH cases treated at two German university hospitals from January 2010 to July 2023. Total score values for the CHESS, CHESS-Huckman and SDASH risk scores were calculated. Follow-up data were reviewed to identify shunt surgeries. Also the association between risk score values and the timing of shunt placement was analyzed. Diagnostic accuracy was compared using receiver operating characteristic (ROC) curve analysis.

### Results

813 patients were included. Among these, 215 (26.5%) required ventriculoperitoneal shunt placement, with a median time to shunting of 29 days post-SAH. Shunt rates were similar between the cohorts (27% vs. 26.1%; p= 0.809). All three risk scores demonstrated significant association with shunt dependency, irrespective of cohort allocation. ROC analysis revealed that the CHESS-Huckman score had the highest area under the curve (AUC) value (0.792;95% CI:0.761–0.824), followed by the SDASH score (0.782;95% CI:0.750–0.814) and the CHESS score (0.780;95% CI:0.748–0.812). Higher CHESS-Huckman scores correlated with increased shunt placement rates in both cohorts. The CHESS-Huckman score showed a strong association with shunt timing; patients with higher scores tended to receive shunts earlier. Delayed shunt placement was most common among individuals with moderate CHESS-Huckman scores (7–8 points), occurring in 47.4% of these cases, compared to 41.4% and 33.3% in patients with CHESS-Huckman scores of 0–6 and 9–10, respectively.

## Conclusion

This multicenter analysis successfully validated existing risk scores for predicting shunt dependency after SAH, with the CHESS-Huckman score demonstrating the highest diagnostic accuracy. Implementing SAH shunt dependency risk scores in clinical practice could facilitate early identification of patients likely to require shunt placement. This approach may help reduce EVD weaning time, potentially shortening hospital stays and lowering the risk of CSF infections.

## RC005

## Die CIRE Konzeption: Vorbereitung von Medizinstudierenden auf die neurochirurgische Facharztausbildung The CIRE Concept: Preparing Medical Students for Neurosurgical Residency

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## Objective

The transition from medical school to neurosurgical residency often poses challenges due to limited exposure to technical skills during undergraduate education. This study evaluates the impact of a structured, simulation-based training program on the technical skill development of medical students during their neurosurgical rotations, aiming to bridge the gap between medical school and residency-level competency.

## Methods

A cohort of six 5th and 6th-year medical students participated in a structured neurosurgical training program during their neurosurgical rotationx. Weekly sessions utilized high-fidelity simulation models replicating key neurosurgical procedures, including craniotomy, microsurgical dissection, aneurysm clipping, and tumor resection. Each session focused on deliberate practice and technical skill refinement, with faculty supervision and immediate feedback. Pre- and post-rotation evaluations were conducted using the Objective Structured Assessment of Neurosurgical Skills (OSANS). The performance of the participants at the end of the rotation was compared to that of second-year neurosurgical residents previously taking part in our simulation course.

## Results

Post-rotation evaluations revealed a significant improvement in the participants" technical skills. Median OSANS scores increased by 40% (p < 0.01) across domains such as instrument handling, dissection accuracy, and operative decision-making. At the end of the rotation, the students" technical skill levels were comparable to those of second-year neurosurgical residents. Notably, participants reported high confidence in performing basic neurosurgical procedures independently. Faculty evaluations highlighted the students" accelerated skill acquisition and readiness to transition into residency roles.

## Conclusion

The results underscore the value of integrating simulation-based training into medical school curricula during neurosurgical rotations. By achieving competency levels equivalent to junior residents, students are better prepared for the demands of neurosurgical residency, potentially reducing the steep learning curve and enhancing patient safety.



Figure 1: A) Simulation setup. B+ C) Medical student staking part in weekly simulation sessions involving the placement of external ventricle drains and the microneurosurhical clipping of MCA aneuryms.





Figure 2: Improvements of technical skills among medical students before and after neurosurgical rotations involving a structructred weekly simulation training.

Abb. 1
# V011

# Molekulare Landschaft und klinische Korrelation petroclivaler Meningeome Molecular landscape and clinical associations of petroclival meningiomas

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# Objective

Petroclival meningiomas (PCM), comprising 2% of all meningiomas, pose significant surgical challenges due to their location and consistency, often leading to neurological deficits. This study examines the relationship between the clinical characteristics, radiological features, and molecular profiles of PCM

# Methods

We performed whole-genome sequencing on 46 PCM samples collected from a single center, focusing on known meningioma-driver genes. We compared the molecular data with the clinical features of the tumors. Patient and tumor data, including age, sex, tumor consistency, and volume, were retrospectively collected. In addition, patient survival was analyzed

#### Results

The study cohort comprised 36 females (78.3%) and 10 males (21.7%), with a median age at diagnosis of 61 years (range 19-88 years). The majority of tumors (78.3%, n=36) were classified as WHO grade 1, and the remaining 21.7% as grade 2 meningiomas. Known driver mutations were found in 87% of patients (n=40). The most common mutations were found in the *TRAF7* (n=15, 32.6%) and *NF2* (n= 14, 30.4%) genes, which occurred mutually exclusive. Further frequently detected mutations were *KLF4K409Q* (n= 13, 28.2%, all co-mutant with *TRAF7*) and *AKT1E17K* (n= 8, 17.4%, including five co-mutant with *TRAF7*), followed by mutations in *POLR2AQ403K* (n= 5), *SMARCB1* (n= 2), *SMO* (n=2), and *PTCH1* (n=1). In seven patients, no known meningioma driver mutations were detectable. The most common histological subtype was meningothelial in 28 cases (60%) with no correlation between histology and mutational profile of PCMs. The median tumor volume at diagnosis was 11.9 cm3. Among tumors with known driver mutations, *NF2*-mutant PCMs presented with the largest median volume (45.6 cm3), whereas *AKT1*- and *TRAF7/KLF4*-mutations were associated with the smallest tumor volumes (10.5 cm3 and 9.6 cm3, respectively). We then correlated the molecular profile with tumor intraoperative consistency, with 10 being firm and 36 of soft tumors. No significant correlation between tumor consistency and molecular features was found

# Conclusion

Distinct molecular subgroups of PCM were identified, with *NF2*-mutant tumors associated with larger volumes and potentially more aggressive behavior. Similarly, other subgroups, such as those with *TRAF7/KLF4* mutations, demonstrated smaller volumes, suggesting less aggressive growth patterns. These findings highlight the value of molecular diagnostics in improving preoperative planning and enabling personalized treatment strategies

# V013

Die routinemäßige Erfassung der Lebensqualität (PROMIS) nach hypophysärer Tumorresektion ergibt Entitätsassoziierte Einschränkungen.

Routine postoperative health-related quality of life assessment (PROMIS) following pituitary tumor surgery reveals entity-associated impairment.

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# Objective

Pituitary neuroendocrine tumours (PitNETs) are known to be associated with reduced health-related quality of life (HRQoL), even after successful surgical tumour resection, due to endocrine disorders or other limitations. However, standardized HRQoL assessment is rarely integrated into routine postoperative care. Here, we show the results of a prospective routine postoperative HRQoL assessment using the standardized, app-based Patient Reported Outcome Measurement Information System (PROMIS).

#### Methods

A prospective HRQoL assessment was conducted in patients who underwent surgical tumour resection in the pituitary region over an average of 4.5 years, using an app-based PROMIS-29 tool. PROMIS T-scores were calculated, with 50 as the mean of the German PROMIS reference population and 10 as the standard deviation (SD) of that population.

# Results

A total of 100 patients were included in the study, 42 with surgical resection of non-functioning pituitary adenomas (NFPA), 16 with acromegaly, 13 craniopharyngiomas, 10 prolactinomas, 4 Cushing's disease patients, and 15 patients with other pituitary tumors (e.g. meningiomas). Gross total resection (GTR) was achieved in 57%, while biochemical remission rates varied among hormonally active tumors. HRQoL outcomes revealed disparities across the six tumor entities. Patients with prolactinomas exhibited the best overall HRQoL, particularly in anxiety (51.2  $\pm$  11.9), depression (48.9  $\pm$  10.0) and social health (53.0  $\pm$  11.8). In contrast, patients with Cushing"s disease displayed the lowest HRQoL, as indicated by elevated T-Scores in fatigue (54.9  $\pm$  4.5) and pain interference (63.7  $\pm$  6.5), along with the highest pain levels (5.0  $\pm$  2.2) on the NRS-11. Craniopharyngioma patients reported highest mental health impairments, as evidenced by elevated T-Scores in depression (58.9  $\pm$  7.1), anxiety (57.5  $\pm$  8.8), and lower T-Scores in social health (44.8  $\pm$  11.0).

# Conclusion

Regarding the postoperative HRQoL impairment as assessed by the app-based PROMIS, patients with both Cushing's disease and craniopharyngioma experienced the highest postoperative impairments. Referral to specialist centers, mental health support in postoperative care and standardized HRQoL assessments in clinical practice are recommended as essential steps for optimizing patient-centered treatment.

# V014

Technologische Fortschritte in der Mikrovaskulären Dekompression bei Hemispasmus Fazialis: Verbesserung der Ergebnisse und Minimierung von Komplikationen Technological Advances in Microvascular Decompression for Hemifacial Spasm: Enhancing Outcomes and Minimizing Complications

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# Objective

Microvascular decompression (MVD) remains the only curative treatment for hemifacial spasm (HFS). With advancements in technology and surgical techniques, MVD has become safer and more effective. This study presents a spectrum of complications observed in a case series, explores their possible causes, and recommends strategies to minimize risks, emphasizing the role of modern technological improvements to classify spasm.

#### Methods

The authors reviewed a prospectively maintained database for MVDs performed from 2005 to 2024 and extracted relevant data, including patient demographics, offending vessel(s), operative techniques, outcomes, and complications. Additionally, they developed a new grading system utilizing facial recognition and tracking technology.

#### Results

Data from 420 patients were included. 92.3% of the series with a minimum follow-up of 12 months had a favorable outcome. Facial tracking could grade the spasms into three grades (minimal, moderate clonic and sever tonic). Moderate clonic spasms had best cure rates following MVD. Immediate complications reached 18.8% (79/420). Complications persisted in only 7.14% of patients (30/420) including persistent hearing deficits (5.95%) and residual facial palsy (0.95%). Temporary complications included CSF leakage (3.10%), lower cranial nerve deficits (3.57%), meningitis (0.71%), and brainstem ischemia (0.24%). One patient died because of herpes encephalitis. Immediate disappearance of spasms and male gender are correlated with postoperative facial palsy, whereas combined vessel compressions involving the vertebral artery (VA) and anterior inferior cerebellar artery can predict postoperative hearing deterioration. VA compressions could predict postoperative lower cranial nerve deficits.

#### Conclusion

A novel grading system utilizing facial tracking technology has demonstrated accuracy and may correlate with outcomes in MVD for HFS. Optimal patient positioning, precise arachnoid dissection, and enhanced endoscopic visualization, combined with continuous facial and auditory neurophysiological monitoring, are crucial strategies to minimize complication rates.

# RC007

Endoskopische navigationsgestütze Implantation von zysto-ventrikulären Kathetern zur Therapie von zystischen Kraniopharyngeomen

Endoscopic navigation assisted placement of cysto-ventricular catheters in craniopharyngioma

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# Objective

Craniopharyngiomas are rare tumors located in the sella region, often characterized by large cystic compartments. This study aims to analyze the impact of placing a catheter within these cystic compartments to alleviate pressure on surrounding structures, as well as to assess the resulting effects on visual impairment and endocrine disorders.

# Methods

We conducted a retrospective analysis of patients with craniopharyngiomas who underwent surgical treatment between 2013 and 2024. MRI scans taken before and after surgery were evaluated to determine the presence of hydrocephalus, compression of the optic chiasm, and hypothalamic edema. Clinical reports were reviewed for signs of visual impairment, hypopituitarism, and diabetes insipidus.

# Results

Out of 33 patients included in the study, a cysto-ventricular catheter (CVC) was placed in 14 (42%) cases at some point during treatment. Among these, 10 (71%) underwent endoscopic placement of the catheter, while in 3 (21%) cases, the catheter was placed using stereotactic techniques. The catheter was placed before resection in 7 cases. All patients showed improvement in visual function after CVC implantation. No new cases of hypopituitarism were observed following CVC placement. Additionally, in all cases, the size of the cyst decreased after CVC placement, and in 3 (43%) cases, hypothalamic edema was found to be regressing. Furthermore, the histopathological diagnosis was confirmed in all cases after endoscopic CVC placement.

# Conclusion

The use of cysto-ventricular catheters in the treatment of cystic craniopharyngiomas has shown promising results in select cases, as it can rapidly improve visual impairment and potentially reduce the impact of the tumor on surrounding tissues, thereby increasing the likelihood of complete removal during subsequent resections. Additionally, the endoscopic-assisted placement technique allows for biopsy collection and removal of crystalloid cyst fluid, which may help prevent aseptic meningitis. However, further studies are needed to identify the specific patient and tumor characteristics that would make this two-step approach preferable over other treatment options.

# V015

Die Diagnose von pyogener Spondylodiszitis mit Next-Generation Sequencing: Ein Leistungsvergleich mit traditionellen diagnostischen Methoden The Diagnosis of Pyogenic Spondylodiscitis with Next-Generation Sequencing: A Performance Comparison with Traditional Diagnostic Methods

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# Objective

The incidence of pyogenic spondylodiscitis is rising, posing significant diagnostic challenges. Traditional methods, such as blood cultures, frequently fail to timely and accurately detect causative pathogens, leading to suboptimal treatment outcomes. This study introduces a novel approach using Next-Generation Sequencing (NGS) of cell-free DNA, aimed at enhancing diagnostic accuracy and improving patient management.

# Methods

This prospective study at a tertiary care university hospital enrolled 21 patients suspected of having pyogenic spondylodiscitis. Participants were tested using both conventional blood culture and advanced NGS with the DISQVER platform, adhering strictly to ethical standards in compliance with the Helsinki Declaration. The study evaluated diagnostic efficacy, sensitivity, and specificity of the methods.

# Results

NGS demonstrated a significantly higher sensitivity (70%) compared to blood culture (50%), and was comparable to histopathology (80%). It also showed superior specificity (75%) relative to traditional diagnostics (blood culture: 67%, histopathology: 33%). NGS reduced the time-to-diagnosis, influencing therapeutic decisions, particularly in cases with inconclusive traditional results. Additionally, NGS identified pathogens in 45% of cases where traditional methods were limited, detecting pathogens such as Streptococcus pneumoniae, Parvimonas micra, and Enterococcus faecalis. The intraclass correlation coefficient (ICC) analysis highlighted the diagnostic concordance of NGS with intraoperative swabs (ICC: 0.46), compared to lower ICC values for blood cultures (0.16) and histopathology (0.12). The lack of statistical significance in these findings (p>0.05) is likely due to the small sample size, with further data collection planned to confirm the initial findings.

#### Conclusion

Early results support the integration of NGS as a standard diagnostic tool for managing pyogenic spondylodiscitis. By offering rapid and precise pathogen identification, NGS has the potential to transform the diagnostic landscape for complex infections, enabling more effective, tailored therapeutic interventions. Further research will validate these findings and potentially expand the use of NGS in diagnosing other complex infectious diseases.

# Abb. 1







# V016

Veränderungen der lumbalen Spinalganglien bei Neurofibromatose Typ 1: Implikationen für die Diagnostik und neurochirurgische Therapie Assessing Dorsal Root Ganglion Changes in Neurofibromatosis Type 1: Implications for Pain Diagnosis and Neurosurgical Management

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# Objective

The aim of this study was to investigate dorsal root ganglion (DRG) changes in Neurofibromatosis Type 1 (NF1) patients, particularly in relation to pain. NF1 is characterized by skin and nervous system anomalies, often leading to chronic and neuropathic pain, which significantly impacts patients' quality of life. We sought to evaluate DRG volume and microstructural alterations using MRI, and to determine whether these changes could serve as biomarkers for pain in NF1 patients, especially for differentiating those with neuropathic pain.

# Methods

This prospective study involved 22 NF1 patients and 28 healthy controls. Patients underwent comprehensive neurological evaluations, including questionnaires on quality of life, physical and mental health, and small fiber tests (quantitative sensory testing (QST), corneal confocal microscopy (CCM), skin punch biopsies, and intraepidermal nerve fiber density measurements). Additionally, all participants underwent MR imaging of the lumbosacral DRG using a 3 Tesla scanner. The MR techniques assessed DRG volume, T2 relaxation time (T2), and proton spin density (PD). Statistical analyses, including comparisons between NF1 patients and controls, as well as between NF1 patients with and without pain, were conducted to identify significant differences.

# Results

The results showed that NF1 patients had significantly larger DRG volumes and higher quantitative T2 and PD values compared to healthy controls. Notably, DRG PD values were substantially higher in NF1 patients with neuropathic pain, suggesting a correlation between DRG microstructure and pain status. The volumetric analysis revealed that NF1 patients had hypertrophy of the DRG at the L5 and S1 segments when compared to controls (NF1 patients: 2235.7 mm<sup>3</sup> vs. controls: 1313.0 mm<sup>3</sup>; p<0.001). ROC analysis demonstrated that DRG PD was the best discriminator for the presence of pain in NF1 patients.

# Conclusion

This study highlights significant macro- and microstructural changes in the DRG in NF1 patients, which are closely associated with pain, particularly neuropathic pain. The observed DRG hypertrophy and PD values suggest that DRG MRI can serve as a valuable diagnostic tool to assess pain-related changes in vivo. DRG MRI could assist in making more informed decisions regarding treatment strategies, including the consideration of spinal tumor resection.

# V017

Ergonomische Herausforderungen in der Wirbelsäulenchirurgie: Vorläufige Ergebnisse zur objektiven Analyse der Körperhaltung von Wirbelsäulenchirurgen mittels Inertialsensoren. Ergonomic Challenges in spinal surgery: preliminary results of objective analysis of spine surgeons' posture using Inertial Measurement Units Sensors.

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# Objective

Surgical ergonomics has become a critical concern due to the high risk of work-related musculoskeletal disorders (WRMSD) among spine surgeons (SS), which can impact surgeon's health. In spinal surgery prolonged operating hours and the use of specialized devices, such as microscopes, place heavy demands on SS, leading to unergonomic postures. (1) While most research studies on ergonomics rely on subjective surveys, objective data, particularly in spinal surgery, remain limited. Validated Risk assessment scores like the Rapid Upper Limp Score (RULA) useful. Assessment are well known and can be (2) This field study aims to evaluate the ergonomic challenges of SS by objectively measuring posture using inertial measurement units (IMUs) in the operating theatre.

#### Methods

Eight IMU sensors are placed on the upper extremities, head, and torso of SS at a single-center neurosurgical department. SS with varying levels of experience are included. The IMU sensors continuously capture surgeon"s kinematic data during different spinal procedures. The data will be analyzed using specialized software (MR 4, Noraxon<sup>®</sup>, Arizona, USA) to identify ergonomic risks assessed by verified RULA Score. Additionally, body part segment angles will be recorded.

# Results

A total of 25 spinal surgeries could be analyzed to date. Preliminary results showed different neck scores between the time of microscopic surgery and open surgery stages, indicating a lower risk profile for microscope use. Lumbar spinal surgeries showed lower total scores than anterior cervical procedures. Overall, the largest proportion of spinal operations were performed in non-ergonomic postures regardless of the spinal level, showing the potential risk of WRMSD in SS.

# Conclusion

This field study will provide valuable insights into SS' postures during different spinal surgeries. The findings may contribute to the development of targeted interventions to improve surgical ergonomics and reduce musculoskeletal strain for SS.

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2. Mavrovounis G, Meling TR, Lafuente J, Fountas KN, Demetriades AK. Tools and Modalities for Postural Ergonomics Research in Surgery and Neurosurgery. Acta Neurochir Suppl. 2023;135:15-20.

# V018

Pilotstudie: KI-gestützte Tiefenanalyse zervikaler Spinalstenosen – Integration von Deep Learning und Radiomics zur Verbesserung der diagnostischen Präzision Pilot Study: AI-Assisted Deep Analysis of Cervical Spinal Stenosis – Integrating Deep Learning and Radiomics to Enhance Diagnostic Precision

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# Objective

The prevalence of degenerative spinal disorders, including cervical spinal stenosis leading to cervical spondylotic myelopathy (CSM), is rapidly increasing in the geriatric population worldwide. Neurosurgeons must adeptly interpret MRI images to correlate complex imaging findings with patient symptoms, a task that is often intricate and nuanced. Here, we present preliminary results from the development of an AI-based algorithm designed to accurately identify cervical stenosis in MRI scans, perform volumetric analysis, and automatically calculate a comprehensive range of metrics to enhance the validation and understanding of the disease.

# Methods

Our system is designed as a multi-step workflow to facilitate rapid end-to-end analysis. First, it automatically identifies the stenosis localization on axial T2 sequences a . Next, it performs automatic spine and vertebrae segmentation. This is followed by the computation of compression metrics, generated using the Spinal Cord Toolbox. Finally, the segmentations and localization data are used to calculate the extension of measures based on radiomics. Aiming to find biomarkers for stenosis quantification we correlated both the morpholic measures of the SCT as well as the radiomics based volumetric measures with the JOA pre OP score using the pearson correlation. Figure 1 presents the work flow.

# Results

Our dataset consists out of 42 subjects on which we trained our models for spinal segmentation and detection. Our nnU-Net based stenosis detection algorithm failed to make predictions in 2/9 test cases. The remaining 7 cases were predicted highly accurately with an absolute mean euclidean distance of  $1.834 \pm 1.209$ . All predictions lie within a 5 mm tolerance. Consequently our model predicted the location of the stenosis correctly in 77.8 % of our test cases. All 5 morphologic measures and 107 radiomics features were compared to JOA preop using pearson correlation. The significance level 0.05 was reduced to 0.00045 in respect to Bonferroni correction. We found a significant correlation (p=0.0001) to one radiomics features.

# Conclusion

This AI-based approach to cervical stenosis detection demonstrates promising accuracy in identifying stenosis and extracting relevant features, with strong potential to enhance clinical decision-making. While the model shows good performance, our future goal is to expand the dataset, improving segmentation quality, and refining the system to achieve broader clinical applicability.

# Abb. 1



# V019

# Intraoperative Diagnostik von spinalen extramedullären Tumoren mittels stimulierter Raman-Histologie und Deep Learning

# Intraoperative rapid spinal extramedullary tumor diagnostics using stimulated Raman histology and deep learning

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#### Objective

Intraoperative tissue diagnosis is crucial for surgical decisions in spinal tumor procedures. While stimulated Raman histology (SRH) provides H&E-like images for fresh tissue analysis using Al<sup>1,2</sup>, current algorithms are optimized for brain tumor classification<sup>2</sup>. This study evaluates the use of existing SRH analyses tools for spinal tumor equivalents and aims to develop a specialized classifier for extramedullary spinal tumors.

# Methods

Study part I: In a monocentric prospective observational study, fresh tissue samples from extramedullary spinal tumors were analyzed using a portable SRH laser imager. SRH images were evaluated using two established AI algorithms, trained on intracranial tumors<sup>1,2</sup>. The tumor detection model classifies images into tumor, non-tumor, and low quality, while the differential diagnosis model predicts histological tumor types. Study part II: In a pilot international multicentric approach we developed a supervised cross-entropy-based spinal tumors, the model classifies into the four most common differential spinal tumors: meningioma, schwannoma, metastasis, and ependymoma. Heatmap overlays were generated for qualitative intraoperative visual feedback.

#### Results

We evaluated 272 SRH images from 96 patients comprising spinal meningiomas, schwannomas, metastases, and ependymomas. While the tumor detection model could identify the tumor tissue on SRH images in all cases, the differential diagnosis model achieved limited 69% accuracy in diagnosing the four classes. In a pilot international multicentric hold-out validation with 30 patients, our novel spinal tumor-specific classifier achieved superior 87% accuracy, correctly identifying all meningiomas (8/8) and neurinomas (6/6), metastases (7/8), and ependymomas (5/8).

# Conclusion

Besides the tumor detection model's strong out-of-domain performance, our novel spinal tumor-specific classifier shows high accuracy in differentiating common extramedullary spinal tumors, outperforming established cranial tumor-trained classifiers. This offers a potential alternative to conventional rapid frozen histopathology, providing effective and reliable intraoperative diagnosis and visual feedback within minutes. Further development and validation are necessary to enhance diagnostic capabilities.

1Reinecke, D., et al., Acta Neuropathol Commun, (2022) 10(1): p. 109

2Hollon, Todd C., et al. Nature medicine 26.1 (2020): 52-58

# RC008

Einführung der robotergestützten Wirbelsäulenchirurgie in einem Zentrum: die ersten 109 Fälle Introduction of robot-assisted spine surgery in a single center: the first 109 cases

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# Objective

The aim of this study is to initation of robot-assisted spine surgery at a single center with use of intraoperative computer tomography (iCT) automatic registration based navigation. Workflow included iCT with automatic registration, fusion with preoperative imaging and review of the preplanned screw trajectories, robotic-assisted insertion of K-wires and insertion of pedicle screws, followed by control iCT scan.

#### Methods

All patients who underwent robot-assisted implantation of pedicle screws using Brainlab"s Cirq<sup>®</sup> surgeoncontrolled robotic arm (BrainLab, Munich, Germany) in the thoracolumbar spine at our Department were included in the study. Pedicle screw accuracy was assessed using Gertzbein-Robbins scale (GRS).

#### Results

108 patients (60 female, mean age  $68.7 \pm 11.4$  years) in 109 surgeries underwent robot-assisted pedicle screw placement. Indications included degenerative spine disease (n=30 patients), spondylodiscitis (n=24), tumor (n=33) and fracture (n=22), with mean follow up of 7.7  $\pm$  9 months. 37 cases (33.9%) were performed in percutaneous and rest in open technique. 33 surgeries were performed in thoracic spine, 44 in lumbar and lumbosacral spine, 29 in thoraco-lumbar, one in cervicothoracic, one in thoracolumbar and one in thoracolumbosacral spine. Insertion of screws was performed under fluoroscopic (first 12 surgeries) or navigated technique (latter surgeries). The mean surgery time was 228.8  $\pm$  106 minutes and mean robotic time was  $31.5 \pm 18.4$  minutes. Mean time per screw for fluoroscopy-assisted screws was  $8.27 \pm 6.54$  minutes and for navigated screws was  $4.6 \pm 1.5$  minutes, the difference which was statistically significant (p<0.05). Robotic time and time per screw improved over time. Out of 688 screws, 592 were GRS A screws (86.1%), 54 B (7.8%), 22 C (3.2%), 12 D (1.7%) and 8 E(1.2%). 7 screws underwent intraoperative revision and following revision all were GRS A. E screws were either revised or removed. In D screws, screws which were at the end of the construct were revised, and so called in-and-out screws in the middle of the construct were not revised. Complications occurred in 29 patients (26.85%), in 12 patients hardware problems.

# Conclusion

Cirq<sup>®</sup> Robotic Alignment module feature enables placement of pedicle screws in thoracolumbar spine with high accuracy. Learning curve is shown through improvement of robotic time and time per screw.

# V020

Inzidenz und Auswirkungen intrakranieller Komplikationen bei Patienten unter Behandlung mit extrakorporaler Membranoxygenierung

Incidence and Impact of Intracranial Complications in Patients Undergoing Extracorporeal Membrane Oxygenation Therapy

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# Objective

Patients undergoing extracorporeal membrane oxygenation (ECMO) therapy are critically ill and may experience intracranial complications. Very little is known about the outcomes of such patients. The aim of this monocentric retrospective study was to investigate the incidence and impact of intracranial complications during ECMO therapy.

# Methods

This study included patients treated with ECMO (veno-venous and veno-arterial) in the anesthesiological ICU of our tertiary care center between January 2013 and December 2023. All patients underwent CT imaging within several hours of ECMO initiation and during the course of therapy if clinical abnormalities arose. Inclusion criteria required the availability of clinical documentation and diagnoses based on specific ICD codes related to intracranial pathologies. Patients were excluded if they underwent procedural transitions between veno-venous and veno-arterial ECMO. For patients with multiple ECMO cycles, only the cycle associated with an intracranial pathology was analyzed. Clinical and imaging data were retrospectively assessed. This study has been approved by the local ethics committee (no. of approval 24-120884-BO).

# Results

Of 775 patients undergoing ECMO therapy, 142 exhibited intracranial pathologies detectable on cranial CT imaging (18%). The cohort had a mean age of 47.9 years ( $\pm$  14.8). 120 of 142 (85%) patients were treated with veno-venous ECMO therapy and 22 of 142 (15%) patients with veno-arterial ECMO therapy. The most common indication for veno-venous ECMO was acute respiratory failure due to pneumonia (N = 96, 68%) and cardiac failure for veno-arterial ECMO. In-hospital mortality was high (N = 108, 7%). Intracranial findings during ECMO therapy frequently included intracerebral hemorrhages (N = 50, 35%), subarachnoid hemorrhages (N = 30, 21%), brain edema (N = 35, 25%), or cerebral ischemia (N = 20, 14%). However, a significant proportion of all patients with intracranial disorders developed additional bleeding, ischemia or edema during the course of therapy (N = 83, 59%). In univariate analysis, the presence of multiple intracranial pathologies (p = 0.009), pupillary abnormalities (p < 0.001), and midline shift (p = 0.005) were significantly associated with in-hospital mortality. Neurosurgical interventions were performed only in a minority of cases (N = 29, 20%).

# Conclusion

Patients undergoing ECMO therapy are at substantial risk of developing intracranial complications, which significantly affect clinical outcomes.

# V021

Postoperatives Monitoring nach elektiven intrakraniellen Eingriffen: Sicherheit, Effizienz und Kosteneffektivität einer PACU.

Postoperative Monitoring after elective intracranial Surgery in a Post-Anesthesia Care Unit is safe, efficient and cost-effective.

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# Objective

This study evaluates whether monitoring patients in the Post-Anesthesia Care Unit (PACU) after elective intracranial surgery is as safe and effective as Intensive Care Unit (ICU) monitoring, focusing on postoperative complications and resource utilization.

# Methods

A retrospective cohort study was conducted at a tertiary academic hospital, analyzing patients who underwent elective craniotomies from March 2013 to September 2023. Patients were allocated to PACU or ICU monitoring based on preoperative risk assessment and intraoperative events. Outcomes measured included complication rates, revision surgeries within 72 hours, transfers from PACU to ICU, and ICU resource utilization.

# Results

5638 consecutive patients (mean age 54 years, 56% female) were analyzed, of which 96.0% were monitored in the PACU, while 3.7% required ICU admission due to high-risk conditions or intraoperative events. The early complication rate in PACU-monitored patients was 17.1%, with most complications occurring within the first 13.2 hours (SD 17.0) post-surgery. Revision surgery was required in 4.6% of cases, and transfers from PACU to ICU occurred in 1.9%. PACU monitoring reduced ICU utilization by 94.4% compared to an all-ICU strategy, with no compromise in safety or outcomes.

# Conclusion

PACU-based monitoring is a safe and efficient alternative to ICU care for elective craniotomy patients, offering comparable complication rates and outcomes. This approach significantly reduces ICU demand, providing a cost-effective strategy that optimizes critical care resources while maintaining patient safety.

# V022

No ICU Unless 2.0 – Optimierung des postoperativen Managements neurochirurgischer Patienten nach elektiver Kraniotomie

NO ICU UNLESS 2.0 - Redefining postoperative management of neurosurgical patients after elective craniotomy

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# Objective

The routine postoperative management of neurosurgical patients in the intensive care unit (ICU) following elective craniotomy remains a topic of ongoing debate. This study aims to identify risk factors associated with unplanned ICU admissions and to compare surgical and outcome parameters between two distinct patient cohorts.

# Methods

Between May 2021 and December 2024, 1,441 elective craniotomies were performed, with 1,162 patients (81%) planned for postoperative management on the general ward following the "No ICU Unless" strategy<sup>1</sup>. Cohort A included patients initially scheduled for the general ward who required unplanned postoperative ICU admission, while Cohort B comprised patients transferred to the general ward as planned. Baseline characteristics, surgical parameters, complications, and outcomes were analyzed using uni- and multivariate logistic regression.

# Results

Cohort A (n = 153, 13%) did not differ significantly from Cohort B patients (n = 1,009, 87%) in baseline characteristics such as sex, pre-existing medical conditions, diagnosis, or lesion location. However, increasing age (OR: 1.01, p = 0.016), intraoperative blood loss (531 mL vs. 230 mL; p < 0.0001), surgical duration (172 vs. 127 minutes; OR: 1.01, p < 0.001), an ASA score > 4 (American Society of Anesthesiologists; OR: 1.66, p = 0.006), and a Karnofsky Performance Scale (KPS) score < 70% (OR: 0.40, p < 0.001) were identified as significant risk factors for unplanned ICU/IMC admission. Postoperative complications were more frequent in Cohort A (44% vs. 24%; p < 0.0001), with hemorrhage, neurological deficits, and respiratory insufficiency as leading causes for unplanned ICU/IMC admission. ICU/IMC stays were significantly longer in Cohort A (4.1 vs. 0.6 days, p < 0.0001).

# Conclusion

This study refines the "No ICU Unless" strategy to focus ICU admissions on patients who definitely require intensive care. In addition to the original criteria (reduced vigilance, ASA > 4, anesthesiologist decision, posterior fossa tumors > 3 cm), factors such as advanced age, significant blood loss, prolonged surgery, and KPS < 70% should guide postoperative planning. These adjustments aim to reduce unnecessary ICU admissions, enhance resource efficiency, and prioritize intensive care for patients with the highest clinical need.

# V023

Die Bedeutung des chirurgischen Zugangsweges für das Auftreten einer venösen Luftembolie in der Halbsitzenden Position

The Role of the Surgical Approach for the Occurrence of Venous Air Ambolism in the Semi-Sitting Position

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# Objective

Neurosurgical procedures in the semi-sitting position are widely used and considered safe in experienced hands. The event of venous air embolism (VAE) is controllable but remains unpredictable in its occurrence. The aim of this study is to analyze specific anatomical and surgical factors related to this phenomenon.

#### Methods

In addition to epidemiological, anesthesiologic and perioperative factors, our main focus was on applied surgical approaches. Access routs were divided into 6 groups (supratentorial, infratentorial-supracerebellar, hemispheric-cerebellar, retrosigmoid, midline or spinal). Grouping was based on the idea of comparable surgical and anatomical conditions during access and intradural dissection, such as venous exposure, risk for venous alteration and cerebrospinal fluid drainage. This largely allowed pooling site (intra- vs. extra-axial) and at the same time a decoupling from the entity. Further, the surgical level in terms of hydrostatic venous pressure gradients could be considered. Transesophageal echocardiography was used as the standard monitoring procedure for VAE in all patients.

# Results

The cohort consisted of 157 patients over a period of 4 years (tumor N=105, vascular N=12, spine N=21, other N=19). VAE occurred in 46 cases (29%), in 14 patients with cardiopulmonary response and mainly during intradural preparation (58%). There was no correlation between operation time (VAE 201±52 min vs. no VAE 195±93 min), surgical approach, location, venous pressure level and VAE event. Although not the primary focus of this study but worth mentioning, we found a significant difference in the occurrence of a VAE and ASA-score in favor of an ASA score  $\leq 2$  (p=0,002; Odds Ratio 3,975).

#### Conclusion

Our results underline the difficulty in the identification of specific risk factors for VAE. Venous pressure gradients, surgical and anatomical peculiarities might be of less importance than functional, cardiovascular and pulmonary factors, which for example are included in the ASA score.

# V025

Gebrechlichkeit ist mit schlechtem neurologischem Outcome bei neurochirurgischen Intensivpatienten assoziiert: eine prospektvive Kohortenstudie. *Frailty predicts neurological outcome in neurointensive care patients: a prospective cohort study* 

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#### Objective

Frailty is increasingly recognized as a critical factor in influencing outcomes in intensive care units (ICU). While chronological age has traditionally been used as a prognostic factor, recent studies suggest that frailty may provide a more accurate assessment of patients" vulnerability and recovery potential. However, data on the predictive value of frailty assessments, particularly in neurocritical care settings, remain limited. The objective of this study is to investigate whether the clinical frailty scale (CFS) is superior to chronological age in predicting neurological outcomes for neurocritical care patients.

#### Methods

In this ongoing prospective single-center cohort study, eighty-seven consecutive patients admitted to the neurosurgical ICU of RWTH Aachen University hospital were included (10/2022-10/2024). Frailty was assessed upon admission using the Clinical Frailty (CSF) score. Demographic data were collected, and neurological outcomes were evaluated using the extended Glasgow Outcome Scale (GOSE) at discharge, three and six months post-admission. Correlation and linear regression analyses were performed. Statistical significance was set at p < .05.

#### Results

In total, eighty-seven patients were included, suffering from traumatic brain injury (n=61) and aneurysmatic subarachnoid hemorrhage (n=26). Median age was 74.5 [1. Q 68, 3. Q 82] years, 47 % of patients were female. Median CFS score was 3 [3,5]. Inhouse mortality was 40% (n=35), mortality after six months was 51% (n=44). Frailty demonstrated a significant association with neurological outcomes across all time points: GOSE at discharge (p = .026), three months (p = .003), and six months (p = .011). In contrast, chronological age was not significantly associated with GOSE at any time point (all p > .107). Notably, the regression models for frailty consistently yielded p-values < .026, indicating robust predictive performance for neurological outcomes.

# Conclusion

Our findings suggest that frailty, as measured by CSF, is a superior predictor of neurological outcomes compared to chronological age in neurocritical care patients. Incorporating frailty assessment into routine clinical evaluation may enhance the prognostic precision and support individualized patient care.

# V026

Heterogenität der Blut-Hirn-Schranke bei menschlichen Hirntumoren: Transkriptomisches Profiling von Endothelzellen primärer und sekundärer Hirntumore im Vergleich zu gesunden Kontrollpersonen Blood-Brain Barrier Heterogeneity in Human Brain Tumors: Transcriptomic Profiling of Endothelial Cells of Primary and Secondary Brain Tumors Compared to Healthy Controls

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#### Objective

While novel systemic treatments have improved overall survival in many brain tumors patients, great variation exists regarding the response to systemic treatment. The blood-brain barrier (BBB), which is the major obstacle for drug delivery and cellular immune responses in the central nervous system, is often neglected, and the transcriptomic phenotypes of the human BM vasculature remain poorly understood.

#### Methods

Public single-cell RNA sequencing (scRNAseq) datasets of human BM, glioblastoma (GBM) and healthy controls (HC) were retrieved. Data processing was performed using the Seurat pipeline. Differentially expressed gene (DEG) analysis was performed on endothelial cells studying transcriptomic differences between tumor samples and HC. Additionally, comparative analyses were performed between GBM and BM, as well as between BM of different primary cancers. The functional significance of DEGs was assessed through gene ontology (GO) term enrichment analysis.

#### Results

A total of 117 scRNA-seq datasets were included in the analysis (29 BM: NSCLC, n=13; melanoma, n=26, 68 glioblastoma, and 10 HC). Endothelial cells comprised only a minority of the total cell population (average proportion of 0.89%, with counts ranging from 1-201, mean=20/sample, Fig.1A-C). Differential gene expression analysis comparing tumor samples to HC revealed numerous significantly (adjusted p-value < 0.05) upregulated (e.g., PLVAP, a known indicator of compromised BBB integrity and trans-endothelial transport processes) or downregulated genes (e.g. ABCB1, a luminal endothelial transporter that plays an important role in the efflux of xenobiotics). Interestingly, notable variations in DEG were observed between GBM and BM, and among BMs from the same primary tumor (Fig.1D). GO analysis suggested a functional link of DEGs to BBB transport processes (Fig.A,C), and immune response signaling.

# Conclusion

In the current study, we analyzed the transcriptome of endothelial cells in human brain tumor samples and uncovered wide transcriptomic variability within and across tumors. This highlights differences in the transcriptomic signature of endothelial cells between BM and GBM, suggesting that radiological contrast enhancement in clinical routine does not reflect an equally compromised BBB at the cellular level. These findings pave the way for more targeted research and clinical strategies to better stratify patients and identify mechanisms of treatment failure and improve patient outcomes.

Abb. 1



# V027

Strukturelle Netzwerkanalyse in Patienten mit IDH mutierten Gliomen Grad 2 und 3 Structural network analysis in patients with IDH-mutant gliomas grade 2 and 3

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#### Objective

Following resection, patients with IDH-mutant gliomas of grade 2 and 3 are managed with watch-and-scan strategies, adjuvant radiotherapy or chemotherapy, or combined radiochemotherapy. While aggressive treatment may improve survival, there is emerging concern about delayed toxicity following CNS-directed radiotherapy which may eventually translate into substantial cognitive deficits. This study aims to assess whether structural networks may serve as objective imaging-based biomarkers for treatment-induced neurodegeneration.

#### Methods

We retrospectively identified 126 patients with newly diagnosed IDH-mutant gliomas of grade 2 and 3, and cohorts were stratified according to the adjuvant first-line treatment (N chemo = 6; radio = 7; radiochemo = 76; watch-and-scan = 47). Anatomic areas were assigned according to the Aparc parcellation atlas and subsequently characterized by quantifying cortical thickness, surface area, volume, gyral curvature and sulcal depth using FreeSurfer (preliminary: n = 32). Structural similarity networks of the unaffected hemisphere were estimated by Morphometric Inverse Divergence (MIND).

# Results

Our proposed workflow focused exclusively on the non-lesioned hemisphere, eliminating confounding effects from the tumor lesion or the morphology of the resection cavity. This enabled reliable quantification of the cortical architecture from standard MR sequences and precise estimation of the cortical connectome. Analysis of post-treatment MRIs revealed increased cortical surface areas in memory and cognition-critical regions, including the parahippocampal gyrus, posterior cingulate cortex, and orbitofrontal cortex (all p < 0.005), in patients undergoing radiotherapy compared to those who did not. These increases may reflect radiation-induced processes such as myelination or gliogenesis, which could contribute to the observed cortical remodeling.

#### Conclusion

Our findings support the use of structural similarity networks as biomarkers for treatment-induced neurodegeneration in glioma patients. If validated in larger datasets, our preliminary findings suggest that surgery alone better maintains the physiological architecture of the healthy hemisphere compared to radiotherapy. It may therefore appear relevant to identify individuals who can be safely managed with resection alone without compromising survival.

# V028

# Tumorvolumenminderung durch PCV-Therapie bei Patientinnen und Patienten mit Oligodendrogliomen Tumor volume decrease through PCV chemotherapy in patients with oligodendroglioma

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# Objective

PCV (procarbazine, CCNU and vincristine) chemotherapy is an integral part of tumor-specific treatment in patients with oligodendroglioma and might be preceded by tumor resection and radiotherapy. PCV chemotherapy has been reported to decrease tumor volume, but to what extent has not been described yet.

# Methods

The institutional database was screened for patients that had been diagnosed with CNS WHO grade 2 or 3 oligodendroglioma, IDH-mutant and 1p/19q co-deleted, between the years 2003 and 2019. Patients either diagnosed by biopsy or with postoperative residual tumor volume and having received PCV chemotherapy were included. Magnetic resonance imaging (MRI) pre- and post-chemotherapy had to be available for volumetric analyses. Tumors were segmented manually, and tumor volume decrease was correlated with patient data.

# Results

Forty-one patients were identified. Median overall tumor decrease after PC(V) was 26% (range 0-92%). In treatment naïve patients, median tumor volume decrease was 35% (range 0-92%). Ten patients (24%) showed a volume decrease of >50%. Comparing patients with a decrease over 50% versus less than 50% showed no differences in age (median, in years: 35 versus 41, p=0.27), sex (p=0.15), initial tumor volume (median, in ml: 65 versus 44, p=0.99), KPS (median: 90, p=0.44), WHO grade (p=0.99), contrast enhancement on MRI (p>0.99) or prior treatment regimens (p=0.26). The median number of completed cycles was higher in patients with a volume decrease >50% (6 versus 5, p=0.04). Progression-free survival was not associated with tumor volume decrease (HR 0.81, 95 CI 0.36-1.92, p=0.62).

# Conclusion

PC(V) chemotherapy is associated with a substantial decrease in tumor volume in most patients with oligodendroglioma. Besides numbers of cycles completed, current demographic and risk factors do not sufficiently predict therapy response on MRI. As one fourth of all patients showed a volume decrease of >50%, evaluation of PCV as a neoadjuvant treatment strategy might be warranted.

# V029

Unreife neuronale Nischen und ECM-Umbau treiben die Epileptogenität in Gangliogliomen voran: Erkenntnisse aus der räumlichen Transkriptomanalyse

Immature Neuronal Niches and ECM Remodeling Drive Epileptogenicity in Gangliogliomas: Insights from Spatial Transcriptomics

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# Objective

Gangliogliomas (GGs) are rare mixed glio-neuronal tumors associated with pharmacoresistant focal epilepsy. Despite favorable seizure outcomes following surgery, the mechanisms underlying GG-associated epilepsy remain unclear. This study investigates whether the neuronal components of GGs are native neurons or neoplastic cells. We used spatial transcriptomics to identify neoplastic neuronal markers and to investigate their role in epileptogenicity.

#### Methods

We analyzed spatial transcriptomic data from 10X Visium GG samples (BRAF-WT, n = 3; BRAF-mut, n = 5) using SPATA2. Cell type deconvolution (cell2location) and Weighted Gene Correlation Network Analysis (WGCNA) were used to characterize the tumor microenvironment.

#### Results

Three key transcriptional features emerged: (i) immature neuronal niches enriched for progenitor-like genes (e.g. *FABP7*, *HOPX*), suggesting disrupted neuronal development and epileptogenicity, (ii) extracellular matrix (ECM) remodeling, influencing tumor morphology and homeostasis, and (iii) distinct cellular niches defined by ECM configurations. WGCNA identified eight transcriptional groups, including astrogliosis and oligodendroglial reactivity including myelination processes (*GFAP*, *S100A1* and *MBP*, *PLP1*). Furthermore, it showed neuron-rich groups enriched for synaptic signaling (p < 0.001, *SNAP25*, *SYP*) and plasticity genes (p < 0.001, *ENC1*, *CHGA*, *CHGB*) and clusters reflecting reactive gliosis (p < 0.001, *THY1*, *PDGFRA*, *SERPINA3*), immune cell infiltration including microglia and macrophages (p < 0.001, *CD63*, *FGF12*, *S100A10*), suggesting interaction between immune and tumor cells.

#### Conclusion

Ganglioglioma is a mixed glioneuronal tumor with a neuronal progenitor-like cell-population and immune cell infiltration. Immature neuronal populations in GG may arise from stem cells, contributing to a malfunctioning neuronal network through inflammatory ECM remodeling, which might enhance their epileptogenic potential.

# V031

# Die homozygote PTEN-Deletion ist ein negativer prognostischer Faktor bei mit TTFields behandelten Glioblastomen, IDH Wildtyp

PTEN Homozygous Deletion is a Negative Prognostic Factor in TTFields-Treated Glioblastoma, IDH Wildtype

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# Objective

Tumor Treating Fields (TTFields) have emerged as an adjunctive treatment modality for patients with newly diagnosed glioblastoma, isocitrate dehydrogenase wildtype (IDH wt). Predictive biomarkers for TTFields efficacy remain unknown. This study used genetic and epigenetic profiling to identify such biomarkers.

#### Methods

A retrospective analysis of 64 patients with molecularly confirmed glioblastoma, IDH wt, treated with surgery, radio-chemotherapy and TTFields was conducted. Clinical data (demographics, KPS, extent of resection, treatment, overall survival) were collected. Tumors underwent next-generation sequencing (Illumina TSO500 DNA/RNA) and DNA methylation profiling (Illumina EPIC arrays). Survival was analyzed using Kaplan-Meier and univariate and multivariate Cox models. Molecular factors present in at least 5 patients, including gene mutations (e.g., PTEN, EGFR, TP53), homozygous deletions (e.g., PTEN, CDKN2A/B), amplifications (e.g. EGFR), along with DNA methylation class, tumor mutational burden, and signaling pathway activation were analyzed for outcome associations. Two TTFields-naïve glioblastoma cohorts served as controls.

#### Results

A total of 25 molecular factors were analyzed for outcome associations. In the TTFields group, univariate analyses identified preoperative KPS and MGMT promoter methylation as protective, while EGFR amplification, CDKN2A/B, and PTEN homozygous deletions were linked to worse survival. Multivariate analysis confirmed KPS and MGMT as protective factors and PTEN homozygous deletion as a significant risk factor for increased mortality (HR: 3.86, 95% CI: 1.51–9.87, p=0.0049). Comparative analysis with TTFields-naïve cohorts showed no link between PTEN homozygous deletion and worse outcomes, with deletion rates comparable across cohorts (TCGA: 7%, Lucas et al.: 7%, our cohort: 11%). Other PTEN alterations, such as mutations or heterozygous deletions, were not associated with worse outcomes in the TTFields group.

#### Conclusion

In this cohort of patients with molecularly confirmed glioblastoma IDH wt, treated with surgery, radiochemotherapy and TTFields, KPS, MGMT, and PTEN homozygous deletion were significantly associated with survival. PTEN deletion status may predict reduced benefit from TTFields, warranting testing before treatment initiation. Abb. 1

#### Figure

Overall Survival in TTFields firstline treated patients with GBM, IDH wt (WHO 21)



Figure: Overall survival (OS) in TTFields first-line-treated patients with molecularly confirmed glioblastoma (GBM), IDH wild-type (WT), stratified by PTEN deletion status.

A: Kaplan-Meier survival curves show significantly shorter survival for patients with homozygous PTEN deletion (median survival: 368 vs. 603 days, p = 0.014). The thicker curve represents patients with homozygous PTEN deletion, while the thinner curve represents those without. B: Univariate Cox proportional hazard (Cox PH) analysis identifies factors with association to survival, including significant factors such as KPS, MGMT methylation,

C: Multivariate Cox analysis confirms independent prognostic significance for KPS, MGMT methylation, and highly significance for PTEN homozygous deletion.

#### Overall Survival in TTFields naive control patients with GBM, IDH wt (WHO 21)



Figure: Kaplan-Meier survival curves showing overall survival (OS) for TTFields-naïve patients with molecularly confirmed glioblastoma (GBM), IDH wild-type (wt), stratified by homozygous PTEN deletion status. The thicker curve represents the survival probability for patients with homozygous PTEN deletion, while the thinner curve Branche of instruction good in the rest of the one of the proteins are don'the producing for patients with one regions in the intercept of the original of the origet of the original of the original of the original of the orig

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# SFNC-01

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Evaluation of Bilateral VIM Radiosurgery in patients with a severe Essential Tremor: A prospective trial.

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# Objective

Safety efficacy of unilateral VIM Gamma Knife Radiosurgery (VIM GK) has been well demonstrated for Essential tremor. The safety-efficacy of bilateral VIMGK has never been assessed strictly. We conducted a prospective and objective assessed of the changes in cognitive functions (primary criteria), speech, balance in addition to the evaluation of the impact activities of daily living.

#### Methods

Between 03/06/2014 & 09/11/2021 have been treated contralaterally by GKS 33 patients presenting with a severe drug-resistant essential tremor previously treated by VIM GK on the dominant side at least 12 months before (monocentric, prospective, non comparative N° EUDRACT : 2013-A01289-36). After frame application stereotactic MR and CTscan imaging a single isocenter of 4mm was positioned at the location of the VIM according to Guiot and adjustment of the target based on a preoperative DTi according to our usual standard technic. Quantitative assessment before, at 6 & 12 months was including neuropsychological testing (MMS, apathy Starkstein scale, Stroop, verbal fluences, similitudes), evaluation of the voice, writing, walk gait (Kinematic gait analysis was performed with the SMART TV image processing system, eMOtion), posture (AMTI force platform), tremor severity (Fahn-Tolosa-Marin rating scale) ADL (Bain Scale) and MRI (volume of T1 contrast enhancement and edema score).). The assessment was perform independently from the neurosurgical team. The results were followed and reviewed by an international independent surveillance committee (MH and PK). Patients acted as their own controls

#### Results

All the 33 patients have completed the study after the one year follow up (19 male 14 female, 32 right VIM and 1 left). Only one adverse event (expected) was observed (hemi-proprioceptive ataxia & dysarthria due to hyperresponse 11 months after VIM GK). The mean age was 71 (55-83). The mean delay between the first and the second GK was 28,7 months. The primary outcome criteria of tolerance on the cognitive functions was altered in none of the patients. The evaluation of speech walk gait and posture (secondary outcome criterion) have shown no worsening. In term of efficacy at 1 year the severity score was improved of 58,5%, the disability score of 84,8% and the functional impact score of 68,6%. Only 4 patients failed to respond but for the 29 remaining the mean improvement was of 74,4% improvement of the tremor on the treated upper limb. No side effect related to the bilaterality of the VIM GKS was found in spite of the independent meticulous prospective assessment.

# Conclusion

This is the first prospective trial assessing the safety efficacy of bilateral VIM GK. This trial is demonstrating the excellent safety efficacy of VIM GK of the contralateral side in a subgroup of selected candidates previously treated by VIM GK at least 1 year before with a good response of the first side operated.

# V032

DTI-basierte MRgFUS-Thalamotomie in Patienten mit essentiellem Tremor: Ersterfahrungen eines Deutschen high-Volume DBS-Zentrums.

DTI-based MRgFUS-thalamotomy in patients with essential tremor: first impressions of a German high-volume DBS center.

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# Objective

Magnetic resonance guided focused ultrasound (MRgFUS) thalamotomy is a relatively novel, incisionless technique to treat essential tremor (ET). The use of DTI-based targeting is associated with a significant reduction in post procedural ataxia related complications as compared to traditional targeting techniques. The objective of this study is to present the early monocentric prospective results of DTI-based MRgFUS thalamotomy performed in a high-volume DBS center in Germany.

# Methods

Patients underwent tremor evaluation and neuroimaging study at baseline and up to 3 months after treatment. Tremor severity and functional impairment were assessed at baseline and then at 1 week and 3 months after treatment. Using DTI imaging, preoperative tractography of the undecussated dentato-rubro-thalamic tract (DRT) was performed via manual segmentation using the Brainlab Elements planning software. Specifically, the ventral intermediate nucleus (VIM) was explicitly not selected as a seeding ROI. The lesion coordinates were then chosen so that the DRT fibers passing the VIM were targeted.

# Results

the first eight consecutive patients of our monocentric series were included in this study. A significant reduction in tremor scores was observed in all patients. The prevalence of ataxia after thalamotomy was lower than that reported in the literature and decreased at 3 months follow-up. Manually segmented, undecussated DRT fibers of the caudal aspect of the VIM were targeted in all patients. Lesion overlap with the DRT fibers was confirmed in all patients on post-thalamotomy MRI.

# Conclusion

We offer early monocentric insights into the application and feasability of DTI-based MRgFUS-thalamotomy in patients with essential tremor by presenting prospective data of the first consecutive MRgFUS cases performed in our high-volume DBS center. Routine experience in DTI-based VIM targeting is essential for maximizing the therapeutic effect of thalamotomy while minimizing adverse effects such as persistent ataxia.



# SFNC-02

# Gait and balance after bilateral DBS or Radiosurgery in essential tremor.

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# Objective

Patients suffering of severe essential tremor (ET) are frequently experiencing gait and balance problems compared to healthy controls. Bilateral VIM neurosurgical therapies are known to carry a risk of gait and balance worsening in patients presenting with ET. This risk clearly identified in old radiofrequency ablation series is not clearly evaluated in bilateral Radiosurgery (SRS) or deep brain stimulation (DBS).

# Methods

In Marseille Functional Neurosurgery department gait and balance have been prospectively evaluated in all the patients operated bilaterally for essential tremor. The assessment was performed relying on multiparametric automated optoelectronic walk analyses before & 12, 17 and 48 months after. Were evaluated 19 patients with bilateral DBS in on and off condition and 28 patients with bilateral SRS.

#### Results

The tremor score after DBS and SRS was decreased respectively of 56 & 72%. The improvement of the quality of life score was respectively of 77% and 83%. After DBS we observed a trend for recurrence with a tremor reduction of 56% and 50% respectively at 1 and 4 years after DBS. On the short term (1 year) we observed no gait & balance worsening both after DBS and SRS. However, in patients stimulated (DBS) more than 4 years we observed a significant decline in gait and balance features both in off and on condition and two patients (10,5%) experience falls after 4 years. Out of a patient with hyperresponse (3,6%) bilateral SRS induced no Gait and balance worsening.

# Conclusion

Both DBS and SRS are sparing gait and balance performances in ET patients at 1 year. On the long run DBS patients are experiencing gait and balance worsening. Large patient cohort followed on the long run are still required for confirmation of these results.

# V033

# Individuelle Konnektivität des stimulierten Areals abgeleitet aus der SPECTRE-Bildgebung kann die Entwicklung nicht-motorischer Symptome nach STN-DBS bei Parkinson-Patienten vorhersagen Individual Connectivity of the volume of activated tissue derived by SPECTRE imaging can predict non-motor outcome after STN-DBS in Parkinson's disease

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# Objective

We previously demonstrated that reduction of levodopa equivalent dose after deep brain stimulation of the subthalamic nucleus (STN) can be associated with individual structural motor connectivity analyzed by Subject sPEcific brain Connectivity display in the Target REgion (SPECTRE, Reisert et al. 2021). Here, we investigated whether non-motor improvement can also be associated with individual connectivity.

# Methods

Patients with Parkinson''s disease, who had given informed consent to our DBS Registry were selected for this analysis, if the following was available: preoperative and 12 months postoperative follow up of Non-Motor Symptom Scale (NMSS), preoperative 3T MRI including dMRI, postoperative CCT, bilateral volumes of activated tissue (VAT, simulated with Brainlab Guide XT) reconstructed from stimulation parameters at follow-up. NMSS change was calculated by subtracting preoperative from postoperative values.

For generation of individual SPECTRE maps, limbic/associative/sensori-motor (green/blue/red) cortical schemes defined in standard space were warped to subject space and in a tract weighting approach 500 probabilistic streamlines per voxel were seeded in the VATs to compute their cortical associations (Fig. 1A). The red/sensorimotor and green/reward associated and in part limbic connectivities of both VATs (left/right) were used to predict changes in NMSS scores in two separate multiple linear regression analyses correcting for the covariates disease duration, age and reduction of levodopa equivalent dose.

# Results

33 patients from our DBS-Registry fulfilled the criteria and were included in the analysis. The regression analysis showed a significant model (F(4,28) = 2.757, p < 0.05,  $R^2$  = 0.28) where individual red (sensori-motor) connectivity of the VATs was positively associated with increasing non-motor symptoms (t = 2.19, p < 0.05, Fig. 1B). The second regression analysis yielded a model at trend level (F(4,28) = 2.423, p = 0.07,  $R^2$  = 0.26) with green/limbic connectivity being associated with reduced non-motor symptoms at trend-level (t = 1.92, p = 0.07, Fig. 1C)

# Conclusion

SPECTRE imaging can predict non-motor symptom change after STN-DBS on the single subject level and has the potential to improve image-based DBS programming and targeting for DBS implantation.

# References:

Reisert M et al. Hum. Brain Mapp. 42,2309–2321(2021)

#### Abb. 1



(A) Bilateral volumes of activated tissue (VAT) addressing the STN in an exemplary patient superimposed on color-coded (see inlay) SPECTRE map of individual midbrain connectivity to the cortex. At follow up nearest to 12 months after surgery we find significant associations between VAT's increased "red" connectivity and NMSS deterioration (B) and a trend towards increased "green" connectivity and NMSS improvement (C). Each dot represents a single patient. Positive values for NMSS change denote deterioration. Associations are corrected for disease duration, reduction of levodopa equivalent dose and patient's age. \* p < 0.05, \*\* p = 0.07



# V034

Im Zweifel lieber Rot - Die Reduktion der Levodopa-Äquivalenzdosis ein Jahr nach STN-THS bei Parkinson-Krankheit kann mit der individuellen Konnektivität am Stimulationsort vorhergesagt werden When in doubt, wear red - Prediction of Levodopa equivalent dose reduction 12 months after STN-DBS for Parkinson's disease based on individual MR connectivity of the volume of activated tissue

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# Objective

To investigate if and how motor improvement 12 months after deep brain stimulation (DBS) in the subthalamic nucleus (STN) and reduction of levodopa equivalent dose (LED) are associated with individual structural connectivity analyzed by Subject sPEcific brain Connectivity display in the Target REgion (SPECTRE) (i).

#### Methods

Patients with Parkinson's disease who had given informed consent to our DBS registry were selected for this analysis, whenever the following data were available: preoperative and 12 months postoperative follow up LED, preoperative 3T MRI including diffusion-weighted MRI, postoperative cCT and stimulation parameters at 12 months follow up ( $FU_{12}$ ).

MDS-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) III was conducted in the Medication OFF state preoperatively, and Med OFF Stimulation ON state at FU<sub>12</sub>.

Reduction of LED was calculated as the ratio of follow up values divided by preOP values and motor improvement as the difference of  $FU_{12}$  and preOP values of MDS-UPDRS III.

For generation of individual SPECTRE maps limbic/associative/sensorimotor (green/blue/red), cortical schemes defined in MNI space were warped to subject space (cf. i) and in a tract weighting approach 500 probabilistic streamlines per voxel were seeded in the volumes of activated tissue (VATs) to compute their cortical associations (Fig.1).

The relation between individual connectivity patterns, represented by the color proportion of the voxels and motor improvement 12 months after STN-DBS was estimated by calculating linear regressions correcting for age and disease duration as covariates.

#### Results

43 patients from our DBS registry fulfilled the criteria and were included in the analysis. MDS-UPDRS III values were available in 36 patients. Regression analyses found a significant positive association for red/sensorimotor connectivity (t=2.51, p=.02) and a trend for a negative association for green/limbic connectivity (t=-1.96, p=.06) predicting LED reduction (Fig.1), but no significant results in models for motor improvement itself.

# Conclusion

Individual connectivity derived by SPECTRE imaging can predict LED reduction after STN-DBS and may therefore be helpful for the definition of the optimal DBS electrode position, its implantation and DBS programming. The missing association with motor improvements may be due to MDS-UPDRS III reflecting motor performance in specific situations while LED reduction signals long-term motor functioning.

#### Abb. 1



(A) Bilateral volumes of activated tissue (VAT) addressing the STN in an exemplary patient superimposed on color-coded (see inlay) SPECTRE map of individual midbrain connectivity to the cortex. At follow up nearest to 12 months after surgery we find a significant association between VAT's "red" connectivity and LED reduction (B) and a negative association on trend level for "green" connectivity and LED reduction (C). Each dot represents a single patient. Positive values for LED reduction denote improvement (more reduction). Associations are corrected for age at surgery and disease duration.



# V035

Real-Time Monitoring der Beta-Frquenz-Aktivität bei Parkinson Patienten nach STN-THS: Einblicke in den Setzeffekt und personalisierte Therapieoptimisierung Real-Time Monitoring of Beta Frequency LFP Activity in Parkinson's Disease Patients Following STN-DBS: Insights into the Microlesion Effect and Personalized Treatment Optimization

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# Objective

Parkinson"s disease (PD) is a progressive neurodegenerative disorder characterized by motor symptoms such as rigidity and bradykinesia. Deep brain stimulation (DBS) is a widely used treatment for PD, targeting the subthalamic nucleus (STN) to alleviate symptoms. Recent advances in brain sensing technology have enabled continuous monitoring of local field potentials (LFPs) during DBS, providing new opportunities to explore the underlying electrophysiological changes associated with symptom relief, particularly the microlesion effect (MLE) that occurs in the immediate postoperative period. This study aimed to examine the relationship between beta frequency LFP activity and the MLE in PD patients following bilateral STN-DBS. The goal was to investigate how LFP patterns correlate with symptom relief and to better understand the dynamics of MLE, with a focus on the potential of LFP monitoring to optimize DBS settings and patient outcomes.

# Methods

Eleven advanced PD patients underwent bilateral STN-DBS. LFP data were continuously recorded over a period of up to 30 days post-surgery, and the power of beta frequency oscillations was assessed every 10 minutes. The median power of the last three recorded days for each hemisphere was defined as 100%, allowing for normalization of data. Statistical analysis was performed to identify differences in LFP power before and after the onset of the MLE.

# Results

The analysis of data of eleven patients with PD following DBS-implantation revealed the detection of electrophysiologic MLE through evaluation of beta frequency LFP activity. Significant interpatient and even interhemispheric variability was observed, with a statistically significant reduction in LFP (p<0.001), that did not consistently correlate with the duration relief of PD-symptoms. After initiating the DBS-stimulation, patients showed an average improvement of 33.3 % (7 points fo UPDRS), along with LED-reduction of 36.5 % (379 mg).

# Conclusion

Continuous LFP monitoring offers unique insights into individual DBS responses in PD patients. Our findings suggest that beta-frequency LFP patterns reveal electrophysiological changes beyond symptom relief, highlighting the need for personalized, adaptive DBS strategies. Real-time LFP data could help optimize DBS settings and timing, improving outcomes and minimizing complications post-surgery. Further research is needed to explore the neurophysiological mechanisms of these findings and to extent LFP monitoring to other DBS-treated movement disorders.

# V036

Kann das intraoperative Ansprechen auf die Teststimulation den langfristig wirksamsten Stimulationsort vorhersagen?

Could the intra-operative stimulation response help to predict the most efficient long-term stimulation site?

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# Objective

Deep brain stimulation is a well-established treatment for Parkinson"s Disease. Awake DBS with intraoperative assessment of symptom control and side effect thresholds is highly useful for the decision of the final lead placement. Here we focus on the comparison of the best lead contacts at intraoperative and at one year follow up testing and related VTA-models.

# Methods

Intra-operative test results and one year test outcome were analyzed in 46 patients (15 female) implanted bilaterally, with 92 STN leads. The best intraoperative contact was defined by the combination of the lowest stimulation amplitude with the maximum therapeutic effect. The intraoperative stimulation location was identified by Guide XT software on image fusion of the individual MRI and postoperative CT scans and used for calculation of the volume of tissue activated (VTA). The same procedure was repeated for the stimulation settings used one year after implantation.

# Results

For the identified stimulation sites, 92 intraoperative and 92 postoperative, 184 VTAs were calculated. The average AC-PC coordinates for the best intraoperative contact were 12.4/2.9/3.1mm (lat./post./inf.) and 12.7/2.2/2mm for the one year follow up. The vector distance between the best intraoperative contact and the chronically used contact was 2.4 + -1.6mm (range 0.2 - 7.7mm).

# Conclusion

Our findings show a significant location difference between the best contact at intraoperative stimulation and the best active contact at one year follow up. At surgery more caudal stimulations sites were identified as best, most likely based on intraoperative rigidity testing. However, long-term the full scope of mobility improvement by STN-DBS is rather achieved by slightly more cranial/ superior lead contacts. In so far, intraoperative test results should be used to decide on a definite lead placement with one directional pole 1-2mm superior to the best intraoperative spot.

# V037

Die Augen sagen alles! - Die motorische Verbesserung und Impulsivität nach STN-THS bei Parkinson-Syndrom kann anhand der Aktivität von periokulären Gesichtsmuskeln bestimmt werden The eyes say it all! - Motor improvement and impulsivity after STN-DBS in Parkinson's disease can be determined by activity of periocular facial muscles

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# Objective

We observed changes in lid fissure width related to motor improvement and impulsivity in patients after deep brain stimulation (DBS) in the subthalamic nucleus (STN) for Parkinson's disease in clinical practice. Here we aim to analyze whether this phenomenon can be corroborated by analyzing the activity of Action Units (AU) of the face.

#### Methods

12 patients who received STN-DBS at our department and gave their informed consent were included. Each patient was examined at least twice in the timespan of a few days prior to surgery, to a year after surgery. Participants were filmed during an emotional imagination task with randomized topics of positive, neutral and negative valence (10 of each) in medication OFF state and at follow-ups  $\geq$  3 months postoperatively in stimulation ON, medication OFF state. The activity of facial AUs as defined by Ekman et al. (2002) was extracted with the FaceReader 9 software (Noldus Information Technology Wageningen, The Netherlands) bv., (Fig. 1). We analyzed how activity of AUs surrounding the eyes correlated with simultaneously collected scores for the motor part of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS III), Self-Report Manic Inventory (SRMI) and the Barratt Impulsiveness Scale (BIS-11).

#### Results

We found a significant correlation (p = 0.002) between the alleviation of motor symptoms (i.e. reduced UPDRS III scores) and the activity of the upper lid raiser muscle (Fig. 2A). Furthermore, we found significant associations of the SRMI score with the activity of the inner brow raiser muscle (p = 0.025) and the BIS-11 attentional subscore with the brow lowerer muscle (p = 0.0002) (Fig. 2B+C).

# Conclusion

We found that specifically the activity of AUs surrounding the eyes were indicative of motor status and measures of impulsivity and might therefore serve as suitable markers that could be analyzed during intraoperative test stimulation and DBS programming.

**References**: Ekman P. and W. V. Friesen (1978). Facial Action Coding System: A Technique for the Measurement of Facial Movement. Consulting Psychologists Press, Palo Alto.




Figure 1: Exemplary Screenshot of FaceReader Analysis Screen (depicting the author)





Each point corresponds with one examination. Examinations of the same patient are color-coded.

Abbreviations: UPDRS III = MDS - Unified Parkinson's disease Rating Scale part III; BIS-11 attentional = Barratt Impulsiveness Scale, attentional subscale, SRMI = Self-Report Manic Iventory



### Funktionelle Neurochirurgie 1 | Functional neurosurgery 1

### SFNC-03

#### Dynamic functional changes upon thalamotomy in essential tremor depend on baseline brain morphometry.

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#### Objective

Patients with drug-resistant essential tremor (ET) may undergo Gamma Knife stereotactic radiosurgical thalamotomy (SRS-T), where the ventro-intermediate nucleus of the thalamus (Vim) is lesioned by focused beams of gamma radiations to induce clinical improvement.

#### Methods

Here, we studied SRS-T impacts on left Vim dynamic functional connectivity (dFC, n = 23 ET patients scanned before and 1 year after intervention), and on surface-based morphometric brain features (n = 34 patients, including those from dFC analysis). In matched healthy controls (HCs), three dFC states were extracted from resting-state functional MRI data.

#### Results

In ET patients, state 1 spatial stability increased upon SRS-T (F1,22 = 19.13, p = 0.004). More frequent expression of state 3 over state 1 before SRS-T correlated with greater clinical recovery in a way that depended on the MR signature volume (t6 = 4.6, p = 0.004). Lower pre-intervention spatial variability in state 3 expression also did (t6 = -4.24, p = 0.005) and interacted with the presence of familial ET so that these patients improved less (t6 = 4.14, p = 0.006). ET morphometric profiles showed significantly lower similarity to HCs in 13 regions upon SRS-T ( $z \le -3.66$ , p  $\le 0.022$ ), and a joint analysis revealed that before thalamotomy, morphometric similarity and states 2/3 mean spatial similarity to HCs were anticorrelated, a relationship that disappeared upon SRS-T ( $z \ge 4.39$ , p  $\le 0.001$ ).

#### Conclusion

Our results show that left Vim functional dynamics directly relates to upper limb tremor lowering upon intervention, while morphometry instead has a supporting role in reshaping such dynamics.

### Funktionelle Neurochirurgie 1 | Functional neurosurgery 1

### RC010

Bestimmung der Schwellenwerte für motorische Nebenwirkungen und nutzbare Stimulationskontakte mittels gerichteter motorischer evozierter Potenziale (MEP) während der subthalamischen Tiefen Hirnstimulation bei der Parkinson-Krankheit

Determination of motor side effects thresholds and usable stimulation contacts using directional motor evoked potentials (MEPs) during subthalamic deep brain stimulation surgery (DBS) in Parkinson''s disease

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#### Objective

Segmented DBS leads, which can steer current toward one of three individual electrode segments, offer the potential to expand the therapeutic window by directing stimulation away from non-target structures, particularly the corticospinal tract (CST). However, it remains uncertain whether MEPs can be used intraoperatively to quantify CST activation thresholds and identify optimal contacts/segments. This study presents evaluation of feasibility of directional MEP measurements under general anesthesia to determine CST thresholds and most suitable segmented contacts of directional DBS leads.

#### Methods

During DBS surgery implantation under general anesthesia, after the placement of definitive leads, MEP stimulation was conducted using 4 square pulses with duration of 200µs and interval of 2ms on each contact (ring and segmented) of the directional lead. Stimulus intensity was gradually increased in range of 1 to 5 mA in 1mA steps until the CST activation threshold on contralateral muscles was recorded. For each contact/segment, threshold values, and the initially activated muscle were documented.

#### Results

A total of 40 hemispheres were included, yielding 320 MEP recordings from individual contacts/segments. Segmented contacts showed threshold ranges of 2 to 5mA, lateralodorsal oriented contacts showed 1-2mA lower thresholds compared to anterior or mediodorsal contacts, as expected based on CST localization, indicating distinct CST activation profiles for different segments. M. mentalis and M. abductor pollicis brevis were the first activated muscles in 45% of cases.

#### Conclusion

MEP-based threshold determination from segmented DBS leads under general anesthesia is feasible. Identifying segments with the highest CST thresholds may aid in orienting the lead and optimizing stimulation parameters, thereby potentially enhancing the therapeutic window and reducing off-target effects.

### V042

Prävalenz und Merkmale von diskogenen Mikrospornen bei Patienten mit Spontaner Intrakranieller Hypotension im Vergleich zur Allgemeinbevölkerung

Prevalence and characteristics of microspurs in patients with spontaneous intracranial hypotension compared to the general population

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#### Objective

In patients diagnosed with spontaneous intracranial hypotension (SIH), microspurs are considered the culprit lesion in most ventral dural leaks (type I). The imaging characteristics of discogenic spurs, and their prevalence in the general population has not been reported in the literature.

#### Methods

This observational case-control study was conducted comparing the prevalence and characteristics of discogenic microspurs between SIH patients with a type I leak treated at a tertiary hospital between 2013 and 2023 and an age- and sex matched cohort of trauma patients.

#### Results

Each group consisted of 85 patients (mean age 51.6 years  $\pm$  11.9 years), 74% (58/85 patients) were female. The prevalence of discogenic microspurs in the control group and SIH group was 31.8% and 90.6%, respectively.

The mean length of the culprit microspur responsible for a dural leak was larger compared to the mean length of all co-incidental microspurs from both the SIH and the control group not causing a dural leak (2.6mm versus 1.6mm, p<0.001).

Our multivariate logistic regression revealed that an increasing length of a microspur (OR 1.942, CI 1.35-2.80, p<0.001) and a narrower diameter of the spinal canal (OR 0.85, CI 0.76-0.96, p=0.008) were predictive for a dural tear.

#### Conclusion

A discogenic microspur is a common incidental finding and may be found in almost one third of the general population. The length of the culprit microspur and the diameter of the spinal canal are distinct morphological characteristics for type I associated CSF leaks.







### V038

# Der Stellenwert anteriorer Stabilisierungsverfahren bei instabilen thorakolumbalen Wirbelsäulenmetastasen Utility of Anterior Stabilization in Unstable Thoracolumbar Spinal Metastases

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#### Objective

Spinal metastases resulting in progressive vertebral body destruction and spinal instability present a severe complication of malignant diseases, frequently requiring surgical intervention in a predominantly palliative context. While both dorsal and dorsoventral procedures are viable options, the biomechanical advantages associated with dorsoventral constructs must be carefully balanced against the less invasive nature of dorsal long-construct procedures.

#### Methods

In this single-center retrospective analysis we included all surgically treated patients with thoracolumbar metastases and Spinal Instability Neoplastic Score (SINS) values of 7-18 from 2012 to 2022. Patients were dichotomized into a dorsal and dorsoventral group and compared for perioperative and implant-related complications during follow-up.

#### Results

Long-segment dorsal instrumentation was performed in 140 (64.2%) cases, compared to 78 (35.8%) dorsoventral procedures. No significant differences were noted in terms of age, gender, Karnofsky Performance Status, degree of epidural spinal cord compression, overall SINS or individual SINS components (e.g., de novo deformity was present in 37.9% of dorsal-only and 42.1% of dorsoventral cases). No significant differences were observed for thromboembolic events (p=0.102), wound-related complications (p=0.566), or non-wound infections (p=0.254). Cardiovascular complications were more frequent in dorsoventral (21.8%) than dorsal procedures (9.3%; p=0.010). Implant-related complications were more frequent in the dorsoventral (10.3%) than the dorsal (3.6%; p=0.046) group and revision surgeries were more frequent after dorsoventral (16.7%) than dorsal procedures (2.9%; p<.001). No unplanned secondary corpectomies were required after dorsal instrumentation during a 9-month follow-up period.

#### Conclusion

In this cohort of patients with unstable thoracolumbar metastatic disease, a higher incidence of complications was observed following dorsoventral procedures, while no unplanned secondary corpectomies following dorsal instrumentation were required. Accordingly, dorsal instrumentation may be non-inferior to dorsoventral approaches in terms of restoring spinal stability, offering potential advantages in terms of reduced complication rates.

### V039

# Molekulare Eigenschaften von spinalen pilozytischen Astrozytomen: Eine multizentrische Analyse bei Erwachsenen

#### Distinct Molecular Signatures of Spinal Pilocytic Astrocytomas: A Multicenter Analysis in Adults

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#### Objective

Adult spinal pilocytic astrocytomas (sPA) pose a challenge to clinicians primarily due to their rarity and limited understanding of their clinical progression and biology. Utilizing epigenetic methodologies and a large database of diffusely infiltrative intramedullary spinal cord gliomas (IMSCG), this study seeks to comprehensively characterize the clinical and molecular aspects of adult intramedullary pilocytic astrocytomas.

#### Methods

This study involves a retrospective analysis of patients who underwent surgery for diffusely infiltrating IMSCG at three university medical centers in Germany. Clinical data were retrieved from digital case records. To identify distinct molecular patterns and provide a diagnosis, we employed the 850K DNA methylation array, with subsequent classification using the Heidelberg classifier. T-distributed stochastic neighbor embedding (t-SNE) was used to identify clustering patterns. The study was approved by the ethics committee (PV4904).

#### Results

Forty-six patients (n=46) were included in the analysis of IMSCG. Among them, 21 tumors were histologically identified as pilocytic astrocytomas (PA). Sixteen of these tumors (n=16) closely matched the molecular characteristics of PA. The average age at the time of surgery for the PA patients was 26.6  $\pm$  16.4 years. Near gross total tumor debulking was achieved in 44% of sPA cases, while 22% of patients underwent biopsy, and the remaining 33% had subtotal resections, all without major complications. Postoperatively, 33% of sPA patients experienced a decline in McCormick scores, and only one patient required gait assistance. The methylation array identified a molecular match with a score of >0.7 in 25% of the sPA patients using the 11.4 classifier and in 44% of cases using the latest 12.8 classifier. Interestingly, in the t-SNE plot, the 16 sPA formed a distinct cluster adjacent to other PA without clear overlap with existing tumor sample clusters.

#### Conclusion

IMSCG present challenges in diagnosis when relying solely on their histological characteristics. Especially for sPA, a combined approach of using both epigenetic and histological analysis is recommended for accurate diagnosis. These sPA tumors may possess distinct epigenetic features that set them apart from their cerebral counterparts.

### RC011

Keimspektrum und Behandlungsergebnisse bei pyogener Spondylodiszitis in einem Zentrum mit bekannter regionaler Häufung multiresistenter Erreger: Bestehen Unterschiede im Vergleich zu einer deutschlandweiten Kontrollgruppe?

Pathogen patterns and treatment outcomes in pyogenic spondylodiscitis in a high-prevalence area for multi-drug resistance: Is there a difference compared to a nationwide German control group?

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#### Objective

Pyogenic spondylodiscitis is a rare but serious condition, and understanding its national characteristics is crucial for optimizing treatment strategies. However, it remains unclear whether national data can be accurately applied to individual centers, especially given regional differences in pathogen spectra.

#### Methods

This retrospective study analyzed data from 2003-2023, focusing on the incidence, pathogen and resistance patterns, and treatment outcomes of conservatively and/or surgically treated spondylodiscitis at a regional university center with a catchment area of ca. 177000 inhabitants and a known high prevalence of multidrug-resistant pathogens. These findings were compared to a nationwide study conducted in Germany in 2020 (reference group).

#### Results

The study included 757 patients diagnosed with spondylodiscitis (61% male; mean age: 65years; mean BMI: 28). The lumbar spine was the most common infection site (45%). Isolated infections occurred in 42%, while 54% were associated with paravertebral and/or epidural abscesses. Surgical intervention was performed in 56% of cases, with 38% requiring reoperations due to instability, spinal stenosis, progressing infection or secondary abscess formation, or superficial wound complications. Pathogens were identified in 75% of cases. Staphylococcus aureus was significantly (p=0.001) more frequent in our regional center (41%, including 6% MRSA) compared to the nationwide reference group (19%). Conversely, other Staphylococci species were significantly (p=0.001) less common in our center (14%vs.27%). Gram-negative bacteria (e.g., E. coli and Enterobacter species) were significantly (p=0.001) more prevalent nationally (22%) than in our regional center (11%). Streptococcal and Enterococcal infections showed similar patterns between our local center and the nationwide reference sample. Overall, multidrug-resistant pathogens were significantly more prevalent in our regional center than in the nationwide sample (17%vs.13%, p=0.002). The mean duration of antimicrobial therapy was 82days (38days of i.v. and 54days of oral therapy). The mean length of in-patient stay was 34days, with an in-hospital mortality rate of 10% in our regional center, which was slightly higher compared to the nationwide reference sample (23days, 7%).

#### Conclusion

The comparison highlights significant regional differences in pathogen prevalence in spondylodiscitis, especially with regard to the rate of multi-drug resistant pathogens.

### V041

Die Relevanz von MRT-Befunden in der Vorhersage des prä- und postoperativen neurologischen Status bei spinalen duralen arteriovenösen Fisteln: 22 Jahre Erfahrung in einem neurovaskulären und Wirbelsäulenzentrum The Impact of Magnetic Resonance Imaging Findings in Predicting Neurological Status Pre- and Post-Treatment of Spinal Dural Arteriovenous Fistulas: A 22-Year Experience in a Neurovascular and Spine Center

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#### Objective

Successful treatment of spinal dural arteriovenous fistulas (SDAVF) requires prompt diagnosis with definitive fistula localization and non-delayed treatment. Magnetic resonance imaging (MRI) is used for the screening and follow-up of SDAVF, although the value of MRI signs such as myelopathy and flow voids is controversial. Therefore, we investigated the predictive value of MRI signs pre- and post-treatment and their correlation with the neurological status of SDAVF patients.

#### Methods

We retrospectively analyzed the clinical records of 81 patients who underwent surgical or endovascular treatment for SDAVF at our hospital between 2002 and 2023. A total of 41 SDAVF patients with follow-up MRI of 4.6 [2.9-6.5] months (median [interquartile range]) post-treatment and clinical follow-up of 3, 6, and 12 months were included.

#### Results

The extent of pretreatment myelopathy was seven [6-8] vertebral levels, with follow-up MRI showing no myelopathy in 70.7% of cases. The pretreatment flow voids extended over seven [4.5-10] vertebral levels and completely disappeared on follow-up MRI in 100% of cases. The modified Aminoff-Logue scale of disability (mALS) was four [2-7] pretreatment and two [0-4.5] at the third follow-up, with improvement in 65.9% of patients. The American Spinal Injury Association motor score (ASIA-MS) was 97 [88-100] pretreatment and 100 [95-100] at the third follow-up assessment, with 78% of patients improving. Pretreatment ASIA-MS correlated with the extent of myelopathy at admission (R2: 0.179; 95% CI: -0.185, -0.033; p = 0.006) but not with flow voids at admission, while pretreatment mALS showed no correlation with either MRI signs. The improvement in ASIA-MS and mALS between admission and the last follow-up showed no correlation with the extent of pretreatment myelopathy and flow voids or with pos-treatment MRI changes. The diagnostic sensitivity of magnetic resonance angiography (MRA) for localization of the fistula was 68.3% (28/41).

#### Conclusion

The severity of the clinical condition in SDAVF patients has a multifactorial cause, whereby the ASIA-MS correlates with the extent of myelopathy pretreatment. MRI changes after treatment showed no correlation with the clinical outcome and cannot be used as a prognostic factor.





### Wirbelsäule 2 | Spine 2

### V043

Einfluss unterschiedlicher Behandlungsmethoden auf das sagittale Profil und das klinische Outcome von Patienten mit osteoporotischen Frakturen der Wirbelsäule am thorakolumbalen Übergang Influence of different treatment methods on the sagittal profile and clinical outcome of patients with osteoporotic fractures of the spine at the thoracolumbar junction

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#### Objective

Osteoporotic vertebral compression fractures (OVCF) usually show a decrease in vertebral body height. This leads to a change in the sagittal profile of the spine with corresponding side effects. The aim of this study is to evaluate the effects of the chosen treatment, both conservative and surgical, on the sagittal profile and the clinical outcome of OVCF.

#### Methods

Patient data from the Evaluation of the Osteoporotic Fracture Classification (OF), Treatment Score and Therapy Recommendations (EOFTT) Study were used. The treatment options - conservative, augmentative techniques (kyphoplasty or vertebroplasty) and surgical instrumentation (bi-/multisegmental) - were compared



radiologically using the bisegmental Cobb angle (biCA). Three defined time intervals were evaluated: day of treatment decision (DTD) to discharge (DIS), discharge (DIS) to follow-up (FU) and day of treatment decision (DTD) to follow-up (FU). The Oswestry Disability Index (ODI), the Visual Analog Scale (VAS), the EQ-5D-5L and the "Timed Up and Go" test (TuG) were used as clinical measures.

#### Results

The study analyzed data of in total 367 patients (276 women, 91 men) at the age of 75  $\pm$  10 years with OVCFs of the thoracolumbar junction (T11- L2). 33% of patients were treated conservatively (33%), 67% underwent surgery. 23 % of these patients underwent augmentation and 44 % underwent instrumentation. Both surgical interventions showed a significant improvement in biCA from DTD to DIS (augmentation p=0.002; instrumentation p < 0.001). Patients showed a significant improvement in biCA after instrumentation compared between DTD and FU, while patients after augmentation showed a decrease in biCA to the values at DTD. The ODI and VAS showed an improvement from DTD to DIS and again to FU, with a significant interaction effect. The TuG showed a significant improvement in conservatively treated and instrumented patients at FU.

#### Conclusion

Patients with posterior fixation showed the least functional limitation, lowest VAS scores, shorter TuG times and better EQ5D results on FU as a result of sustained correction of fracture-related kyphosis compared to the augmented group. Only the conservatively treated and instrumented patients showed a lasting effect with further improvement at FU. The poorer long-term outcome of augmentation procedures raises questions about the indication for these surgical techniques and argues in favor of instrumentation.

### RC012

Traumatische Wirbelsäulenfrakturen bei Mehrfachverletzten: eine Vergleichsstudie zwischen alleiniger dorsaler Stabilisierung und kombiniertem Ansat *Traumatic Spinal Fractures in Polytrauma Patients: A Comparative Study Between Stand-Alone Posterior Stabilization and Combined Approach* 

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#### Objective

This study examines the surgical approach for traumatic spinal fractures in polytrauma patients by comparing stand-alone posterior stabilization (Group I) with the combined posteroanterior approach (Group II). Radiological outcomes, including sagittal index (SI) and loss of vertebral height (LVH), clinical outcomes, and complications were analyzed.

#### Methods

A retrospective single-centre study included polytrauma patients with spinal fractures (T1 to L5) treated surgically between 1, 1, 2015, and 30, 9, 2024. Patient records and imaging were reviewed. SI, LVH, pain (VAS), and neurological status (on an ordinal scale relative to initial status, 1= worsened, 2= stabile, 3= improved) were assessed at baseline, after each intervention, and at follow-up. Linear mixed-effects regression and proportional odds ratio models were employed to compare outcomes.

#### Results

77 patients (47 men) were included, with 31 in Group I and 46 in Group II. Age, gender, cause of injury, initial haemoglobin levels, and co-injuries were comparable between groups. The median follow-up was 16 months in Group I and 19 months in Group II. Most fractures occurred at the thoracolumbar junction (T12 and L1), and according to AO classification, the majority were compression fractures (A3 or A4), with a smaller proportion classified as B or С fractures. The regression model revealed superior sagittal alignment in Group II, with an adjusted mean difference for SI of -4.24 (95% Cl -7.13 to -1.36; p = 0.004) and enhanced restoration of vertebral body height with an adjusted mean difference for LVH of 0.11 (95% CI 0.02 to 0.20; p = 0.02). Regarding pain reduction at follow-up, the combined approach showed better results, with a mean difference of -1.55 (95% CI -3.05 to -0.05; p = 0.047). Neurological outcomes were also superior in Group II, with a proportional odds ratio (POR) of 5.12 (95% CI 1.51 to 23.77; p = 0.022). Postoperative complications occurred equally in both groups (7 patients each).

#### Conclusion

The combined posteroanterior stabilization achieves better sagittal alignment, vertebral height restoration, and clinical outcomes, including pain and neurological recovery, compared to stand-alone posterior stabilization, without significant differences in complication rates.

### RC014

Bewertung der Validität des OF-Scores bei der Behandlung osteoporotischer Wirbelsäulenfrakturen: Erste Erkenntnisse aus einer retrospektiven Analyse eines einzelnen Zentrums Assessing the validity of the OF-Score in Treating Osteoporotic Spine Fractures: Initial Insights from a Single-Center Retrospective Analysis

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#### Objective

Osteoporotic spine fractures can be managed conservatively or surgically. The OF score was introduced to aid clinical decision-making by integrating multiple factors, including fracture morphology, osteoporosis severity, deformity progression, pain intensity, neurological symptoms, mobility, and overall health status. This study aims to assess the validity and feasibility of the OF score as a standardized tool for guiding treatment in osteoporotic spine fractures.

#### Methods

We retrospectively analyzed 177 patients (mean age: 77 years; female-to-male ratio: 2.32:1) with osteoporotic spine fractures treated at our neurosurgical department between January 2023 and December 2024. A total of 264 fractures were evaluated, of which 219 received surgical treatment and 45 were managed conservatively. The OF score was calculated for each fracture.

#### Results

Among the 219 surgically treated fractures, the OF score recommended surgery in 47.48% (n=104). In 11.8% (n=26), both treatment options were suggested by the OF score. However, 40.6% (n=89) were operated on despite a conservative recommendation. Within this subset, OF2 fractures were the most frequent (84%, n=75), whereas OF3 fractures were less common (14.6%, n=13). kyphoplasty was performed in 87.6% of these cases, with the remainder treated via dorsal instrumentation. Among the 45 fractures managed conservatively, the OF score recommended conservative treatment in 86.6%, whereas 8.8% were managed conservatively despite a surgical recommendation. In 4.4%, both approaches were indicated.

#### Conclusion

The OF score is a valuable tool for guiding the management of osteoporotic spine fractures. However, factors such as pain intensity and diminished quality of life can significantly influence final treatment decisions—especially when conservative measures (e.g., pain therapy including strong opioids, physiotherapy, and orthotic support) fail to provide relief. Certain parameters of the OF score may eventually need revision, particularly when they cannot be accurately assessed at the time of clinical decision-making (e.g., ongoing fractures). On the other hand, minimally invasive surgery (e.g., kyphoplasty or percutaneous instrumentation) may offer with relative low-risk a rapid improvement of symptoms. With further refinement, the OF score holds promise as a reliable, standardized instrument for optimizing treatment strategies in patients with osteoporotic spine fractures.

### V126

Knochenqualität und Cage-Sinterung nach ACDF: Beeinflusst die Sinterung das langfristige klinische Outcome? Bone Quality and Cage Subsidence in ACDF: Does Subsidence Affect Long-Term Outcomes?

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#### Objective

This study aimed to evaluate the association between preoperative bone quality and cage subsidence, as well as its impact on fusion rates and clinical outcomes in long term-follow up.

#### Methods

We retrospectively reviewed records of patients who underwent ACDF for degenerative cervical disc disease between 12/2012 and 12/2023. Trabecular bone mineral density was measured using preoperative CT scans with SpineQ v1.0 (Bonescreen GmbH, Munich). Cage subsidence was defined as  $\geq$ 3 mm migration into adjacent vertebral bodies on postoperative X-rays. Clinical outcomes were assessed at 12 months follow-up using the modified Japanese Orthopedic Association (mJOA) score and Visual Analog Scale (VAS) for arm and neck pain. Patients were grouped into those with and without cage subsidence.

#### Results

A total of 102 patients (median age: 57 years; IQR: 49–68) were included; 74.5% underwent stand-alone cage implantation and 25.5% received additional anterior plate fixation. Cage subsidence occurred in 20 patients (19.6%). Median BMD was 148 mg/cm3 (IQR 139-198) among patients with cage subsidence and 165 mg/cm3 (IQR 127-214) in the non-subsidence group (p=0.944). No differences were found between groups regarding age (p=0.253), cage-material (p>0.999), anterior plate fixation (p=0.585) or levels operated (0.403). At 12 months follow-up mJOA was improved in 60.8%, neck pain in 79.4% and arm pain in 91.2%, with no significant differences between groups. Fusion was achieved in 7 patients with cage subsidence but was more frequent in the non-subsidence group (p=0.004). Furthermore, binary logistic regression showed that cage subsidence was negatively associated with segment fusion (OR 0.214; 95% CI 0.075–0.595; p = 0.003) and higher revision surgery rates (OR 4.879, 95% CI 1.379-17.13; p=0.012). Non-fusion of the segment significantly worsened neck pain (OR 3.182; 95% CI 1.158–8.782; p = 0.024) but had no effect on mJOA scores (p=0.360) or arm pain (p=0.243).

#### Conclusion

Contrary to previous findings in the lumbar spine, trabecular bone mineral density was not associated with cage subsidence in ACDF. Interestingly cage subsidence did not directly affect clinical outcomes at 12 months follow up, butwas associated with non-fusion, contributing to persistent neck pain and increased revision surgery rates.

### V049

Prospektive Untersuchung der pathologisch-geführten supramaximalen Resektion von Hirnmetastasen und der Auswirkung von präoperativer Bestrahlung auf die perimetastatische Nische Prospective investigation of cellular-guided supramaximal resection of brain metastases (HiResMet Trial) and effects of preoperative radiation on the perimetastatic niche

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#### Objective

Treatment of single brain metastases (BM) typically involves gross total resection followed by tumor site radiation. However, metastatic tumor cells in the perimetastatic niche (PN) beyond the contrast-enhancing MRI signal pose a risk for recurrence, underscoring the need for refined treatment strategies targeting the PN. The HiResMet trial investigates the safety and effectiveness of histologically-guided supramaximal resection in BM. This study focuses on the effects of supramaximal resection, comparing postoperative radiation with the emerging concept of preoperative radiation.

#### Methods

As part of the HiResMet trial, a stepwise resection beyond tumor margins into the PN is conducted using intraoperative neuropathological examination of peritumoral tissue. If smear preparations (unfixated, methylene blue) indicated tumor presence, up to four additional resections per direction were performed to achieve possible R0 resection. The primary outcome is the number of perimetastatic resections required to achieve R0. Secondary outcomes include histopathological assessment of the PN.

#### Results

Fifteen patients with 16 BM were enrolled, including 9 radiated and 7 non-radiated metastases. In 7/16 cases (44%), resection was extended after initial peritumoral probes revealed neoplastic cells in the PN. Among radiated BM, 2/9 cases (22%) required re-resection (1-3 re-resections per BM), compared to 5/7 non-radiated BM (70%; 1–3 re-resections per BM; mean 1.6 re-resections/BM). Perimetastatic probes from non-radiated BM showed perivascular tumor cells, whereas necrosis was more commonly observed in radiated BM.

#### Conclusion

Preliminary analyses indicate that supramaximal resection is safe and feasible, showing promise in effectively eliminating residual tumor cells within the PN to achieve RO resection. Preoperative radiation appears to reduce tumor cell presence in the PN, presenting itself as a promising adjunct for combination therapy.

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### V044

Bedeutung der supramarginalen Resektion bei Hirnmetastasen Role of supramarginal resection in brain metastasis

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#### Objective

Surgery is a key element in brain metastases (BM) treatment. While gross total resection (GTR) appears beneficial, little evidence is available on supramarginal resection and its role in BM management. We, therefore, aimed to analyze the impact of supramarginal resection on BM patient's outcomes.

#### Methods

We analyzed 353 patients (162 female, 191 male) with a median age of 62.8 years (range: 23.4 – 86.2 years) who underwent surgical resection of one or several BM. Patients presented with multiple metastases in 45.5%, singular in 36.7%, and solitary in 17.8%. Fluorescence guidance (FG) was used in 207 patients (58.6%). Supramarginal resection was determined by volumetry of the pre-and postsurgical FLAIR- or non-contrast enhancing (non-CE) tumor volume as previously defined by the RANO resect group for primary brain tumors. Outcome analysis included progression-free (PFS) and overall survival (OS).

#### Results

264 (74.8%) patients underwent a complete CE resection. In 52.4% of these patients, we could identify an additional supramarginal resection. The extent of supramarginal resection was significantly higher in the FG group (p=0.004). Supramarginal resection improved OS in patients with multiple metastases (p=0.023); PFS was prolonged in younger patients (p=0.020) and in those who did not receive adjuvant systemic treatment (p=0.008). PFS was negatively influenced by residual FLAIR volume in patients without disease control (p=0.035), no adjuvant systemic (p=0.009), or radiotherapy (p=0.027). Multivariate Cox regression analysis revealed age (p=0.013) and the extent of supramarginal resection (p=0.020) as independent positive prognostic factors for OS in patients with multiple metastases.

#### Conclusion

Supramarginal resection was beneficial for both, PFS and OS in specific subgroups of BM patients. Fluorescence guidance greatly increased the extent of supramarginal resection







### V045

#### Die Rolle der Neurochirurgie in der Behandlung von Hirnmetastasen im Zeitalter molekularer Therapien:Ergebnisse der multizentrischen SUBARoMA Studie The role of neurosurgery for treatment of brain metastases in the molecular era: results of the multicenter SUBARoMA study

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#### Objective

Multicenter analysis of real-life care patterns of patients undergoing brain metastasis (BM) surgery and adjuvant treatment in the context of molecular therapies with the aim of confirming/refuting known predictors of local intracranial progression (LP) and overall survival (OS).

#### Methods

We conducted a retrospective, multicenter study (2012-2022) of patients who underwent surgery as initial treatment for their BM. Prognostically relevant parameters in relation to LP and OS were analyzed using the Kaplan-Meier method (univariate) and Cox regression model (multivariate).

#### Results

We analyzed a total of 2657 patients (see Table 1 for the individual parameters).

Surgery was classified as complete in 73% and significantly improved patients' overall KPS (p<0.001); postoperative morbidity rate was 20%.

Intracranial progression occurred in 1036 (38%) patients after a mean/median time of 8.9/ 5.7 months (range: 0.17-74.0).

Progression of the initially resected BM occurred in 19 %, distant progression in 25 % and LMD in 6 %.

The primary tumor type (PT), the time interval between PT and BM, active extracranial tumor, and the use of radio- and systemic therapy proved to be significant predictors of LP.

PT and radiotherapy remained independent predictors (for p-values and HR see Table 2).

After a mean/median survival time of 7.5/15.0 months (range: 0-129.3), 1659 (60%) patients had died. For the 38% of patients for whom the cause of death was known, systemic progress was the most common (63%).

Gender, age, PT, number of BM, and the presence of extracranial tumor, pre- and postoperative KPS, extent of resection and postoperative morbidity significantly influenced OS. Adjuvant radio- and systemic therapy showed the strongest influence on OS.

In the multivariate analysis, age, PT, number of BM, EOR as well as active extracranial tumor, postoperative KPS, radio- and systemic therapy remained independent predictors (for p-values and HR see Table 2).

#### Conclusion

The SUBAROMA study shows how the current treatment guidelines are implemented in practice and points to the prognostic importance of adjuvant radiotherapy and systemic therapy, including immunologic and targeted therapies. Furthermore, the prognostic relevance of postoperative KPS and the high morbidity rate emphasize the careful selection of patients to be treated surgically.

#### Abb. 1

Parameter	20 C	Total No. 2751	Percent
Condot	female	1382	50.2
Genuer	male	1369	49.8
Age	median	63 years	
	range	19 - 88 years	
	≤ 65years	1581	57.5
	Non Small Cell Lung Cancer	1155	42.0
	Breast cancer	342	12.4
	Malignant Melanoma	293	10.7
	Colorectal carcinoma	204	7.4
	Small cell lung cancer	154	5.6
Primary tumor	Cancer of unknown primary tumor	107	3.9
	Renal Cell Carcinoma	99	36
	Oesonbarus carcinoma	78	28
	Urothelial carcinoma	58	21
	Prostate cancer	45	1.6
	Other antities*	216	7.0
	modian	10.7 months	1.0
	median	F0 to 476 A months	
Time interval	nange procedeurs before primary tumor	- 60 t0 476.4 months	50.0
between PT & BM	precocidus: before primary tumor	622	10.0
	synchronous: winim s monurs or diagnosis primary tumor	529	19.2
	metachronous: 3 month after primary tumor	600	21.8
Stable primary tumor	1	1186	46.1
at time of BM	0	1387	54.0
diagnosis	n.a.	178	10.1
Systemic metastasis	1	1142	43.1
at time of BM	0	1508	57.0
diagnosis	n.a.	101	
Extracranial tumor at	1	741	28.6
diagnosis of RM	0	1850	71.4
diagnosis or bin	n.a.	160	*********
	median	1	
Number of BM	range	1-41	
Number or own	1 BM	1718	62.5
	>1 BM	1033	37.5
	1	2542	92.4
Number of resected	2	184	6.7
BM	3	23	0.8
	4	2	0.1
Extend of Resection	gross total resction	1303	72.6
	near total resection	286	15.9
	subtotal resection	205	11.4
	n.a.	957	
KPS preoperative	median	80	
	range	20-100	
	≥ 70	2329	84.7
	< 70	422	25.3
KPS postoperative	median	80	
	range	0-100	
	≥ 70	2394	87.0
	< 70	357	13.0
Radiation therapy after BM resection	none	482	18.1
	whole brain radiation therapy	499	18.8
	focal radiation	1676	63.1
	n.a.	94	
			20.7
	systemic therapy without immuno- and targeted therapy	623	25.1
Systemic therapy	systemic therapy without immuno- and targeted therapy systemic therapy including immuno- and targeted therapy	623 981	37.3
Systemic therapy after BM resection	systemic therapy without immuno- and targeted therapy systemic therapy including immuno- and targeted therapy none	623 981 1027	37.3 39.0

KPS, Karnofsky performance status; n.a., not applicable.

Parameter	Local intracrar	nial progression	Overall survival		
	univariate Kaplan Meier	multivariate Cox Regression	univariate Kaplan Meier	multivariate Cox Regression	
Gender	0.373		<0.001		
Age	0.083		<0.001	0.003 (HR 0.872, 95% CI 0.765-1.011)	
Primary turnor type	0.002	0.002	<0.001	0.004	
Time interval between PT and BM	0.042		0.450		
Extracranial turnor at diagnosis of BM	0.049	8	<0.001	<0.001 (HR 1.604, 95% CI 1.383-1.860)	
Number of BM (1 vs. >1)	0.824		0.007	0.003 (HR 1.213, 95%Cl 1.066-1.380)	
No. of resected BM	0.063		0.994		
Extend of Resection GTR vs. NTR+STR GTR+NTR vs. STR	0.169 0.068 0.147		0.021 0.071 <i>0.006</i>	0.003 (HR 0.749, 95% CI 0.619-0.906)	
KPS preoperative	0.373		<0.001	-	
KPS postoperative	0.986	20	<0.001	<0.001 (HR 1.779. 95% CI 1.419-2.231)	
Radiation therapy after BM resection	<0.001 <0.001*	<0.001 (HR 1.572, 95%CI 1.222-2.023)	<0.001	<0.001 (HR 1.855, 95% CI 1.590-2.164)	
Systemic therapy after BM resection	0.039 0.016**		< <i>0.001</i> <0.001	<0.001 (HR 2.125, 95% Cl 1.857-2.432)	
Complications	0.262		<0.001		

Table 2. Univariate Kaplan Meier and multivariate Cox regression analysis. \*any radiation therapy vs. none; \*\*immune-/targeted therapy vs. classic chemo- or no systemic therapy. EOR, Extend of Resection; GTR, gross-total resection; NTR, near-total resection; STR, sub-total resection. No., number; HR, Hazard Ratio; CI, Confidence Interval; n.a., not applicable; BM, brain metastasis; PT, primary tumor type; KPS, Karnofsky Performance Status.

### V046

Einfluss von Tumorrandproben auf das Outcome bei Patienten mit intrakraniellen Metastasen – eine retrospektive Analyse Impact of Tumor Margin Biopsies on the Outcome of Patients with Intracranial Metastases – a Retrospective Analysis

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#### Objective

The role of tumor margin biopsies in the neurosurgical treatment of intracranial metastases has not been sufficiently investigated. Tumor margin biopsies could serve as a predictor for recurrence risk and patient prognosis. The aim of this study is to analyze the impact of positive margin biopsies on clinical outcomes and to identify potential factors influencing the risk of tumor recurrence.

#### Methods

Between December 2008 and July 2021, 297 patients underwent surgery of intracranial metastases and were included in a retrospective study. Tumor margin biopsies were taken from all patients and histopathologically analyzed. A total of 358 metastases were resected, and 1348 tumor margin biopsies were analyzed. Primary endpoints were recurrence rate, overall survival (OS), and time to recurrence.

#### Results

Tumor cells were detected in 15.5% of the margin biopsies. Metastases from breast cancer and malignant melanoma showed the highest rates of positive margin biopsies (64.9% resp. 44.2%), while renal cell carcinoma had the lowest rate at 7%. Among patients with positive tumor margin biopsies, 68% experienced recurrence within the first-year post-surgery, compared to 45% in the negative biopsy group. The median time to recurrence was 5.8 months for patients with positive biopsies and 8.3 months for those with negative biopsies. Although patients with positive margin biopsies had a higher recurrence rate, this did not translate to a significant difference in overall survival (p=0.443). Adjuvant radiotherapy was associated with a significant reduction in recurrence risk (p<0.001), lowering the recurrence rate by 40%. Particularly for metastases larger than 15 cm<sup>3</sup>, the risk of recurrence was significantly increased (p=0.009), with a 72% recurrence rate within six months post-surgery. Multivariate analysis confirmed that metastases from breast cancer and malignant melanoma were most likely to show positive margin biopsies and had the highest recurrence risk.

#### Conclusion

The analysis of tumor margin biopsies provides valuable prognostic information for patients with intracranial metastases. Positive margin biopsies could serve as markers for increased recurrence risk. The combination of surgical resection and adjuvant radiotherapy improves long-term prognosis and should be considered, especially in patients with large metastases.

### V047

#### Die heutige Rolle der chirurgischen Therapie für singuläre Hirnmetastasen The current role of surgery for singular brain metastasis (BM)

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#### Objective

Surgery for singular BM aims to control CNS disease, which in turn should lead to improved survival. This concept may need to be refined against the background of recent advances in medical and radiation oncology. There is in particular a debate about the prognostic role of residual tumor. To this end, we have reviewed our institutional experience vis-à-vis these issues.

#### Methods

We retrospectively analyzed 202 patients with singular BM who underwent surgery 2015-2023 at our institution. All patients had a pre- & postop. MRI for volumetric analysis and complication assessment.

#### Results

Surgical indications included a tumor too large for radiosurgery ( $\geq$ 15.0 cm3; 42.5%), histological diagnosis confirmation (33.5%) and tissue acquisition for molecular analyses (21.8%). A neuroradiological review revealed 2 asymptomatic cases with unilateral sigmoid sinus thrombosis (cf. 11/16 [69.0%] complications requiring treatment in symptomatic patients) and categorized resections into incomplete (8.4%), questionably complete (22.3%), and complete (69.3%). Median residual tumor volume (incl. questionable cases) was only 0.12 (IQR 0.04-0.35) cm3. We recorded 6.2% major (CTCAE III-V) surgical, 5.3% neurological, and 7.2% medical complications. 57.9% retained and 25.2% improved their preop. KPS after surgery. Complication rates and postop. KPS did not vary significantly with resection category. 92.6% of cases with incomplete/questionably complete resections had postop. radiotherapy (RT, cf. 76.2% with complete resections; p=.012; systemic treatment/ST: 64.7 vs. 62.4%, p=.774). Median OS (mOS) was 15.7 (95% CI: 12.4-19.0) months. Complete resections were not correlated with better OS and CNS-PFS (1 yr. OS: 54.7% vs. 70.4%; p=.168 & 1 yr. PFS: 49.6% vs. 61.9%; p=.190). Prominent prognostic factors for OS were postoperative RT (mOS: 19.0 vs. 3.7 months; p<.001) and ST (mOS: 21.4 vs. 10.4 months; p=.012) as well surgical (mOS: 5.9 vs. 16.8 months; p<.001) and neurological (mOS: 6.9 vs. 16.8 months; p=.042) complications.

#### Conclusion

Small tumor remnants may have limited impact on survival (in patients undergoing intense RT/ST). Survival may have improved over time possibly reflecting the impact of better systemic treatments against the background of CNS disease controlled by surgery (and RT). BM is not a single entity and treatments vary widely with the primary tumor. Tissue acquisition is already a prominent indication for surgery and is likely to become more relevant in the era of targeted therapies.

### V050

Abschließende Analyse einer prospektiven, einarmigen, offenen Phase-2-Studie zur INTraoperativen RAdiotherapie nach Resektion von GehirnMETastasen – INTRAMET Final analysis of a prospective, single-arm, open-label phase 2 study of INTraoperative RAdiotherapy after resection of brain METastases – INTRAMET

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#### Objective

40% of all cancer patients develop brain metastases during the course of their disease. The current standard of care for space-occupying lesions is neurosurgical resection followed by adjuvant radiotherapy. INTRAMET (NCT03226483) investigated the efficacy and safety of single-session, high-dose intraoperative radiotherapy (IORT) of the resection cavity.

#### Methods

Patients aged  $\geq$ 18 years with Karnofsky  $\geq$ 50 and brain metastases confirmed by frozen section were included. Radiotherapy (RT) was delivered with a mobile irradiation unit using low energy X-rays up to a dose of 30 Gy. The primary endpoint was local tumor control (LCR). Secondary endpoints were regional brain control (RCR), overall survival (OS), time to start anticancer therapy, and adverse events (AEs).

#### Results

35 patients were included. Mean follow-up was 25.7 (0.8-64.5) months. 45.7% were women. Mean age was 65 (45-85) years. At the time of analysis, 48.6% of patients had died. The most common primary tumor site was lung (68.6%). LCR was 94.3% (95% CI 82.9-98.8% - Figure 1) and RCR was 57.1% (95% CI 40.7-72.4% - Figure 2). Leptomeningeal progression occurred in 8.6% of patients (all distant from the IORT-treated metastasis). Median OS was 43.6 months (95% CI 8.8-78.4). 7 (20%) patients received salvage whole brain RT with a median initiation time of 147 (20-601) days and a significant survival benefit for those not requiring WBRT (p=0.027). Regarding OS, no significant survival differences were observed according to primary histology (p=0.618), immunotherapy (p=0.928), seizures at baseline (p=0.169), Karnofsky performance score (p=0.056), or radionecrosis appearance (p=0.214). Anticancer therapy was initiated at a median of 45.0 (95% CI 35.1-54.8) days. No grade 4-5 AEs related to IORT occurred. 7 (20%) patients developed radionecrosis (RN) (n=5 grade 1, n=1 grade 2, n=1 grade 3). No risk factors could be associated with RN. 10 patients (28.6%) presented with postoperative seizures with eloquent localization as the only predictive factor (p=0.008).

#### Conclusion

IORT for resected BM provides excellent local control rates and has a toxicity profile similar to that reported in postoperative SRS trials. By facilitating the prompt initiation of subsequent systemic treatments, IORT may shorten the overall treatment course for many cancer patients.









### V051

Intra-kavitäre Strahlentherapie bei chirurgisch resezierten Hirnmetastasen: Eine umfassende Analyse einschließlich einer individuellen Patientendaten-Meta-Analyse zur intraoperativen Strahlentherapie (IORT) und Brachytherapie (IBT)

Intra-Cavitary Radiotherapy for Surgically Resected Brain Metastases: A Comprehensive Analysis Including an Individual Patient Data Meta-Analysis of Intraoperative Radiotherapy (IORT) and Brachytherapy (IBT)

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#### Objective

The management of brain metastases (BM) often involves surgical resection followed by adjuvant radiotherapy to improve local tumor control. Local intracavitary radiotherapy, including intraoperative radiotherapy (IORT) and brachytherapy, has emerged as an alternative to whole-brain radiotherapy (WBRT), potentially mitigating neurocognitive decline and treatment burden. Despite its increasing use, comprehensive data on its safety and efficacy remain limited.

#### Methods

This meta-analysis combined conventional meta-analysis and individual patient data (IPD) from studies on intracavitary radiotherapy techniques for surgically treated BM. Primary endpoint is the local tumor control. Secondary endpoints are overall survival (OS) and distant tumor control. IPD was reconstructed using the R package IPDfromKM. Pooled IPD Kaplan-Meier charts stratified by IORT and intra-cavitary brachytherapy were created using the R package Survminer. Forest plots were created with the R package meta.

#### Results

Twenty-two studies with a total of 780 patients were included in this analysis, and nine studies with 447 patients enabled IPD meta-analysis of BM patients treated with intracavitary radiotherapy modalities. The pooled analysis of intraoperative intracavitary radiotherapy (IORT) and intracavitary brachytherapy (IBT) showed high local control rates, with a 1-year local control rate of 94.0% (95% CI: 90.0–96.0%). The 1-year local control rate was 94.0% (95% CI: 90.0–96.0%) for IORT-treated patients (n=360) and 92.0% (95% CI: 87.0–96.0%) for those treated with IBT (n=420). IPD meta-analysis for the 447 BM patients demonstrated a median follow-up of 8.6 months (IQR: 4.0–21.0). In the univariable Cox regression analysis comparing IORT and IBT for local control, no significant difference was observed (HR = 1.283, 95% CI: 0.695–2.369, p = 0.426). Longitudinal IPD analysis for overall survival (OS) was available for 177 patients, showing a 1-year OS rate of 60.0% and a median OS of 14.1 months (95% CI: 10.1–18.1).

#### Conclusion

Intracavitary radiotherapy, including IORT and brachytherapy, provides an effective local tumor control. The present IPD meta-analysis presents the largest pooled analysis on this topic to data and might inform future prospective trials.

Study	Total	Р	roportion	95%-CI	Weight
Bogart 1999 (IBT)	15		0.80	[0.52: 0.96]	3.0%
Dagnew 2007 (IBT)	26		0.96	[0.80: 1.00]	4.3%
Huang 2009 (IBT)	40	· · · · · · · · · · · · · · · · · · ·	0.88	[0.73: 0.96]	5.5%
Julie 2020 (IBT)	30	<b></b>	0.90	[0.73; 0.98]	4.7%
Nakaji 2020 (IBT)	11 +		0.82	[0.48; 0.98]	2.4%
Wernicke 2014 (IBT)	24		0.96	[0.79; 1.00]	4.1%
Wernicke 2017 (IBT)	42		1.00	[0.92; 1.00]	5.6%
Bander 2023 (IBT)	79	<b></b>	0.85	[0.75; 0.92]	7.2%
Rogers 2006 (IBT)	54		0.83	[0.71; 0.92]	6.3%
Xia 2018 (IBT)	9		1.00	[0.66; 1.00]	2.1%
Chen 2022 (IBT)	20		0.90	[0.68; 0.99]	3.7%
Cummins 2022 (IBT)	16		0.81	[0.54; 0.96]	3.2%
Pham 2015 (IBT)	24		1.00	[0.86; 1.00]	4.1%
Kutuk 2023 (IBT)	10		1.00	[0.69; 1.00]	2.3%
Imber 2022 (IBT)	20	<b>_</b>	0.90	[0.68; 0.99]	3.7%
Layer 2023 (IORT)	35		0.97	[0.85; 1.00]	5.1%
Kahl 2024 (IORT)	105		0.90	[0.83; 0.95]	7.8%
Diehl 2022 (IORT)	18		0.94	[0.73; 1.00]	3.4%
Layer 2024 (IORT)	103		0.98	[0.93; 1.00]	7.8%
de Castro 2023 (IORT)	10		0.90	[0.55; 1.00]	2.3%
Cifarelli 2019 (IORT)	54	<del> -</del>	0.94	[0.85; 0.99]	6.3%
Brehmer 2023 (IORT)	35	<b>=</b>	0.94	[0.81; 0.99]	5.1%
Random effects mode	780	<b></b>	0.94	[0.90; 0.96]	100.0%
Heterogeneity: $I^2 = 46.8\%$	$, \tau^2 = 0.00$	$p_{63, p} = 0.0086$			
	0.5	5 0.6 0.7 0.8 0.9 1			
	Local	Control Rate at 1 Year (Proportio	n)		

Abb. 2

Study	Total				Proportion	95%-CI	Weight
Bogart 1999	15		-		0.80	10 52.0 061	5 2%
Dognow 2007	26		-		L 0.00	[0.32, 0.30]	7.0%
Lugar 2000	20		04	_	0.90	[0.00, 1.00]	0.50/
Huang 2009	40				0.00	[0.73; 0.96]	0.5%
Julie 2020	30	-		-	- 0.90	[0.73; 0.98]	1.5%
Nakaji 2020	11 ←───		-		- 0.82	[0.48; 0.98]	4.2%
Wernicke 2014	24			-	- 0.96	[0.79; 1.00]	6.7%
Wernicke 2017	42			-	1.00	[0.92; 1.00]	8.7%
Bander 2023	79				0.85	[0.75; 0.92]	10.6%
Rogers 2006	54	_	-	_	0.83	[0.71; 0.92]	9.5%
Xia 2018	9	-			<b>1.00</b>	[0.66; 1.00]	3.7%
Chen 2022	20			-	- 0.90	[0.68; 0.99]	6.1%
Cummins 2022	16 ——		-		0.81	[0.54; 0.96]	5.4%
Pham 2015	24			_	-■ 1.00	[0.86; 1.00]	6.7%
Kutuk 2023	10				■ 1.00	[0.69; 1.00]	4.0%
Imber 2022	20			-	- 0.90	[0.68; 0.99]	6.1%
Random effects me	odel 420			-	0.92	[0.87; 0.96]	100.0%
Heterogeneity: $I^2 = 50$	0.2%, p = 0.0136			1			
	0.5 0.6	0.7	0.8	0.9	1		
	Local Con	trol Rat	te at 1	Year (IE	BT)		

### V052

#### Verbesserte Chemotherapieaufnahme durch Tumor Treating Fields (TTFields)-induzierte Tumorzellpermeabilität Improved chemotherapy uptake by Tumor Treating Fields (TTFields)-induced cancer cell permeability

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#### Objective

#### Objective

Tumor Treating Fields (TTFields) therapy, which uses electric fields, was shown to enhance the membrane permeability of glioblastoma cells. This study characterizes this phenomenon and investigates whether TTFields can be used to facilitate uptake of anticancer agents and overcome multidrug resistance (MDR), a major challenge in cancer treatment.

#### Methods

#### Methods

4T1 breast carcinoma cells were treated with TTFields (300 kHz; 1.7 V/cm). Utilizing flow cytometry, intracellular 7-aminoactinomycin D (7-AAD) accumulation was measured, adding the agent before or after treatment end. With or without blocking G1/S phase by thymidine, cell cycle was analyzed following TTFields application using Hoechst reagent. TTFields were applied together with doxorubicin (DOX) to the 4T1 and 4T1-MDR cells (generated by 4T1 repeated DOX exposure), and DOX accumulation and the effect on cell count were analyzed. To study drug accumulation in vivo, mice were orthotopically inoculated with 4T1 cells or lung carcinoma LL/2 cells, treated with TTFields and injected with DOX or paclitaxel (PTX), respectively. Drug accumulation was determined both in whole tumors and single-cell tumor suspension, using LC-MS/MS for PTX, and flow cytometry or an in vivo imaging system (IVIS) for DOX. PTX accumulation was also measured in the healthy lung. To study efficacy, mice were orthotopically inoculated with 4T1 or 4T1-MDR cells, treated continuously for 8 days with sham-heat or TTFields, and injected with DOX (1 mg/kg for 4T1 cells; 5 mg/kg for 4T1-MDR cells) or vehicle on days 2 and 6. Tumor volumes were determined using a caliper.

#### Results

Evaluating 7-AAD accumulation revealed that TTFields-induced cancer cell permeability is reversible after cells passed through the G2/M phase during TTFields application. TTFields treatment permitted DOX accumulation in DOX-resistant cells to the same level as DOX-sensitive cells w/o TTFields and sensitized both cell types to DOX cytotoxicity. In vivo, increased drug accumulation was detected with DOX in breast tumors and PTX specifically in lung tumors. TTFields together with DOX significantly reduced tumor growth in both mice with 4T1 and 4T1-MDR tumors.

#### Conclusion

TTFields increased cancer cell permeability reversibly and in a G2/M-dependent manner, enabling enhanced intracellular accumulation of chemotherapeutics in vitro and in vivo. When applied together with DOX, TTFields improved efficacy in DOX-sensitive and -resistant cells both in cells and in mice.

### V048

Die Rolle des chirurgischen Sicherheitsabstand im Rahmen der zerebralen Metastasenresektion im Zeitalter der adjuvanten stereotaktischen Radiochirurgie

Reconsideration of the surgical safety margin around a brain metastasis in the era of postoperative stereotactic radiosurgery

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#### Objective

To decrease recurrence rates after complete resection of brain metastasis, removal of a surgical safety margin is advocated. However, this is not always feasible when resecting metastases in an eloquent location. We aimed to assess the recurrence rate after resection of metastasis in an eloquent location followed by postoperative stereotactic radiosurgery (SRS) to the resection cavity.

#### Methods

We retrospectively included patients with 1–3 brain metastases undergoing gross total resection (GTR) and postoperative SRS between 2010 and 2022. Our primary endpoint was local recurrence free survival. Secondary endpoints were overall survival and distant brain recurrence free survival. Patients were grouped according to the location of their metastasis into eloquent and non-eloquent. Eloquent localization was considered a surrogate for resection without a safety margin according to our institutional practice.

#### Results

We included 193 patients with 201 resected metastasis; median age 64 years. Ninety-five metastases (47.3%) were classified as eloquent and 106 (52.7%) as non-eloquent. Kaplan-Meier analysis demonstrated no difference in local recurrence free survival between patients with eloquent and non-eloquent metastasis (HR 0.821, 95%-CI 0.447-1.507, p=0.523). In a multivariable model using backward elimination, increasing preoperative tumor volume (HR 1.015, 95% CI 1.001-1.029, p=0.033),increasing number of fractions (HR 2.011, 95% CI 1.337-3.024, p<0.001) and decreasing total SRS dose (HR 0.784, 95% CI 0.674-0.911, p=0.002) were significantly associated with local recurrence free survival. Kaplan-Meier analysis demonstrated no differences in overall survival (HR 0.930, 95%-CI 0.651-1.327, p=0.688) and distantbrain recurrence free survival (HR 0.855, 95%-CI 0.549-1.330, p=0.487) between patients with eloquent and non-eloquent metastasis.

#### Conclusion

Omitting a surgical safety margin in at least a part of the resection cavityhad no effect on local control after resection and postoperative SRS of eloquent brain metastasis. Local control seems to depend more on radiosurgical parameters. This data could influence the surgeon"s strategy during resection of an eloquent metastasis.



## FIG 1. Resection of eloquent and non-eloquent metastases







Kaplan-Meier analysis of local recurrence free survival found no difference between eloquent and non-eloquent metastasis after resection and postoperative SRS (p=0.523).

### Vaskuläre Neurochirurgie 2 | Vascular neurosurgery 2

### V053

Wert der primären dekompressiven Kraniektomie nach aneurysmatischer Subarachnoidalblutung - eine gepoolte Analyse mit 2395 Fällen

# Value of primary decompressive craniectomy after aneurysmal subarachnoid hemorrhage - a pooled analysis with 2395 cases

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#### Objective

Decompressive craniectomy (DC) is a widely used neurosurgical intervention to alleviate intracranial pressure. However, its clinical utility in patients with aneurysmal subarachnoid hemorrhage (aSAH) remains a topic of debate. This multicenter pooled analysis examines the impact of DC on short-term outcomes in aSAH, with a particular focus on the timing of the procedure.

#### Methods

Institutional observational aSAH cohorts from three German university hospitals, encompassing cases treated between January 2003 and September 2024, were pooled. Baseline patient and aSAH characteristics, along with the need for DC during hospitalization, were documented. Poor short-term functional outcome was defined as a modified Rankin Scale score of 5 or 6 at discharge. Subgroup analyses were conducted to identify potential target populations for primary DC (performed within 24 hours of aSAH onset).

#### Results

The pooled cohort included 2,395 consecutive aSAH cases (median age: 55 years, 67.1% female). The overall DC rate was 21.8% (n=522), varying between 12.6% and 27.8% across the participating institutions. Poor short-term outcomes were observed in 41.6% of the cohort. In a subgroup of younger patients ( $\leq$ 55 years) with an initial World Federation of Neurosurgical Societies (WFNS) Scale score of 3 or 4 and evidence of additional intracerebral and intraventricular hemorrhages on admission CT scans (n=71), primary DC was associated with a significantly lower rate of poor short-term functional outcomes compared to secondary or no DC during hospitalization (31% vs. 67.5%; odds ratio [OR]: 0.22, 95% confidence interval [CI]: 0.08–0.61, p=0.0036). This subgroup also showed reduced in-hospital mortality rates with primary DC (10.3% vs. 32.5%; OR: 0.25, 95% CI: 0.06–0.97, p=0.0454). In other subgroups, no definitive benefit of primary DC regarding the study endpoint was demonstrated.

#### Conclusion

While DC can be life-saving in specific scenarios, our findings suggest that only a small subpopulation of aSAH patients is likely to benefit from primary prophylactic DC. More than 97% of aSAH patients do not appear to experience significant short-term clinical benefits from primary DC at admission. Further research is necessary to assess long-term functional outcomes in aSAH patients treated with and without primary DC.

### Vaskuläre Neurochirurgie 2 | Vascular neurosurgery 2

### V054

Trend des Vitamin-D-Mangels bei der aneurysmatischer Subarachnoidalblutung - eine bundesweite Analyse Trends in vitamin D deficiency in aneurysmal subarachnoid hemorrhage – a nation-wide analysis

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#### Objective

Hospitalization of patients with aneurysmal subarachnoid hemorrhage (aSAH) is often prolonged due to the high morbidity. Vitamin D has been discussed to have neuroprotective properties; the proportion of vitamin D deficiency for aSAH is uncertain. We assessed proportion of vitamin D deficiency for aSAH vs. a control group of traumatic brain injury (TBI) patients.

#### Methods

We included hospitalization data from the German Federal Statistical Office (DeStatis) for aSAH (ICD-10 I60) and TBI (ICD-10 S06) from January 1st, 2015 to December 31st, 2022. Data on vitamin D deficiency (ICD-10 E55) were collected for both disease groups. Patients  $\geq$  20 years were included and subcategorized into adults (<65 years) and elderly ( $\geq$ 65 years). We calculated odds ratios (OR) with 95% confidence intervals (CI) and adjusted for age and sex.

#### Results

Between 2015 and 2022, 135,508 hospitalizations for aSAH (57.15% female) vs. 1,944,399 for TBI (48.8 % female) were included. Mean proportion of vitamin D deficiency in aSAH was 1.09% vs. 1.06% in TBI [OR 0.94 (CI: 0.79-2.66), Figure 1]. Adult subgroup analysis showed significantly increased proportions of vitamin D deficiency in aSAH 0.67% vs. TBI 0.19% [OR 2.44 (CI: 1.52-3.91)]. This significant effect was observed in both female [OR 4.11 (CI: 2.7-6.25)] and male populations [OR 2.82 (CI: 1.58-5.06)]. Among the elderly, vitamin D deficiency was not statistically different with 1.53% aSAH vs. 1.62% TBI [OR 0.92 (CI: 0.75-1.12).

#### Conclusion

Higher proportion of vitamin D deficiency among aSAH vs. TBI in the adult subgroup was detected. Both genders were affected with a more pronounced effect in female population. Further data stratification might investigate whether addressing vitamin D deficiency impacts hospitalization rates among younger aSAH populations.
Abb. 1



Figure 1. Trend of vitamin D deficiency proportion 2015 – 2022 Odds ratios (OR) with 95% confidence intervals (CI) compare vitamin D deficiency proportions between aSAH vs. TBI across all hospitalizations and adult und elderly subgroups during the study period 2015 – 2022.

## V055

#### Vorbereitung der CONFUSE-Studie: Ein umfassender Umbrella-Review zu psychiatrischen Folgen nach nichttraumatischer Subarachnoidalblutung

#### Preparing the CONFUSE Study: A Comprehensive Umbrella Review of Psychiatric Outcomes Following Non-Traumatic Subarachnoid Hemorrhage

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#### Objective

Clinical observations suggest that patients with non-traumatic subarachnoid hemorrhage (ntSAH), including aneurysmal or prepontine subarachnoid hemorrhage, often experience psychiatric symptoms even when achieving favorable functional outcomes (modified Rankin Scale scores of 0-3). This umbrella review is the first to synthesize qualitative and quantitative evidence linking ntSAH with psychiatric sequelae, drawing on published, peer-reviewed systematic reviews and meta-analyses. While several meta-analyses have investigated this topic, critical limitations remain underexplored. This review therefore examines the prevalence of depression, anxiety, post-traumatic stress disorder (PTSD), and overall psychiatric impairments associated with ntSAH.

#### Methods

The umbrella review adhered to PRISMA guidelines and was registered with a protocol on PROSPERO. Databases including PubMed, EMBASE, and EBSCOhost (PsycINFO) were searched for English-language, peer-reviewed systematic reviews and meta-analyses up to October 2024. Included studies were summarized and categorized, with their quality assessed using the AMSTAR checklist.

#### Results

Of 20 full-text articles assessed, 11 studies met inclusion criteria. PTSD was addressed by one meta-analysis and one systematic review, fatigue by one meta-analysis and one systematic review, and depression by two meta-analyses. General neuropsychiatric disorders were analyzed in three studies, while anxiety following aneurysmal SAH (aSAH) was discussed in only one study. The meta-analysis on fatigue showed moderate heterogeneity, whereas all other meta-analyses displayed high heterogeneity. Among the included reviews, six focused on aSAH and five on ntSAH. Primary studies relied predominantly on multiple-choice, self-reported inventories such as the Beck Depression Inventory (BDI). All included reviews and meta-analyses reported an increase in psychiatric sequelae following ntSAH.

#### Conclusion

This umbrella review confirms that psychiatric sequelae are common consequences of ntSAH. However, the extent and nature of these psychological impairments remain insufficiently studied. More robust and controlled research is needed to reduce heterogeneity, deepen understanding, and improve treatment of the psychiatric outcomes associated with ntSAH. To address these gaps, we plan to initiate a prospective study, called the CONFUSE-Study.

### V056

Vorhersage von posthämorrhagischem Hydrozephalus und zerebralem Vasospasmus nach aneurysmatischer Subarachnoidalblutung (aSAH) mithilfe des OLINK-Proteoms Predicting post hemorrhagic hydrocephalus and cerebral vasospasm after Aneurysmal Subarachnoid Hemorrhage (aSAH) using OLINK-proteomics

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#### Objective

Inflammation plays a crucial role in the disease course following aneurysmal subarachnoid hemorrhage (aSAH). However, the role of specific inflammatory biomarkers in predicting post SAH complications is still not fully explored.

#### Methods

We performed OLINK-proteomics inflammatory panel analysis on the serum of patients collected at day 4 after aSAH. The data was analyzed by performing T-test. The data is presented as mean±standard deviation.

#### Results

In total we prospectively recruited 54 patients (38 women, 16 men; 28 poor grade WFNS (4-5), 26 good grade WFNS (1-3). The concentration of 30 biomarkers was elevated in patients with delayed cerebral ischemia (DCI) (n=12) than in patients without DCI (n=39). The top five biomarkers were CCL20 (no DCI=8,43±1,63 vs DCI=10,09±1,65, p=0,004), IL-6 (no DCI=6,93±1,86 vs DCI=8,53±1,50, p=0.01), IL-17C (no DCI=3,93±1,52 vs DCI=5,17±1,09, p=0.0130), IL-17A (no DCI=1,42±1,31 vs DCI=2,51±1,57, p=0.028), and MCP-3 (no DCI=4,10±0,86 vs DCI=5,17±1,26, p=0.002). 21 biomarkers showed significantly altered expression in patients with hydrocephalus (HC) (n=30) and patients without HC (n=22). The top 5 biomarkers with higher concentration in patients with HC than in patients with no HC were FGF21 (no HC=7.43±1.67 vs HC=9.29±2.37, p=0.003), IL6 (no HC =6,57±1.42 vs HC=7.73±1.89, p=0.02), CCL20 (no HC=8.16±1.28 vs HC=9.20±1.78, p=0.026), IL-17A (no HC=1.15±0.94 vs HC=2.06±1.49, p=0.027) and MCP-3 (no HC=3.82±0.75 vs HC=4.60±0,90, p=0.0023). The top 5 biomarkers with lower concentration in patients with HC than in patients with no HC were SCF (no HC=9.68±0.73 vs HC=9.13±0.58, p=0.004), TWEAK (no HC=8.81±0.66 vs HC=8.30±0.44, p=0.002), TRANCE (no HC=3.78±0.84 vs HC=3.36±0.57, p=0.04), TRAIL (no HC=9.33±0.59 vs HC=9.01±0.52, p=0.045) and DNER (no HCP=9.14±0.28 vs HC 8.91±0.37, p=0.022). The concentration of 6 biomarkers was significantly different between patients with no cerebral vasospasm (CVS) <4 MTT (n=30) and patients with cerebral vasospam ≥4 (seconds) mean transit time (MTT) (n=24). The top three biomarkers were MCP-3 (no CVS=4,09±0,83 vs CVS=4,73±1,19, p=0.023), CCL23 (no CVS=12,49±0,73 vs CVS=13,09±0,64, p =0.003), FGF-19 (no CVS=7,09±0,69 vs CVS=7,58±0,82 p=0.022).

#### Conclusion

Analysis of the OLINK inflammatory panel revealed potential biomarkers for predicting post-aSAH complications including vasospasm and hydrocephalus. These biomarkers together with clinical parameters may offer valuable insights for early risk assessment and targeted intervention.

### V057

Vergleichende Analyse von KI-Modellen für Behandlungsstrategien bei nicht rupturierten intrakraniellen Aneurysmen

Comparative Analysis of AI Models in Predicting Treatment Strategies for Unruptured Intracranial Aneurysms

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#### Objective

The increasing incidence of unruptured intracranial aneurysms (UIAs) has led to significant demands on neurovascular boards. AI-models, such as GPT-4, GPT-3.5, Claude, and Atlas GPT, have emerged as tools to assist clinical decision-making. This study compares treatment recommendations from these AI models with those of an interdisciplinary neurovascular board to evaluate their accuracy and alignment.

#### Methods

We retrospectively included all 57 patients with UIAs discussed by the neurovascular board in 2023. Key clinical and radiographic data, including PHASES, ELAPSS, and UIATS scores, were provided to the AI models. Each model was tasked with recommending either conservative or operative management and specifying treatment modality (clipping, coiling, flow diverter, WEB-device) where appropriate.

#### Results

Operative treatment was recommended in 31 cases (54%) = by the neurovascular- board, compared to 33 (57.9%) by GPT-4, 35 (61.4%) by GPT-3.5, 30 (52.6%) by Claude, and 28 (49.1%) by Atlas GPT (p=0.266). GPT-4 demonstrated the highest accuracy in correctly predicting conservative or operative treatment decisions (89%), followed by GPT-3.5 (82%), Atlas GPT (74%), and Claude (70%) (p = 0.003). For follow-up intervals in conservative management, the neurovascular board recommended a mean of 13.36 months, while AI models suggested shorter intervals: GPT-4 (10.0 months), GPT-3.5 (12.0 months), Claude (7.7 months), and Atlas GPT (10.8 months).

#### Conclusion

AI models, particularly GPT-4, align closely with expert neurovascular board decisions and offer promising support for initial clinical decision-making. However, interdisciplinary neurovascular boards remain the gold standard for UIA management. Continuous advancements in AI technology are expected to further enhance performance and accuracy.

Abb. 1





Figure 1: **A)** Accuracy of each AI model in correctly identifying conservative treatment recommendations for unruptured intracranial aneurysms. Chat GPT-4 achieved the highest accuracy, followed by GPT-3.5, Atlas GPT, and Claude GPT. **B)** Accuracy of each AI model in correctly identifying the specific treatment type for unruptured intracranial aneurysms.

## RC017

Behandlung von cerebralen Vasospasmen nach einer aneurysmatischen Subarachnoidalblutung mit intraarterieller Gabe von Nimodipin Treatment of cerebral vasospasm after aneurysmal subarachnoid hemorrhage with intraarterial Nimodipine

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#### Objective

Cerebral vasospasm is a significant complication following aneurysmal subarachnoid hemorrhage contributing to an unfavorable neurological outcome. Intraarterial Nimodipine is used to treat cerebral vasospasm after subarachnoid hemorrhage. However, there are insufficient data on the efficacy and outcomes of intraarterial spasmolysis. The aim of this study was to collect demographic data and assess the outcome.

#### Methods

A database with patients who underwent intraarterial vasospasmolysis with Nimodipine at our institute between 2011-2021 was analysed. We identified 229 eligible patients. The modified Rankin Scale (mRS) was used to assess clinical outcome (favorable outcome <2; unfavorable 3-5).

#### Results

In this series, 176 of the total 229 patients were female (76.9%), while 53 patients were male (23.1%). The mean age was 56.4 years. The majority of patients were classified as grade 4 (56 patients, 24.5%) and grade 5 (62 patients, 27.0%) according to the Hunt and Hess classification. In 167 patients (73.0%), the ruptured aneurysm was treated by clipping, while in 56 patients (24.5%), the aneurysm was coiled. A total of 129 patients (56.3%) underwent a single intraarterial vasospasmolysis, in 44 patients (19.2%), vasospasmolysis was performed twice, and the remainder (24.5%) underwent vasospasmolysis more than two times. The median follow-up time for 168 patients was 4 months (range: 3-12 months). 26.6% of patients were lost to follow-up. A favorable outcome was achieved in 47% of patients, while 26.2% had an unfavorable outcome. The remainder (26.8%) died. No significant difference was found between the group of patients with single vasospasmolysis and the group with multiple vasospasmolysis (P > 0.05). A non-significant small positive correlation was found between the number of repeated vasospasmolysis and the mRS (Spearman's r=0,112. P > 0.05).

#### Conclusion

Intraarterial Nimodipine is safe and a likely effective method for the treatment of severe cerebral vasospasm. Further research is needed to understand the long-term benefits of intraarterial Nimodipine treatment.

### RC018

#### Vorhersage von schweren aneurysmatischen Subarachnoidalblutung vor der Ruptur Prediction of Severe Aneurysmal Subarachnoid Hemorrhage Before Rupture

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#### Objective

Predicting the initial severity of aneurysmal subarachnoid hemorrhage (aSAH) is critical for optimizing the management of patients with unruptured intracranial aneurysms (IA). The aim of this study is to identify key patient and aneurysm characteristics that correlate with severe presentations of aSAH, thereby aiding in clinical decision-making and risk stratification.

#### Methods

This retrospective study analyzed data from all patients aged 18 years and older diagnosed with acute aSAH at our institution between January 2003 and June 2016. Severe aSAH was defined based on the World Federation of Neurosurgical Societies (WFNS) Scale Grades 4-5 and the original Fisher Scale Grades 3-4, reflecting the initial condition of patients at presentation. Demographic, clinical, and radiological parameters that could be assessed before aneurysm rupture were recorded. Both univariate and multivariate regression analyses were conducted to identify predictors of severe aSAH.

#### Results

A total of 932 patients were included, with a median age of 55 years. Among these, 404 patients (43.35%) experienced severe aSAH. Multivariate regression analysis revealed that advanced age (over 55 years) significantly increased the likelihood of severe aSAH (adjusted odds ratio [aOR] = 1.33, 95% confidence interval [CI]: 1.01-1.76). Similarly, larger aneurysm size (greater than 6 mm) was strongly associated with severe aSAH (aOR = 1.90, 95% CI: 1.45-2.50). Interestingly, smoking appeared to have a protective effect, being associated with a lower risk of severe aSAH (aOR = 0.49, 95% CI: 0.36-0.67). Additionally, a history of migraines was found to correlate with reduced severity (aOR = 0.26, 95% CI: 0.10-0.70).

#### Conclusion

The severity of aSAH can be anticipated based on patient and aneurysm characteristics prior to rupture. Factors such as older age and larger aneurysm size increase the risk of severe aSAH, whereas smoking and migraines appear to reduce the likelihood of severe outcomes. These findings underscore the importance of incorporating patient-specific and aneurysm-specific data into risk assessments for individuals with unruptured IAs. Future research should explore the underlying mechanisms of these associations and evaluate how these insights can inform preventive strategies and personalized clinical management.

### V058

Optimale Gefäßrekonstruktion durch maßgeschneiderte Clipauswahl bei der chirurgischen Versorgung intrakranieller Aneurysmen Optimized Vascular Reconstruction through customized Clip Selection in the Surgical Management of Intracranial Aneurysms

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#### Objective

Vascular reconstruction (VR) is a fundamental objective in the surgical management of intracranial aneurysms, aiming to exclude the aneurysm from vascular circulation while maintaining physiological flow in the feeding vessel (FV). The efficacy of different clip designs (straight, bent, lateral and fenestrated) depends on the anatomy of the FV and the surgical approach employed. Optimized clip selection may therefore enhance clinical outcome by improving VR and minimizing residual perfusion (RP).

#### Methods

In a retrospective analysis (2020-2024) we examined 198 surgically clipped aneurysms. The study focused on the correlation between the FV, the clip design used, the quality of VR achieved and the presence of RP. FV were classified into 4 groups: A. cerebri media (MCA), A. communicans anterior (ACOM), A. carotis interna (ACI) and aneurysms of the posterior circulation (post). Additional parameters included occurrence of postoperative vasospasms (postV), temporary clipping (tC), intraoperative complications (iopC) and the modified Rankin Scale (mRS). The evaluation was based on the angiographic data (CT-A, DSA) and independently assessed by a neuroradiologist and two neurosurgeons. To detect statistically significant differences Pearson's Chi-Squared test was applied.

#### Results

Among 198 aneurysms, the FV distribution was as follows: 112 MCA, 50 ACOM, 32 ACI and 4 post. Overall, VR was achieved in 52% of cases, with 17% demonstrating RP. Patients who did not achieve VR had an 8% higher incidence of postV. Overall, patients who achieved VR showed a better clinical outcome as measured by the mRS. There appears to be no significant correlation between tC or iopC and the mRS. Regarding the VR, a clear advantage was observed in the ACOM group for fenestrated (fen.) clips. VR was achieved in 86% of ACOM aneurysms treated with fen. clips (p<0.001), compared to 74% across all clip types. Furthermore, RP occurred in only 15% of ACOM aneurysms treated with fen. clips, in contrast to 26% for all clip types in this group.

#### Conclusion

Tailored clip selection significantly improves VR and reduces RP rates, particularly for ACOM aneurysms treated with fen. clips. To validate the observed trends and mitigate potential bias favoring fen. clips, a multicenter study with a broader patient population is planned.

### V059

Retrospektive Analyse endovaskulär versorgter intrakranieller Aneurysmen im elektiven vs. notfallmäßigen Setting

A retrospective analysis of ruptured versus unruptured intracranial aneurysms treated with interventional endovascular techniques

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#### Objective

Endovascular treatment of intracranial aneurysms has become increasingly significant in clinical practice. This study aimed to assess recanalization rates and the need for secondary interventions following endovascular therapy for both ruptured and unruptured intracranial aneurysms. Secondary endpoints included therapy-related complications associated with the interventional procedures

#### Methods

A cohort of patients from our hospital with either unruptured or ruptured intracranial aneurysms, treated between 2014 and 2023, was identified. Patient demographics, recanalization rates, and the need for secondary interventions following initial endovascular treatment were compared. Recanalization rates and the necessity for secondary interventions were evaluated using the Raymond-Roy scale. All recurrences with significant residual perfusion of the aneurysm dome, classified as Raymond-Roy scale 2 or higher, were considered clinically significant and required treatment. Follow-up data were collected at one, three, and five years to analyze time-dependent differences between the groups. Peri-interventional intracerebral hemorrhages, acute ischemic strokes, and other complications were documented and compared between the two groups.

#### Results

After data cleaning, 88 patients (44%) were treated following aneurysm rupture (Group 1), while 114 patients (56%) underwent elective treatment for unruptured aneurysms (Group 2). Group 1, which consisted of patients who underwent emergency interventions for ruptured aneurysms, exhibited a significantly higher rate of reperfusion. This group had a notably higher incidence of requiring more than one intervention for revision (26% vs. 20%). The follow-up analysis revealed that the recanalization rate was significantly higher in Group 1, with repeated interventions being required more frequently. These differences were particularly pronounced during the first year after treatment and persisted throughout the three- and five-year follow-up periods. Furthermore, Group 1 exhibited a higher incidence of cases requiring multiple re-interventions. Perioperative complications occurred less frequently in Group 2.

#### Conclusion

Endovascular treatment strategies for intracranial aneurysms have gained popularity due to their less invasive nature and lower peri-interventional risks. According to our findings ruptured aneurysms treated endovascularly in an emergency setting showed the need for more frequent interventions which must be considered as potential complications.

### V060

Zeitliche Analyse des Ventrikelvolumens im Mausmodell der Subarachnoidalblutung Temporal Dynamics of Ventricular Volume Alterations in a Murine Model of Subarachnoid Hemorrhage

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#### Objective

Hydrocephalus and e vacuo ventricular enlargement are hallmarks of subarachnoid hemorrhage (SAH) pathology in humans, especially in the subacute and chronic stage of the disease. The exact pathomechanisms are poorly characterized and it remains unclear whether and how these phenomena contribute to long-term posthemorrhagic brain damage. So far, there is only little experimental data assessing these changes and the majority of animal studies concentrates on the early phase after SAH (24-72h). The aim of the present study is to characterize the long-term temporal changes in ventricular volume in a murine model using serial MRI imaging.

#### Methods

Male C57BI/6N mice (n=11) underwent SAH induction via the endovascular middle cerebral artery perforation model, while a sham-operated group and naïve animals (n=9 each) served as controls. T2-weighted MRI scans were obtained at baseline (prior to surgery), 24 hours, 3 days, 7 days, and 1-month post-surgery. Ventricular volumes were calculated using Fiji ImageJ software

#### Results

Naïve animals did not show relevant changes in ventricular volume over time. Sham-operated mice demonstrated minimal ventricular volume changes throughout the observation period. Within 24 hours post-SAH, ventricular volume doubled, with an average enlargement of  $102.4\% \pm 28.0\%$  compared to baseline (p<0.001). In the SAH group, ventricular enlargement persisted up to the end on the observation period at one month (p<0.001 vs. baseline), however, regressed over time. Ventricle volume was higher in SAH animals than in sham operated mice at all time points.

#### Conclusion

This study provides a detailed and longitudinal characterization of ventricular volume dynamics in the murine endovascular perforation model of SAH. Acute hydrocephalus was observed in all SAH cases, ventricular enlargement persisted up to one month. These findings underscore the need for further studies to elucidate the pathophysiological mechanisms underlying the progression and resolution of both acute and chronic hydrocephalus after SAH. Further analyses (e. g. by immunohistochemistry, CSF analysis) in order to further characterize pathomechanisms are ongoing.

## V061

# Profiling tumor-associated macrophage subtypes and PD-L1 status in colorectal cancer and corresponding brain metastases

Verteilung der Subtypen Tumor-assoziierter Makrophagen und PD-L1-Status im zerebral metastasierten kolorektalen Karzinom

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#### Objective

Tumor-associated macrophages (TAMs) have been suggested to strongly impact tumor microenvironment dynamics in brain metastases originating from colorectal cancer. Due to their plasticity, which allows them to adopt antitumoral (M1 type) and protumoral (M2 type) phenotypes, TAMs exert a profound effect on tumor behavior and patient outcomes. Therefore, the aim of this study was to characterize the inter- and intratumoral distribution of different TAM subsets.

#### Methods

Formalin-fixed, paraffin-embedded tumor samples from 50 patients with brain metastases from colorectal cancer, including 31 matched primary and metastatic tumors, were analyzed. Tissue microarrays were constructed, and immunohistochemical staining was performed for CD68 (pan-macrophage marker), CD86 (antitumoral M1 type), CD163 (protumoral M2 type), and PD-L1. Semiquantitative scoring was used to assess TAM markers, while PD-L1 immunopositivity was analyzed using established scores. TAM infiltration rates were compared between primary and metastatic tumors, across tumor regions, and correlated with PD-L1 status and clinical data, including survival.

#### Results

We observed infiltration of both antitumoral and protumoral TAMs across all tumor regions in both primary and metastatic tumors. Tumor region analysis revealed a higher abundance of TAMs in the tumor stroma compared to the tumor nest. Notably, metastases exhibited increased protumoral TAM infiltration in the stroma relative to their primary tumors. Discordant PD-L1 status was observed in 37% of matched pairs, mostly due to newly acquired expression in the metastases. Correlation analysis showed a greater presence of TAMs in PD-L1-positive tumors. Survival analysis indicated that lower CD68+ TAM scores in the primary tumor were linked to longer progression-free survival. However, TAM infiltration in either primary or metastatic tumors did not significantly impact overall survival.

#### Conclusion

Both primary and metastatic tumor microenvironments harbor a combination of protumoral and antitumoral TAMs, influencing tumor progression in ambivalent ways. TAMs are most abundant in the tumor stroma, with metastases showing a slightly higher proportion of protumoral phenotypes. Variations in PD-L1 status are indicative of increasing immune evasion during the metastatic process.

### V063

Einfluss von präoperativ kumulativ verabreichtem Dexamethason auf die Tumormikroumgebung bei NSCLC-Hirnmetastasen Influence of Pre-Operative Cumulative Dexamethasone on the Tumor Microenvironment in NSCLC Brain

Influence of Pre-Operative Cumulative Dexamethasone on the Tumor Microenvironment in NSCLC Brain Metastases

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#### Objective

Dexamethasone (DEXA) is commonly used to manage peritumoral edema in patients with brain metastases, but its impact on the tumor microenvironment (TME) remains underexplored. The immunosuppressive effects of DEXA, including T-cell inhibition, may alter the immune cell composition within non-small cell lung cancer brain metastases (NSCLC-BrM), potentially diminishing the efficacy of subsequent immune checkpoint inhibitor therapy.

#### Methods

We analyzed retrospectively collected formalin-fixed, paraffin-embedded (FFPE) tissue from 30 resected NSCLC-BrM patients, stratified into three groups: no DEXA exposure before resection (n=10), high-dose short-term DEXA exposure (n=10), and high-dose long-term DEXA exposure (n=10). DNA methylation profiling using the Illumina EPIC array, combined with a reference-based deconvolution algorithm (methylDeConv), allowed for the quantification of immune cell fractions within the bulk tumor. Methylation profiles from cell-sorted populations served as a reference for normal cells, while those from LUAD cell lines represented the malignant signature. H&E staining and multiplex immunohistochemistry (mIHC) targeting CD3, CD8, FoxP3, CD163, PD-L1, and panCK were applied to 18 matching samples to assess the spatial distribution of immune cells.

#### Results

DNA methylation deconvolution revealed a significant reduction in CD8+ T cells in patients receiving DEXA treatment, regardless of whether a short-term or long-term regimen was used, compared to DEXA-naïve patients (Fig. 2A, 2B). These findings were further corroborated by mIHC, which demonstrated that CD8+ T cell depletion occurs predominantly in the tumor stroma (Fig. 2C, 2D), whereas tumor infiltrating CD8+ T cells are quantitatively unaffected.

#### Conclusion

Cumulative pre-operative DEXA administration significantly alters the immune cell composition within NSCLC-BrM, fostering an immunosuppressive TME. These results underscore the importance of considering the potential immunomodulatory effects of DEXA, particularly for patients eligible for immune checkpoint inhibition. Further analyses of an expanded cohort are currently underway.



**Figure 1:** Graphical abstract summarizes the study design investigating the influence of preoperative dexamethasone (DEXA) on the tumor microenvironment in non-small cell lung cancer brain metastases. The cohort includes 30 NSCLC patients divided into three groups: no DEXA (n=10), high-dose short-term DEXA (n=10), and high-dose long-term DEXA (n=10). Tissue-based analyses conducted after surgical resection include H&E and immunohistochemistry (IHC), multiplex IHC, and EPIC array profiling, aimed at evaluating immune cell infiltration and tumor microenvironment composition. Abb. 2



**Figure 2:** DNA methylation data depicting relative cell type frequencies across patient samples, with reduced T-cell fractions in DEXA-treated groups (**A**, **B**). Multiplex IHC data describing the percentage of immune cell phenotypes (CD3+, CD8+, CD3+FoxP3+, CD163+, PD-L1+CD163+) across stroma (**C**) and tumor (**D**) compartment, highlighting reduced T-cell populations within the stroma after DEXA treatment.

### RC019

Stimulierte Raman Histologie und künstliche Intelligenz-basierte Analysetechniken zur schnellen intraoperativen Resektionsrandkontrolle in der Hirnmetastasenchirurgie Stimulated Raman Histology and Artificial Intelligence-based Analysis for Rapid Intraoperative Resection Margin Control in Brain Metastases Surgery

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#### Objective

Extent of resection (EOR) is crucial in brain metastases (BM) surgery, yet margin control largely depends on the surgeon's subjective assessment and incomplete resections remain prevalent. This study aims to evaluate the feasibility of stimulated Raman histology (SRH) and artificial intelligence (AI)-based algorithms for rapid intraoperative tissue analysis for resection control in BM surgery.

#### Methods

In this prospective observational diagnostic study, we screened all adult patients indicated for complete surgical resection of non-eloquent BM by the interdisciplinary tumor board panel at our center in 2024. SRH images were obtained from 1mm<sup>3</sup> tissue samples taken from predefined areas of the resection cavity after the surgeon's subjective assessment of complete BM removal, at least 4 samples per resection cavity in addition to the tumor core. These images were classified into the likelihood of 'tumor', 'non-tumor' or 'low quality' using a pre-established AI analysis algorithm<sup>1</sup> on the basis of a tumor reveal score. The surgeon was blinded to the results to disable further intervention. Tissue samples were then sent for routine histopathological review, as reference standard for the presence of microscopic tumor. EOR was assessed by postoperative MRI within 72 hours.

#### Results

So far, we enrolled 26 patients generating 221 SRH images in total, of which 119 were taken from resection margins (34.6% posterior fossa location, 15.4% recurrencies). We detected microscopic remnant tumor at the resection bed in 19.2% of patients. We found a tumor reveal threshold of 55 on AI based SRH analysis to best differentiate tumor from non-tumor tissue, revealing an overall accuracy of 88.2% in correctly diagnosing the margin samples regarding microscopic tumor remnants (sensitivity 83.3%, specificity 88.5%, AUC 85.9%, and a remarkably high negative predictive value of 99.0%). In subgroup analysis, false positives were significantly more often detected in the posterior fossa (p=.007). The MRI correlation analyses are still ongoing.

#### Conclusion

SRH imaging may serve as a rapid tool for intraoperative resection margin assessment in BM surgery. However, the AI tumor reveal threshold should be set higher for BM than glioma surgery to account for interference with the hypercellular granular layer in the cerebellum. Further studies are required to clarify the impact on the complete resection rate in BM surgery.

<sup>1</sup>Reinecke D et al., Acta Neuropathol Commun 2022;10:109.

### V066

Evaluation des Fluoreszenzverhaltens von Hirnmetastasen unter Verwendung von Natrium-Fluoreszein und 5-ALA

#### Evaluation of the fluorescence patterns of brain metastases using sodium fluorescein and 5-ALA

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#### Objective

Gross total resection (GTR) of brain metastases (BM) is relevant for overall survival (OS). The use of fluorescence during surgery can be useful in this respect. 5-ALA is well established for gliomas, but brain metastases usually do not respond to it. Sodium fluorescein (Na-FI) can be used there, but to date there is far less experience in this field.

#### Methods

We performed a retrospective analysis of fluorescence guided resections of brain metastases from 2020 to date. The surgical reports were analyzed to determine whether 5-ALA or Na-Fl was used and whether fluorescence was visible with the specific microscope filter. The histopathological findings were documented, too. Finally, a Fisher's exact test was performed.

#### Results

Out of 80 fluorescence-assisted BM resections, Na-Fl was applied in 54 cases and 5-ALA in 28 cases (2 patients were resected with the help of both agents). Following Na-Fl-administration, there was visible fluorescence in the Yellow 560 nm filter in 52 BM (96.3 %), but no response in 1 BM (1.9 %) and no documentation in another case. In contrast, 5-ALA induced fluorescence in the Blue 400 nm filter was positive in 11 (39.3 %) and negative in 12 (42.9 %) patients. In 5 cases, the fluorescence pattern was not documented (17.9 %). Table 1 provides an overview of this. The difference in positive fluorescence between Na-Fl and 5-ALA was statistically significant (p<0.001). Of the two patients who received both active agents, one responded only to Na-Fl and the other to both. The fluorescence patterns of the different metastases are presented in figure 1.

#### Conclusion

In brain metastases, Na-FI induced fluorescence was more frequently observed in contrast to 5-ALA. Na-FI can therefore be useful in the identification of brain metastases as well as the rapid and cost-effective differentiation of metastatic from healthy brain tissue, irrespective of cancer type. Further studies should be undertaken to investigate if using Na-FI influences extent of resection or even OS.

#### Abb. 1

Response	Fluorescence			Total
Agent	Positive	Negative	Not available	
Sodium fluorescein	52	1	1	54
5-ALA	11	12	5	28

#### Abb. 2



### RC020

Ist Epilepsie ein prädiktiver Faktor für längeres Überleben in Patienten mit Gehirnmetastasen? Is Epilepsy a predictive factor for longer overall survival in patients with brain metastasis?

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#### Objective

Seizures may reflect interactions between tumor and brain cells. Emerging evidence suggests that such interactions play a critical role in regulating tumor growth and invasion also in brain metastases (BM, Zeng et al., *Nature* 2019). This study aimed to identify clinical correlates, including the potential prognostic role of epilepsy, in a cohort of patients (pts.) with BM.

#### Methods

We performed a retrospective analysis of 414 pts. who underwent surgical treatment for newly diagnosed BM (59.7% singular) at our institution. A detailed epilepsy follow-up until death or >12 months (including 85 prospective cases) was available for 198 patients. Preop. and postop. MR studies were used for volumetric analysis.

#### Results

Preop. epilepsy was observed in 16.7% of pts., and early postop. seizures ( $\leq$ 30 days, EPS) occurred in 8.9%. Among pts. with detailed follow-up, 28.2% experienced postop. seizures and any epilepsy affected 39.5%. Denovo epilepsy >30 days postop. was documented in 14.4% of cases. Seizure freedom rates were 76.4% at 6 months and 69.5% at 12 months (pts. with complete resections of singular BM: 80.1% and 69.9%). Pts. with preop. epilepsy had seizure freedom rates of 52.6% at 6 months and 48.5% at 12 months. Preop., postop., and overall epilepsy were not prognostic for overall survival (OS); however, EPS was associated with worse OS (med. OS: 4.7 vs. 12.9 months, *P*=.003). Any supratentorial tumor localization was significantly associated with preop. (62/265 [23.4%] vs. only infratent.: 7/149 [4.7%]) and any epilepsy (62/128 [48.4%] vs. 15/67 [22.3%]; both *P*<.001). Age, histology, tumor multiplicity, preop. Karnofsky Performance Index (KPI), sex, and GPA score did not correlate with preop., any or de-novo epilepsy. Smaller (index) tumors and pts. with lesser tumorloads presented more frequently with epilepsy (mean tumor volume; preop. epilepsy: 14.7±16.0 vs. no: 22.4±20.8 cm3, *P*=.003 & mean tumorload; preop. epilepsy: 16.0±16.6 vs. no: 23.3±21.1 cm3; *P*=.006).

#### Conclusion

Preop. and any epilepsy did not impact survival, while EPS was associated with worse outcomes, potentially reflecting the effect of complications. Epilepsy is a frequent complication in pts. with BM. De-novo epilepsy after surgery is not uncommon. Surgery has limited efficacy in preventing seizure recurrence. Overall, there was limited evidence to support epilepsy as an important clinical biomarker in pts. with BM in general, possibly due to the systemic nature and heterogenity of the disease.

### RC021

#### Epilepsie und zerebrale Metastasen – Eine Analyse der stationären Fallzahlen in Deutschland Epilepsy and Cerebral Metastases – An Analysis of Inpatient Cases in Germany

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#### Objective

Cerebral metastases (CM) are the most common intracranial neoplasms, significantly affecting patient quality of life. Despite advancements in diagnostics and therapeutics, the burden remains substantial. Epileptic seizures, which often cause unplanned hospitalizations, are acute crises associated with high stress and injury risks. This study examines the frequency of epilepsy coding in CM patients hospitalized in Germany in 2023.

#### Methods

A cross-sectional analysis was conducted on 72,020 inpatient cases of CM and leptomeningeal malignancies in German hospitals in 2023. Data reported under §21 of the Hospital Remuneration Act were analyzed, including demographics, primary tumor types, epilepsy codes, and mortality.

#### Results

Among 72,020 cases, 35,578 (49%) were female, and 53.7% were aged  $\geq$ 65 years. Malignant lung tumors were identified in 43,436 cases (60.3%), followed by breast malignancies (8,290 cases, 11.5%), diffuse large B-cell lymphoma (4,746 cases, 6.5%), and malignant melanoma (4,682 cases, 6.5%). An epilepsy code (ICD-10-GM G40) was documented in 10,586 cases (14.6%). Of these, 1,937 cases involved focal symptomatic epilepsy with simple focal seizures (18.3%, G40.1), 3,555 with complex focal seizures (33.6%, G40.2), and 2,612 with other or unspecified epilepsy (24.7%, G40.8-9).

Hospital mortality was 13.1% (9,413 cases). Of these, 4,404 were female, and nearly 60% (5,603 cases) were aged  $\geq$ 65 years. Epilepsy was coded in 1,629 fatal cases (17.6%). Male gender, age  $\geq$ 65 years, and coded epilepsy were significantly associated with higher hospital mortality (each p<.0001, Fisher's exact test).

#### Conclusion

Despite therapeutic advancements, CM patients experience high mortality rates, emphasizing the need for integrated palliative care and specialized training to improve outcomes. Male gender, age  $\geq$ 65 years, and epilepsy are key risk factors for in-hospital mortality among CM patients. Further studies are need to further evaluate the identified and other risk factors and the effect of effective anti-epileptic therapies.

### RC022

#### Vergleich der DNA-Methylierungsanalysen von Tumor-DNA aus Liquor und Gewebe bei Glioblastomen Comparison of CSF and tissue derived tumor-DNA methylation analysis in Glioblastoma

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#### Objective

Cerebrospinal fluid (CSF)-derived DNA has shown promise as a minimally invasive source for detecting tumorspecific DNA methylation signatures. However, it remains unclear to what extent DNA methylation subclasses in CSF align with those in the primary tumor, especially when studying tumor subclasses and their clinical relevance. This study evaluated the accuracy of CSF-based DNA methylation profiling and explored the composition of methylation signatures in glioblastoma patients.

#### Methods

This study included five glioblastoma patients (mean age: 70.4 years; SD: 10.15; range: 55–82) with histologically confirmed CNS WHO Grade 4, IDH wildtype glioblastoma. Both tumor tissue and CSF samples were collected. DNA extracted from tissue and CSF was analyzed using DNA methylation microarrays (EPICv2) and nanopore sequencing. Bioinformatic methods included cell-type deconvolution and tumor subclassification using the DKFZ classifier (v12.8).

#### Results

Bioinformatic analysis revealed that DNA methylation profiles from tissue-derived samples predominantly aligned with RTK1 and RTK2 subtypes (4 of 5 samples) and showed high neural scores. In contrast, CSF-derived DNA profiles predominantly displayed low neural characteristics, higher immune cell scores, and were classified as the mesenchymal (MES) subtype by the DKFZ classifier (3 of 5 samples).

#### Conclusion

These results suggest that the mesenchymal subtype identified in CSF may represent immune responses specific to the CSF environment that contaminate tumor-specific methylation signatures. Future studies should focus on filtering immune cell signatures from CSF samples to enhance the accuracy of tumor-specific DNA methylation profiling. This approach could improve the utility of CSF-derived DNA for subclassifying glioblastoma and understanding tumor biology.

### BO-02

Sexuelle Dysfunktion nach Operationen bei primären sporadischen kranialen Meningeomen Sexual dysfunction after surgery for primary sporadic cranial meningiomas

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#### Objective

Although postoperative quality of life (QoL) has been studied in relation to a variety of aspects following meningioma resection, the impact of meningiomas on sexual life has not been investigated. The aim of this study is to determine the impact of cranial meningioma surgery on patients" postoperative sexual life.

#### Methods

A standardized questionnaire, anonymous and based on the Arizona Sexual Experiences Scale (ASEX), was sent to 87 patients who had been selected for participation in the study based on the following criteria: a postoperative Karnofsky performance of  $\geq$  80 and below 60 years of age at diagnosis.

#### Results

53 patients (53/87; 61%) responded to the survey. The study identified eleven patients (20.8%) who reported sexual dysfunction (SD) according to ASEX criteria. Six of these patients were women (55%) and five were men (45%). Univariable analysis revealed that SD was observed with greater frequency in patients with non-skull base tumors (p = 0.006) and in those with a left-hemispheric meningioma (p = 0.046). Multivariable analysis revealed that non-skull base tumor location is the only independent factor being associated with SD (OR = 5.71, 95% CI = 1.02-31.81, p = 0.047)

#### Conclusion

This first investigation of sexual functioning post-surgery for cranial meningiomas indicates that SD is a prevalent issue among non-skull base meningioma patients. Consequently, we recommend that pre- and postoperative sexual health should be further addressed in future QoL investigations of cranial meningioma patients.

### V065

The HiResMet Trial: Sicherheit und Effektivität pathologisch-kontrollierten, supramaximalen Resektion bei der operativen Behandlung von Hirnmetastasen – vorläufige Ergebnisse The HiResMet Trial: Safety and effectiveness of cellular-guided supramaximal resection in surgery for brain metastases – preliminary results

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#### Objective

Achieving RO resection is a primary goal in the surgical treatment of many cancer entities but is often considered unfeasible in surgery for brain metastases (BM) due to the risk of neurological deficits and the biological characteristics of BM. The HiResMet trial evaluates the feasibility and safety of histologically-guided resection using real-time intraoperative neuropathological assessment.

#### Methods

Supramaximal resection was performed with real-time analysis of up to five native tissue samples from each resection margin direction. If smear preparations (unfixated, methylene blue) indicated tumor presence, up to four additional resections per direction were performed to achieve possible RO resection. RO resection was defined as the absence of tumor cells in intraoperative smear preparations. The primary outcome was the Karnofsky Performance Scale (KPS) score at 30 days postoperatively. Secondary outcomes included the number of additional resections required, comparisons of RO resection with radiological gross total resection (GTR) and surgery terminations due to safety concerns.

#### Results

Fourteen patients with 15 BM were enrolled. The median KPS at 30 days postoperatively was 80%. In 6 of 15 BM (40%), resection had to be extended into the peritumoral niche (PN), with a mean of one additional resection per direction (range: 0–3). R0 resection was achieved in all cases and corresponded to radiological GTR (100% success rate). No surgeries were terminated due to safety concerns. Despite the absence of tumor cells in intraoperative smear preparations, postoperative histopathological analysis identified panCK and melanA-positive cells in 7% of the final ('R0') peritumoral samples. Additionally, reactive tissue (gliosis) was observed in 88%, activated endothelial cells in 29%, hemosiderin in 13%, focal lymphocytic infiltrates in 14%, and necrosis in 5% of the samples.

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#### Conclusion

Preliminary results from the HiResMet trial suggest that histologically-guided supramaximal resection is both effective and safe in surgery for brain metastases. Biological RO resection reliably aligns with radiological GTR, demonstrating the feasibility of this approach.

### BO-03

#### LINNDA - LymphomIdentifikation mittels neuraler Netzwerk basierter DetekionsAssitenz LINNDA – Lymphoma Identification through neural network detection aid

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#### Objective

The preoperative distinction between glioblastoma (GBM) and primary central nervous system lymphoma (PCNSL) can be difficult, even for experts. Ruling out PCNSL early in the diagnostic workflow enables corticosteroid treatment, which acutely relieves symptoms in GBM but compromises diagnosis in PCNSL. We recently developed an easy-to-use algorithm based on a convolutional neural network (CNN) that was non-inferior to expert clinicians. We now aimed to validate a workflow integrating human and artificial intelligence in the diagnostic routine of PCNSL.

#### Methods

We enrolled 26 patients with histopathological diagnoses of GBM (n=17) or PCNSL (n=9). Ten human raters (7 neurosurgeons and 3 radiologists) and our previously developed CNN were tasked with diagnosing the tumor entities. We statistically compared the correlations between raters and assessed differences in diagnostic performance using t-test, ANOVA, and chi-square where applicable.

#### Results

The CNN correctly diagnosed 61.5% of all tumor entities. In GBM, the accuracy was slightly lower than in PCNSL (57.89% vs. 71.43%, p=0.53, Chi-square). Human raters individually reached 83.46  $\pm$  7.26% accuracy for the entire collective. Assuming a diagnostic decision to be based on the consensus between several clinicians, we formed a paradigm where two raters must agree on a final decision. In this case, the diagnostic accuracy fell to 69.7%. Clinicians tended to err in similar cases, with positive correlations among radiologists (0.395  $\pm$  0.2) and neurosurgeons (0.23 $\pm$ 0.29) and an overall correlation between clinicians at 0.33  $\pm$  0.27. The CNN showed a marked deviation, correlating significantly less with Clinicians (-0.06  $\pm$  0.11, p=0.0004, 2-way ANOVA, Fig. 1). Our combined workflow, relying on the CNN"s diagnosis only in cases of dissent between two raters, significantly augmented the diagnostic performance to 90.76% (p<0.001, chi-square) with a PPV for GBM of 97.78%

#### Conclusion

We validated a diagnostic workflow for the preoperative diagnosis of PCNSL based on imaging alone, integrating expert opinion with artificial intelligence. Our model has the potential to improve the preoperative care for these patients significantly.

Fig.1: left: Sankey-Chart illustrating the benefit of CNN-based diagnosis in cases of human dissent. Right: Raters (R1-10) showed heterogeneous performances regarding tumor classification (pie charts). The correlation between cases diagnosed correctly and incorrectly between raters is color-coded by the connecting lines.





### V067

#### Evaluierung visueller lokoregionaler Antigenbestimmung für CAR-T-Zell Therapie beim Glioblastom Evaluating Visual Locoregional Antigen Profiling for CAR T-Cell Therapy in Glioblastoma

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#### Objective

Genetic modification of T-cells to express chimeric antigen receptors (CARs) provides promising results in tumor therapy. However, in glioblastoma (GBM), selecting suitable tumor-associated antigens (TAAs) is challenging due to its high intra- and intertumoral heterogeneity. Effective treatment requires striking a balance between comprehensive tumor coverage to prevent antigen escape and relapse on the one hand, and minimizing target antigen overlap to reduce off-tumor toxicity on the other. Thus, this work presents and evaluates a novel automated artificial intelligence pipeline for CAR T-cell therapy target selection solely based on immunohistochemically (IHC) stained whole-slide images (WSIs).

#### Methods

The pipeline processes one Hematoxylin and Eosin stained WSI and multiple IHC WSIs stained for different TAAs. Initially, all slides are aligned using the VALIS framework, followed by machine-learning-based tumor detection. The WSIs are quantified for antigen coverage, and antigen combinations with minimal overlap and maximum coverage are identified. Reliability of this approach was assessed by comparing results with conventional methods using Pearson correlations between pipeline quantification results, QuPath-derived H-scores, and 3D Histech tumor coverage. The analysis was conducted on a dataset of 11 GBM tumors, each stained for six potential targets for CAR T-cell therapy.

#### Results

The results show a strong correlation of the developed pipeline with conventional methods. The comparison with the H-Score showed an average correlation coefficient of  $0.83 \pm 0.12^{**}$  ( $0.64^* - 0.95^{***}$ ). Similarly, the comparison to the coverage calculations yielded an average correlation of  $0.79 \pm 0.10^{**}$  ( $0.60^* - 0.89^{***}$ ). Despite some variability, most results were  $\geq 0.82$  for the H-score and  $\geq 0.79$  for the antigen coverage, indicating the pipeline"s reliability.

#### Conclusion

This work first evaluates an innovative automated artificial intelligence pipeline for assessing tumor coverage and testing its performance against conventional H-Score and antigen coverage calculations. The strong correlations confirm the pipeline"s reliability compared to conventional methods and indicate its potential as a decision support system for CAR T-cell therapy target selection. To further assess its clinical applicability, the pipeline is currently evaluated on a larger dataset of GBM patients, including validation of the CAR T-cell therapy efficacy of selected antigen combinations on organoid models.

### V068

Deep Learning basierte automatische Segmentierung von Glioblastomen Deep Learning-based automatic Segmentation of Glioblastoma

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#### Objective

Identification, localization, and segmentation of brain tumors such as glioblastomas pose a great challenge in medical imaging. Manual detection and segmentation still remain the gold standard, but however are time-consuming, heavily user-dependent and complex. This raises the need for automated approaches to reliably, precisely, and efficiently detect and outline brain tumors for diagnostics, therapy planning, and disease monitoring.

#### Methods

For automated detection and segmentation of the glioblastoma within routine MRI data encompassing T1- and T2- weighted, FLAIR and contrast-enhancing T1-weighted data sets, with its surrounding edema and contrast-enhancing parts to quantify further characteristics of the lesion, a standard 3D-nnU-Net, an adaption of a convolutional neuronal network for image segmentation, with region-based training was implemented. The framework was trained with comprehensive data from the BraTS 2023 Adult Glioma Challenge, UCSF-PDGM data set, and the UPENN-GMB data set, including over 1500 data sets with diverse image quality, resolution, and tumor localizations, and an initial validation was performed using MRI data of 10 patients with glioblastoma. Therefore, manual segmentation of the lesion, the lesion with its surrounding edema as well as its contrast-enhancing compartments was performed and compared to the automatically generated data utilizing the Dice coefficient as measure of spatial overlap and segmentation quality.

#### Results

All tumors were identified automatically, yielding a mean volume of  $15.20 \pm 12.39 \text{ c}^3$  (tumor),  $12.33 \pm 10.90 \text{ cm}^3$  (contrast-enhancing compartment), and  $51.26 \pm 36.93 \text{ cm}^3$  (tumor with surrounding edema). Based on the integrated 3D-nnU-Net approach, Dice Coefficients of  $0.91 \pm 0.04$  (tumor),  $0.86 \pm 0.02$  (enhancing tumor) and  $0.89 \pm 0.04$  (tumor with surrounding edema) were achieved. Automated analysis took about 5 minutes for image preprocessing and less than 1 minute for detection and segmentation.

#### Conclusion

The nnU-Net framework revealed very good to excellent Dice coefficients, providing promising results on automatic lesion detection and segmentation, allowing for further investigations in image-based characterization of glioblastoma.

### V069

Untersuchung des Potenzials von Deep Learning für die Fasertraktographie in der Nähe von Hirntumoren *Examining the potential of deep learning for fiber tractography in the close vicinity of brain tumors* 

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#### Objective

Fiber reconstruction plays a crucial role in neurosurgical planning, especially for tumors near eloquent areas. Traditional deterministic approaches often yield incomplete results, while probabilistic methods frequently produce false positives or unrealistic fibers. Complex diffusion models designed to overcome these issues are often impractical due to time constraints during image acquisition and surgery planning. Furthermore, traditional methods involve manual steps, resulting in time-intensive and irreproducible outcomes. To address these challenges, we implemented a deep learning (DL)-based fiber tracking approach and explored whether it can provide better results for tracking fiber bundles in tumor patients.

#### Methods

We utilized the public TractoInferno dataset with 284 MRI datasets, including T1, diffusion MRI, and reference fibers. Additionally, we employed the Brain Tumor Connectomics Data test set comprising pre-operative data from 11 glioma, 14 meningioma, and 11 control subjects, including T1 and diffusion MRI data. Tumors ranged from grades I to III. A bundle-specific recurrent DL model predicts fibers iteratively from a seed region directly from raw diffusion data, bypassing the need for diffusion models. Seed regions and anatomical ROIs are derived from a DL-based segmentation. The approach includes automated fiber filtering using anatomical ROIs, ensuring precise and efficient reconstruction of white matter tracts.

#### Results

The study evaluates results for the corticospinal tract (CST), arcuate fasciculus (AF), and optic radiation (OR) both qualitatively and quantitatively. Evaluation criteria include fiber bundle completeness, proximity to the tumor, and comparisons with deterministic and probabilistic methods. Qualitative evaluation shows bundles that maintain anatomical consistency, while quantitative metrics reveal a high mean fiber count per bundle, reflecting robustness and precision. The high seed-to-fiber ratio reduces computational overhead while maintaining accuracy. Importantly, the method exhibits no performance degradation near pathological regions, underscoring its reliability for clinical applications requiring precise intervention planning or monitoring near critical structures.

#### Conclusion

This method demonstrates exceptional reconstruction quality near brain tumors, particularly for the AF, CST, and OR. By eliminating complex diffusion models, this streamlined approach minimizes errors, enabling reliable and rapid fiber tracking.

Abb. 1



Fig. 1: CST, AD and OR of patient with Meningioma grade I tumor in left hemisphere from BTC dataset.

### Abb. 2

**Tab. 1**: Evaluation metrics for probabilistic and deep-learning-based fiber trackingof the BTC dataset.

		Num of seeds	Num of	Success Rate
			Fibers	(per seed)
CST left	Prob. <sup>1</sup>	9458 ± 2291	5436 ± 3182	2.30%
	DL-based	9458 ± 2291	5172 ± 1994	53.74%
	DL-based (tumor)*	9302 ± 1711	4950 ± 1983	51.80%
CST right	Prob. <sup>2</sup>	11 720 ± 1527	3365 ± 2435	0.83%
	DL-based	11 720 ± 1527	3844 ± 1729	33.30%
	DL-based (tumor)*	11826 ± 722	2683 ± 2078	22.94%
AF left	Prob. <sup>3</sup>	8259 ± 1156	805 ± 1117	0.0005%
	DL-based	8259 ± 1156	1830 ± 898	22.09%
	DL-based (tumor)*	8268 ± 1290	2027 ± 857	24.41%
AF right	Prob. <sup>3</sup>	7797 ± 1211	626 ± 775	0.0004%
	DL-based	7797 ± 1211	1382 ± 781	17.83%
	DL-based (tumor)*	7718 ± 1395	1073 ± 459	13.80%
OR_ML left	Prob. <sup>3</sup>	22 452 ± 2532	879 ± 900	0.0002%
	DL-based	22 452 ± 2532	732 ± 598	3.43%
	DL-based (tumor)*	20 455 ± 1228	1438 ± 714	7.17%
OR_ML right	Prob. <sup>3</sup>	23 044 ± 2801	344 ± 531	0.00007%
	DL-based	22 452 ± 2532	764 ± 515	3.41%
	DL-based (tumor)*	22 951 ± 1649	557 ± 395	2.37%

<sup>1</sup> Number of iterations: 25 to achieve similar fiber numbers as DL-based.

<sup>2</sup> Number of iterations: 35 to achieve similar fiber numbers as DL-based.

<sup>3</sup> Number of iterations: 200 to achieve similar fiber numbers as DL-based.

\* Only considering DL-based fiber bundles with minimum distance to tumor below 1cm.

### V070

#### Intraoperative konfokale Endomikroskopie zur Autofluoreszenzbildgebung von Hirntumoren und Nicht-Tumorgewebe in situ

#### Intraoperative Confocal Endomicroscopy for in situ Autofluorescence Imaging of Brain Tumor and Non-Tumor Tissues

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#### Objective

Autofluorescence (AF) imaging of human brain tumor tissue using confocal laser endomicroscopy (CLE) enabled the detection of brain tumor specific AF patterns (Reichenbach et al 2025, J Cancer Res Clin Oncol 151:19). In continuation of this research, we investigated non-tumor brain tissue in situ with the goal of identifying differences in AF patterns of tumor and normal brain tissue and evaluating the potential of this approach for brain tumor delineation.

#### Methods

In situ label-free intraoperative AF imaging was performed in 24 patients (14 cases of high-grade glioma ,10 cases of metastasis) using a clinical CLE system (Convivo, Zeiss). Images were acquired from tumor tissue and non-tumor brain in the surgical access path. The dataset was evaluated for interpretability and images with motion artifacts were excluded. The presence and density of AF features including diffuse AF, fibers, large ( $\geq$  25 µm diameter) and small (< 25 µm diameter) cells and punctuated AF were quantified by visual inspection and statistically analyzed (Mann-Whitney test).

#### Results

In total, 563 AF images were rated interpretable. For brain tumors and non-tumor brain regions, in median 16 images/case (range 4-39) and 6 images/case (range 2-14) were analyzed, respectively. Sparse punctuated AF as well as low density (< 5/per field of view) of small cells were detected in almost all cases. In about half of the cases, images showed diffuse AF and dense punctuated AF patterns. Fibers and high density ( $n \ge 5$ ) of large cells were rarely observed in either tissue type, consistent with previous ex vivo findings.

Comparison of the prevalence of AF features revealed that non-tumor tissue images exhibited significantly more often small cells (P = 0.02 and 0.03 for <5 and  $\geq$ 5cells/field of view; respectively), large cells (<5 cells/field of view P = 0.02) and dense punctuated AF (P = 0.025) than brain tumors. However, diffuse AF was not different between the two tissue types (P = 0.06).

#### Conclusion

Label-free CLE of human brain tumor and non-tumor tissue provides visually distinct images showing altered AF characteristics. Faster image acquisition speeds could substantially reduce motion artifacts, thereby improving image interpretability. The observed changes in AF patterns indicate a promising direction for future research and may form the basis of a novel strategy for brain tumor delineation and classification, providing real-time intraoperative insight.

### V071

#### Die Anwendbarkeit des REVEAL<sup>™</sup> in der Gliomchirurgie The applicability of the triple LED/loupe device REVEAL<sup>™</sup> in glioma surgery

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#### Objective

Surgical loupes are gaining popularity in neurosurgery due to easy use, increased surgical speed and portability. A notable shortcoming is the inability to perform fluorescence-guided surgery due to the lack of blue light filter. This was addressed by introducing a customized triple LED/ loupe device, i.e. REVEAL<sup>™</sup>. An initial validation study proved the REVEAL<sup>™</sup> to be a safe alternative to the conventional wide-field microscope with a sensitivity of 100% and a specificity of 95%. The current study aims to analyze whether the REVEAL<sup>™</sup> depicts fluorescence beyond the extent of the established gold standard.

#### Methods

Seventy-three tissue samples with heterogeneous fluorescence signals were assessed *ex vivo*. Images of fluorescent tissue samples were acquired using the REVEAL<sup>TM</sup>. The fluorescent areas as determined by six raters were calculated and compared to the gold standard. Intraclass correlation coefficients (ICC) were calculated to assess reliability and reproducibility of results. Real-time intraoperative comparison between the two devices were performed using a ruler which was positioned on the transition zone of fluorescence. Two blinded surgeons independently reported the transition zone of fluorescence as assessed by the scale on the ruler. Equivalence testing using the TOST method was performed to assess whether the REVAL<sup>TM</sup> visualizes fluorescence equivalent to the gold standard, i.e. the BLUE400 filter technology. The predefined equivalence margin was  $\pm 0.2$ cm.

#### Results

Unpaired t-test shows significant difference between the BLUE400 and the REVEAL<sup>TM</sup> (t(10)=5.705, p=.0002) regarding the extent of fluorescence as assessed *ex vivo*. ICC values showed *excellent* agreement among raters, indicating reliability and consistency of our results. A significant result for equivalence of the BLUE400 and REVEAL<sup>TM</sup> was not obtained with t(16)=0.481, p=.319. With a 90% CI = -0.551 to 0.418, the REVEAL<sup>TM</sup> is not within the predefined equivalence range of  $\pm 0.2$ cm.

#### Conclusion

Our *ex vivo* analysis shows that the extent of fluorescence visualization of the REVEAL<sup>TM</sup> is greater compared with the gold standard. This is further supported by the results of the equivalence test which shows that fluorescence visualization of the two technologies is not equivalent. These results suggest that the REVEAL<sup>TM</sup> might be more sensitive regarding 5-ALA visualization. This would directly influence the extent of resection in glioma surgery and ultimately, progression-free survival.

### V072

# Navigierte 3D-Sonographie zur intraoperativen Resektionskontrolle bei zerebralen Tumoren. Eine prospektive, bizentrische Studie

Navigated 3D ultrasound for resection control in brain tumor surgery. A prospective bicenter trial

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#### Objective

Intraoperative ultrasound (iUS) is a readily available, cost-effective tool for real-time localization of cerebral lesions. 3D reconstructed iUS (i3DUS) provides intraoperative imaging updates through a 3D sweep integrated in the navigation system. This study evaluated the feasibility of navigated, i3DUS for detecting tumor remnants during brain tumor surgery compared to a retrospective matched pair group without iUS, based on residual tumor volumes identified by intraoperative magnetic resonance (iMR).

#### Methods

Adult patients with suspected gliomas or cerebral metastases (cM) were prospectively recruited at two institutions. During surgery, i3DUS resection control was performed until presumed gross total resection. Then an iMR was performed. Clinical and surgical data, tumor volumes, and iEOR based on iMR was assessed. Each patient was matched to a retrospective case undergoing tumor surgery with iMR-only resection control. Matching criteria comprised tumor diagnosis, volume, WHO grade, eloquent location and preoperative symptoms. Matched pairs were then analyzed using Mann-Whitney U and Fisher's exact tests.

#### Results

Seventy-nine patients were included (34 females [43.0%], 45 males [57.0%]; mean age 56 years [SD 16.7]). Diagnoses were high grade gliomas (n=38, 48.1%), low grade gliomas (n=19, 24.0%), cM (n=21, 26.6%), and medulloblastoma (n=1, 1.3%). Mean volume of tumor remnants on iMR was significantly lower (p=0.007) in the i3DUS cohort (1.1 cm<sup>3</sup> [SD 2.5]) than the iMR-only cohort (1.7 cm<sup>3</sup> [SD 4.2]). Mean iEOR was significantly higher (p=0.018) in the i3DUS (96% [SD 0.09]) versus iMR-only cohort (94% [SD 0.13]). Tumor remnant resection after iMR was significantly less frequent (p<0.001) in the i3DUS (n=24, 30.4%) than iMR-only cohort (n=46, 58.2%). Mean surgical time was shorter in the i3DUS (286 minutes [SD 117]) compared to iMR-only cohort (320 minutes [SD 129]), with a trend towards significance (p=0.087).

#### Conclusion

In our study, i3DUS significantly improved the extent of tumor resection as confirmed by iMR and showed a potential to reduce surgical time. Further randomized controlled trials are needed to evaluate utility of i3DUS for resection control in settings without iMR.

### RC023

Multispektrale Intraoperative Optische Bildgebung – Vergleich verschiedener Wellenlängenbänder zur Generierung von funktionellen Aktivitätskarten Multispectral Intraoperative Optical Imaging - Comparison of different light wavelength bands for generation of functional activity maps

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#### Objective

Intraoperative Optical Imaging (IOI) is a non-invasive imaging technique that is able to visualize functional areas of the cerebral cortex based on the actual intraoperative scene. Dependent of the used light wavelength either changes in cerebral blood volume (CBV) or changes in blood oxygenation are mainly contributing to the observed intrinsic signal. Here we are investigating and assessing the reliability of three different light wavelength bands, captured simultaneously with a customized multispectral imaging camera setup, for the generation of maps of cortical activity.

#### Methods

Imaging was performed in eight patients (4 male, 4 female, median age 47.5) undergoing tumor resection. Stimulation to induce cortical activation was performed by electrical stimulation of the median nerve (5 patients), visual stimulation using flashlight goggles (2 patients) or by motor tasks during awake surgery (1 patient). Data from three different light wavelength bands that are sensitive either to changes in CBV, Oxy-, or Deoxyhemoglobgin (HbO / Hbr) was acquired simultaneously during stimulation and later analyzed using a Fourier-based data analysis approach. For each wavelength band a two-dimensional map of cortical activity was generated and the three resulting maps were compared in respect to their similarity using the structural similarity (SSIM) index. Furthermore, a signal-to-noise ratio of the maps was calculated for each light wavelength band.

#### Results

The results are revealing, that activity maps generated from HbO channel are having highest similarity with CBV channel resulting in a mean SSIM of 0.85  $\pm$  0.02, whereas HbO channel and Hbr channel respectively CBV channel and Hbr channel are showing a lower and comparable SSIM (0.69  $\pm$  0.07 / 0.70  $\pm$  0.07) towards each other over all patients. SNR was calculated for patients that were stimulated electrically on the median nerve. Here, the Hbr outperforms on average the CBV channel and the HbO channel (12.6 % / 14.2 % increased SNR).

#### Conclusion

Overall, the findings are suggesting that a light wavelength band sensitive towards Hbr changes may result in best results for the generation of activity maps. Nevertheless, further investigations are mandatory to assess the reliability especially in respect towards different tumor entities and their influence on cortical hemodynamics.

### V073

Luftstrahl-basierte optische Kohärenz-Elastografie zur Abgrenzung von Hirntumorgewebe und Grundlagenforschung in der Gewebemechanik Air-Jet based Optical Coherence Elastography for brain tumor tissue delineation and fundamental research in tissue mechanics

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#### Objective

Delineation of brain tumor and healthy tissue during neurosurgery remains a challenging task. Optical coherence elastography (OCE) is successfully applied in breast cancer detection [1]. Our aim is to apply OCE during neurosurgery intervention. We present results from a demonstrator system capable of distinguishing tissue types based on quantifiable mechanical parameters within brain tumor biopsies.

#### Methods

The OCE system is based on a self-developed air-jet, which generates and measures the applied force [2]. Combined with a 3.2MHz optical coherence tomography (OCT), which measures tissue displacement using OCT phase data [3]. Brain tumor tissue samples are excited with 200ms air-jet pulses and 70µN load. Force and displacement are used to calculate pixel-wise mechanical properties within the OCT B-scan. The long excitation time results in a semi-steady state, enabling constant-load analysis, simultaneously the fast pulse edges support dynamic mechanical analysis.

#### Results

The results are visualized as contrast maps aligned with OCT B-scan dimensions. Furthermore, to simplify the correlation of the mechanical and histological data and aiding further tissue-mechanical research. Key mechanical properties such as bulk stiffness, creep constant, and regression constants are categorized (Fig.1 D) as elastic (red), ductile (blue), and viscous (green) and visualized as pixel-wise spider plots with the property classes as sectors for intuitive interpretation.

#### Conclusion

We demonstrated the ability to measure and quantify the mechanical properties of brain tumor samples, the processing and visualizing of OCE data, and are able to correlate mechanical maps with histology. The data supports Al-based tissue classification and intuitive spider plots support interpretation. This enables tumor delineation and allows further fundamental tissue mechanics research. An in situ clinical study with a co-robot-supported system is pending. Future work will explore correlations between mechanical parameters and tissue pathology.

Abb. 1



Figure 1: A) Histology of a human meningioma sample, B) the corresponding OCT Intensity Scan, C) Bulk Stiffness map, D) Mechanical "Fingerprint" at position 4 in the OCT image as spider plot. The red dot is the centroid of the distribution indicating that the sample at this position is primarily ductile.
### RC024

Sensitivität und Spezifität der ICG-Angiographie des Sehnervs bei der Resektion perichiasmaler Läsionen: eine zweijährige Erfahrung.

Sensitivity and specificity of ICG angiography of the optic nerve during resection of perichiasmal lesions: a twoyear experience.

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### Objective

Anterior skull base tumors can affect the optic nerve (ON), causing visual impairment due to ischemia or demyelination from disrupted blood supply. Preserving ON microcirculation during decompression surgeries is critical, yet no reliable intraoperative test for predicting visual outcomes exists. Our study aims to share our two years of experience using ICG-angiography as a predictive factor, comparing it to intraoperative visual evoked potentials (ioVEP).

### Methods

Thirteen patients with perichiasmatic pathologies underwent MRI, CT, ophthalmological examinations, and ioVEP testing. Nine control patients with presumed normal pial ON circulation were included from aneurysmal clipping cases. ICG (0.2 mg/kg) was administered intraoperatively before and after tumor resection using software with flow analysis (flow 800 software, Kinevo/Pentero, Carl Zeiss Co). The intervals between the first appearance of ICG in the internal carotid artery (ICA) and pial circulation of the ON to full saturation of both were measured at each pre-and postresection state.

### Results

A total of 13 patients and 9 control subjects (mean age: cases  $55.30 \pm 15.2$  years, controls  $57.11 \pm 10.61$  years; 8 males and 14 females; p > 0.05) were included in the study. Twelve patients experienced impaired visual fields preoperatively, and 10 showed improvement following surgery. Prolongation of P100 latency was observed in 8 cases and 7 controls on the ipsilateral side. The sensitivity of visual evoked potentials (VEP) was 50%, with 100% specificity, a 100% positive predictive value, and a 28.6% negative predictive value. In contrast, the sensitivity for indocyanine green (ICG) angiography was 66.7%, with 100% specificity, a 100% positive predictive value. The mean improvement in the peak time of the optic nerve relative to the ipsilateral internal carotid artery was  $0.39 \pm 1.34$  seconds after lesion resection. Among the pathologies, 38.5% involved one optic nerve and the chiasma, 30.8% involved only one optic nerve, 13.6% involved only the chiasma, and 4.5% involved the chiasma along with both optic nerves, eventually resulting in a supra-/infrachiasmatic spread.

### Conclusion

ICG-angiography of the optic nerve seems to reveal a promising tool to predict the visual outcome compared to ioVEP. More research and data are needed to prove a significant difference.

### V075

Der frontoparietale Condition-and-Peturb Ansatz verbessert das präoperative nTMS Mapping bei spracheloquenten Hirntumoren. *The frontoparietal condition-and-perturb approach improves preoperative nTMS mapping in patients with language-eloquent tumors.* 

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### Objective

The use of preoperative navigated transcranial magnetic stimulation (nTMS) is becoming increasingly common in patients undergoing eloquent brain tumor surgery. Yet the optimal stimulation paradigms for language mapping still lack specificity and need to be refined. This study aims to evaluate the added value of the condition-and-perturb approach (CAP) to preoperative language mapping in non-aphasic patients with language-eloquent brain tumors involving the anterior inferior frontal (aIFG) or angular (AG) gyrus.

### Methods

Patients underwent peritumoral online nTMS involving the affected node (AG or aIFG) with or without prior offline neuronavigated repetitive TMS (nrTMS, 1 Hz, 15 min) of the ipsilateral healthy node (aIFG or AG).

### Results

8 patients underwent the full protocol. Offline nrTMS decreased error threshold of online language mapping in all patients in comparison to sham nrTMS in those patients. 4 peritumoral language hotspots [2-5] could be isolated in each patient. Compared to direct cortical stimulation, nTMS language mapping with CAP achieved a sensitivity of 84.2%, a specificity of 98.3%, a PPV of 84.2% and an NPV of 98.3%. This means that nearly all CAP-nTMS hotspots induced language disturbances when stimulated intraoperatively with DCS.

### Conclusion

This pilot study suggests that the CAP could be a possible solution to the specificity concerns of preoperative TMS mapping, as prior frontoparietal network disruption might enhance the precision of language mapping around semantically eloquent brain tumors.

### V076

Die Auswirkungen repetitiver transkranieller Magnetstimulation auf die Sprachleistung und Gehirnkonnektivität bei gesunden Probanden The Effects of Repetitive Transcranial Magnetic Stimulation on Language Performance and Brain Connectivity in Healthy Subjects

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### Objective

This study investigates the effects of combining high-frequency rTMS (HF-rTMS) to the left superior posterior temporal gyrus (spTG) and low-frequency rTMS (LF-rTMS) to the contralateral homologue on language performance, functional connectivity and white matter integrity in healthy individuals. The aim is to validate a dual hemisphere rTMS protocol in healthy individuals to enhance language processing and connectivity within the language network's arcuate fasciculus (AF), with potential applications in post-surgical aphasia treatment.

### Methods

Thirty healthy participants (aged 18-65) are randomized into a treatment group (n = 15), receiving dual hemisphere rTMS, or a sham group (n = 15), following the same procedure with a plastic adapter, ensuring no active brain stimulation. The rTMS protocol includes sequential LF-rTMS at 1 Hz to the right sPTG and HF-rTMS at 10 Hz to the left homologous region, guided by tractography of the AF. Sessions are conducted daily over seven consecutive days, lasting about 18 minutes, during which participants additionally engage in language training exercises. Language performance is assessed pre- and post-intervention, measuring semantic correctness, reaction time, and fluency. Resting-state functional Magnetic Resonance Imaging evaluates functional connectivity, focusing on the language network via correlation coefficients and graph metrics. Structural changes in AF white matter integrity are measured by differences in mean fractional anisotropy values using diffusion-weighted imaging.

### Results

We found significant improvement in language measures in the treatment group compared to sham. Semantic correctness increased from 93.5% to 96.4% (p = 0.004), reaction times decreased from 3.97 to 3.75 seconds (p = 0.006), and fluency rose from 38.5 to 48.5 words (p = 0.002). Functional connectivity analysis revealed increased global efficiency within the left inferior frontal gyrus ( $\beta$  = 0.09, p-FDR = 0.035), highlighting enhanced language network connectivity.

### Conclusion

This study provides evidence that a dual hemisphere rTMS approach enhances language performance and modulates functional connectivity in healthy individuals. Significant improvements in semantic correctness, reaction time, fluency, and left inferior frontal gyrus connectivity suggest that rTMS can optimize language-related neural processes, offering insights for clinical applications in aphasia treatment.

### V077

### Behandlung postoperativer Sprachstörungen nach Hirntumorresektion mittels rTMS – eine Pilotstudie *rTMS-based neuromodulation for treatment of postoperative aphasia after tumor resection – a pilot study*

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#### Objective

Postoperative aphasia is a serious complication after brain tumor resection which can occur despite monitoring during awake craniotomies. In addition to a considerable impairment of the quality of life, the oncological prognosis in these patients is also limited. The neuromodulatory application of rTMS is already established in the treatment of stroke-related aphasia. The aim of this study is to investigate the feasibility of rTMS-based neuromodulation to patients with postoperative aphasia after brain tumor resection.

#### Methods

This pilot study includes patients with new or worsening aphasia after brain tumor resection. rTMS therapy starts within three days post-surgery with contralesional inhibitory stimulation (1 Hz; 110% of the individual RMT; 10 min) followed by ipsilesional excitatory stimulation (10 Hz; 110% of the individual RMT; 8 min). Patients perform specific tasks during stimulation to intrinsically activate the language areas. This is followed by 30-45 min of speech and language therapy. In addition to monitoring treatment-related side effects, the primary outcome is assessed using the Aachener Aphasie Test (AAT) before, immediately after, at 1 and 3 months post-therapy. Secondary outcomes are evaluated with the NIHSS and QoL questionnaires.

#### Results

Ten patients were included and all of them completed the rTMS treatment without serious side effects. Seven (70%) patients experienced a mild, temporary headache during a session (VAS≤2), whereby pain medication was only rarely (2/7 sessions in 2 patients) taken additionally. During stimulation over the wound, pain of max. 6 (VAS) was reported in some sessions. No wound healing disorders occured. Short-term outcome analysis (immediately after rTMS therapy) revealed clear improvements of the patients compared to the post-operative deficits (mean AATpre therapy: 196/440; mean AATpost therapy: 258/440). At this time, the follow-up examinations of five patients were completed and showed further improvement (mean AAT3-months: 383/440).

### Conclusion

The preliminary data indicate that rTMS can be used safely as neuromodulatory technique in the immediate postoperative period. Apart from mild, tolerable headaches, no significant treatment-related side effects were observed. Postoperative neuromodulation represents the first interventional approach to rehabilitate postoperative neurological deficits, the effectiveness of which should be evaluated in subsequent prospective studies.

### V078

Monitoring Evozierter Motorischer Potentiale und Kontinuierliches dynamisches Mapping: Warnkriterien während der Operation von 473 intraaxialen Gehirntumoren Motor evoked potential monitoring and continuous dynamic mapping: warning criteria during surgery on 473 intra-axial brain tumors

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### Objective

We investigated the relationship between intraoperative changes of direct cortical stimulation (DCS) motor evoked potentials (MEP) (Figure 1.A), lowest motor threshold (MT) reached during subcortical dynamic mapping (Figure 1.B), and the patient's motor outcome in a consecutive cohort of patients undergoing surgery for motor eloquent brain tumors under general anesthesia.

### Methods

We included data from 473 intra-axial brain tumor surgeries, 432 of which had motor outcome reported directly after surgery, at discharge and the 3-month follow-up visit. The MEP changes and MT groups were correlated with clinical parameters. Ordinal logistic regression was used to model the motor outcome with respect to the severity of the deficits based on MEP changes, MT groups and clinical parameters.

### Results

The lower the MT, the higher was the chance of significant MEP changes (Figure 2). MEP changes, MT group and histopathology were predictors of deficit. The more significant the MEP changes and the lower the MT, the higher the likelihood of more severe deficits (Figure 2). MEP loss was associated with 184 times higher odds of causing a deficit than no MEP changes. The lowest dynamic mapping MT group (1–3 mA) was associated with 20% of significant MEP changes and 20% permanent deficits.

### Conclusion

This study validates intraoperative neurophysiological monitoring paradigms and warning criteria during surgery of motor eloquent brain tumors under general anesthesia. MEP loss and irreversible alteration, as well as low dynamic MT (1–3 mA) should be used as critical intraoperative neurophysiological warning criteria.



Abb. 2



### V079

# Korrelation der Interhemisphärischen Konnektivität mit der Epigenetischen Neuralen Signatur in hochgradigen Gliomen

### Correlation of Interhemispheric Connectivity and Epigenetic Neural Signature in High-Grade Glioma

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### Objective

The epigenetic neural signature is linked to survival outcomes in glioblastoma, with a high-neural signature associated with poorer prognosis. Given the resource-intensive nature of epigenetic analyses, we evaluated preoperative tractography as a potential indicator of the neural signature in high-grade glioma.

#### Methods

We retrospectively analyzed 19 patients who underwent high-grade glioma resection and received preoperative DTI sequences alongside postoperative 935k analyses. Patients were categorized based on the median neural signature. Tractography of interhemispheric connectivity between each arcuate fascicle (AF), corticospinal tract (CST), frontal aslant tract (FAT), inferior fronto-occipital fascicle (IFOF), inferior longitudinal fascicle (ILF), uncinate fascicle (UF), and optic radiation (OR), was performed using BrainLab. Volume segmentations were evaluated for radiomic diffusion and shape parameters, comparing high-neural and low-neural groups using paired t-tests. P-values were adjusted for multiple comparisons using the Benjamini-Hochberg method.

### Results

The mean age was 56 (34–72) years, with 53% female patients. One patient suffered from grade 3, 18 from grade 4 glioma. The mean neural signature was  $0.43 \pm 0.03$ , with a median of 0.40. After correction for multiple comparisons, significant different patterns in interhemispheric connectivity were observed in FA energy (p<sub>corr</sub>= 0.006), FA median (p<sub>corr</sub>=0.010), flatness (p<sub>corr</sub> =0.036), sphericity (p<sub>corr</sub> =0.010), surface area (p<sub>corr</sub> =0.006) and voxel volume (p<sub>corr</sub> =0.006) of the interhemispheric segmentations.

### Conclusion

Interhemispheric connectivity varies in high-grade glioma based on the epigenetic neural signature, with highneural cases exhibiting higher FA values, but smaller tract volumes. In the future, preoperative tractography radiomics may help identify candidates for postoperative epigenetic sequencing.

### V080

Die Beziehung von Hirnödem und einem DNA methylierungsbasierten Klassifikationssystem für Meningeome. Relationship between Tumor Edema and a DNA methylation-based grading system for meningiomas

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### Objective

Recent studies have shown that methylation classes (MC) of meningiomas are highly predictive of tumor recurrence and more accurate than the previously used WHO classification. However, no association has been demonstrated between meningioma tumor edema and MC. This study aimed to investigate the relationship between tumor edema and MC.

#### Methods

Based on DNA methylation patterns, meningiomas were categorized into MC benign 1 through 3 (ben-1, ben-2, ben-3), MC intermediate (int-A and int-B), and MC malignant (MAL), as described in previous publications. A 3D volumetric analysis was performed to calculate edema size for each patient. Tumor progression was assessed through serial MRI scans. Univariate and multivariate logistic regression models were used to analyze the relationship between MC and tumor edema.

#### Results

Among 186 patients, the distribution of MCs was as follows: ben-1 (44, 23.7%), ben-2 (57, 30.6%), ben-3 (9, 4.8%), int-A (62, 33.3%), int-B (8, 4.3%), and MAL (6, 3.2%). Higher rates of edema were observed in the two MC intermediate groups compared to the three MC benign groups [Mean: 18.3 cm<sup>3</sup>, Range: 0–113.8 cm<sup>3</sup> vs. Mean: 9.1 cm<sup>3</sup>, Range: 0–97.8 cm<sup>3</sup> (P = 0.045)]. A change in diagnostic classification was noted in 20 patients (10.75%). Early tumor progression occurred in 17 patients [Median: 22 months (P25–75: 15–53 months)]. Independent factors for early tumor progression included a higher MC class (OR: 5.61; 95% CI: 1.65–19.61; P = 0.07) and a higher Simpson grade (OR: 1.74; 95% CI: 1.01–4.02; P = 0.044).

### Conclusion

Larger edema size is associated with a greater likelihood of MC intermediate classification. Independent factors for early tumor progression include higher MC class and higher Simpson grade. The inclusion of MC analysis led to a diagnostic reclassification in one out of eleven patients.

### V081

MGMT Methylierungsstatus korreliert mit dem positiven Effekt der operativen Zytoreduktion in GBM Patienten *MGMT methylation status correlates with the beneficial effect of surgical cytoreduction in GBM patients* 

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#### Objective

A negative MGMT methylation status correlates with reduced survival in Glioblastoma patients, mostly due to decreased sensitivity to alkylating agents. Increased cytoredution in those patients should therefore correlate with prolonged survival. In this study, we have collected data of a large monocentric patient cohort with newly diagnosed GBM and sought to analyze the correlation between EOR and patient outcome in MGMT positive and negative GBM patients.

#### Methods

A total of n=347 GBM patients undergoing surgery at the University Hospital of Regensburg between 2005-2021 were included in this study. Volumetric analysis was performed on T1 weighted MRI images with and without contrast enhancement using the ITK-SNAP software. Multivariate Cox regression analysis was performed including age, preoperative KPI, MGMT status and residual tumor volume. Correlation of EOR with survival was assessed by linear regression and the difference of two linear regression models or breaks within a linear regression model were statistically analyzed by a Chow linear equal slope test.

#### Results

We included n=158 patients with positive and n=177 patients with negative MGMT status. Multivariable Cox regression analysis showed correlation of negative MGMT status, age and higher residual tumor volume (p=0.0001) with reduced OS, while higher preoperative KPI correlated with increased OS. For PFS only negative MGMT status correlated significantly with reduced survival (p=0.0001). The hazard ratio for death in MGMT positive patients was 0.398 (CI 0.258-0.612; p=0.0001) while negative MGMT status had a HR of 0.585 (CI 0.406-0.843; p=0.004). Linear regression of OS with EOR in MGMT positive and negative patients showed a significant correlation (p=0.0001) in both groups. While the slope of the regression model for MGMT positive patients was 0.489, the slope in MGMT negative patients was 0.205. This difference was statistically different (Chow equal slope test; p=0.0076). Interestingly, the correlation between OS and EOR changed dramatically at an EOR >80%. When comparing low EOR (<80%) and high EOR (>80%) in the total patient cohort, there was a significant difference with an increased beneficial effect on OS for EOR >80% (slope 0.765 vs. 0.152; p=0.032).

### Conclusion

While cytoreduction overall correlates with increased survival in GBM patients - regardless of the MGMT status - the beneficial effect is significantly higher in MGMT positive patients and when EOR >80% is achieved.

### V082

### Psychosoziales Screening mittels direkter Begfragung im Arzt-Patienten-Gespräch vs. Fragebogen - eine Clusterrandomsierte kontrollierte Studie

# Referral to psychosocial services via integrated psychosocial screening compared to questionnaires in adult patients with high-grade glioma: a cluster randomized controlled trial

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#### Objective

Patients diagnosed with high-grade gliomas (HGG) suffer from significant distress. Due to neurological and neurocognitive deficits its assessment remains challenging. We evaluated face-to-face assessment during doctor-patient consultations (DPC) regarding impact on referral to psychosocial services and effects of DPC on patients" emotional well-being.

### Methods

In a cluster-randomized study across 13 German centers, the intervention group (IG) underwent screening via three structured questions (SQ) during DPC, while the control group (CG) completed a questionnaire (Distress Thermometer). Emotional functioning (EF) was measured using the EORTC Quality of Life Questionnaire (EORTC QLQ-C30), with poor EF defined as a score  $\leq$ 71 (score 0-100, higher scores indicating higher function). Specialized psychosocial care (PC) utilization was assessed at follow-up, and mixed-model logistic regression was used to evaluate outcomes. Associations between SQ responses and EF scores were also analyzed.

#### Results

Of 763 patients enrolled, 506 completed follow-up. Emotional functioning was poor in 59.7%, both in the IG (168/281) and in the CG (134/225). No gender-specific differences occurred.

PC utilization rates were similar (IG: 55.4%, CG: 64.9%; OR=0.67, 95% CI=0.40-1.11, p=0.115). DPC duration was comparable between groups (IG mean=23.06 min, SD=9.16 vs. CG mean=23.04 min, SD=14.63). Most patients (71%) reported feeling relieved after the consultation, no significant difference between IG and CG (Fisher''s exact test, p=0.322). A relationship emerged between positive SQ responses and lower EF scores: none positive (n=39, EF median=91.7), one positive (n=70, EF median=75.0), two positive (n=113, EF median=58.3), and three positive (n=121, EF median=50.0).

#### Conclusion

Face-to-face distress screening during DPCs resulted in similar psychosocial service referrals to questionnairebased assessments. However, patients responding positively to any SQ item should be considered at clinically relevant risk, warranting further psychosocial evaluation and support.

### V083

Klinische und molekulare Prädiktoren für den Verlauf IDH-mutierter Gliome: Einfluss verzögerter Diagnosestellung und Behandlung

Clinical and molecular predictors for outcome in IDH-mutant gliomas WHO grade 2 and 3 diagnosed per WHO 2021 classification: effects of delayed time to diagnosis and treatment

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### Objective

Treatment is based on risk factors identified in historical cohorts from the pre-molecular era. With the introduction of the WHO 2021 classification, key risk factors in molecularly defined IDH-mutant gliomas remain to be elucidated. Given improvement in imaging modalities with increasing numbers of incidental lesions, it appears particularly unclear whether time to tissue-based diagnosis and initiation of adjuvant treatment affects outcome.

### Methods

We retrospectively searched for adult patients with a newly diagnosed IDH-mutant gliomas of WHO grade 2 or 3 per WHO 2021 classification. Predictors of outcome were identified by uni- and multivariate Cox"s proportional hazard regression. Interactive effects between prognostic factors were assessed by recursive partitioning analysis (RPA), with splits determined by martingale residuals.

### Results

145 patients were identified, including 88 IDH-mutant astrocytomas and 57 1p19q-codeleted oligodendrogliomas. After a median follow-up of 40 $\pm$ 5 months, 62 patients progressed after a median time to first progression of 69 $\pm$ 5 months while overall survival was not reached. In 24 patients (16.6%), time from first disease evidence on imaging until tissue-based diagnosis was  $\geq$ 6 months; but high extents of resection could still be achieved in the majority of those cases. Univariate analysis yielded the presence of a 1p19q-codeletion, superficial tumor localization, and higher pre- and post-operative KPS to be associated with favourable outcome. In turn, neither time from first imaging to tissue-based diagnosis (HR: 0.99, CI: 0.9-1.0) nor time to initiation of first-line adjuvant non-surgical treatment (HR: 0.83, CI: 0.6-1.2) were prognostic. Forwarding the significant markers into a multivariate model, the effect of pre-operative KPS was lost while the relevance of a 1p19q-codeletion, tumor localization, and post-operative KPS was retained. Notably, a RPA showed that post-operative KPS was the most relevant predictor of outcome; and only in patients with a KPS  $\geq$ 90 the presence of a 1p19q-codeletion was relevant for survival.

### Conclusion

While inherent tumor factors including localization and the molecular glioma signature affect outcome in IDHmutant gliomas, post-operative function represents a relevant and modifiable risk variable. As such, preservation of neurologic function should be prioritized when excelling surgical decision-making. If extensive resection can be achieved, prolonged intervals until surgery may not necessarily compromise outcome.

### V084

Die prognostische Bedeutung der Zeit bis zur Bestrahlung bei Glioblastom-Patienten mit Resttumormasse: eine single-center Analyse The prognostic role of time to irradiation in glioblastoma patients with residual tumor mass: a single-center

The prognostic role of time to irradiation in glioblastoma patients with residual tumor mass: a single-center analysis

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### Objective

Newly diagnosed isocitrate dehydrogenase wild-type glioblastoma (GB) is treated with maximum safe resection followed by adjuvant radio(chemo)therapy. The optimal time interval post-surgery for initiating radiotherapy remains unclear but seems to range between two to six weeks after surgery. This study aims to investigate the relationship between the time to radiation (TRT) and both overall survival (OS) and progression-free survival (PFS), considering the impact of residual tumor volume (RV) post-operative.

### Methods

We reviewed data from all patients newly diagnosed with GB at our institution between 2014 and 2024. Inclusion criteria comprised adult patients (>18 years) with newly diagnosed IDH wild-type GB who underwent adjuvant radio-chemotherapy. Residual tumor volume was quantified using post-operative MRI. Multivariate analysis was conducted using Cox proportional hazards regression, and patients were dichotomized based on the presence or absence of residual tumor (RV=0 ml vs. RV>0 ml). A subgroup analysis for patients with RV>0 ml was performed using Cox proportional hazard regression.

### Results

A total of 344 patients were analyzed, with a mean TRT of 31.44 days +/-14.02. Significant factors influencing OS included residual tumor volume, total radiation dose in Gray, and O6-methylguanine DNA methyltransferase (MGMT) promoter methylation (p < .05). TRT showed no effect on OS in the overall cohort. For PFS, significant associations were observed with TRT, MGMT promoter methylation, and total radiation dose (p < .05). Subgroup analysis indicated a significant link between TRT and PFS for patients with residual tumor mass (p=0.044, HR 1,014), while no correlation was found between TRT and OS.

### Conclusion

In our cohort, TRT showed no significant association with OS, but with PFS. When dichotomized for residual volume TRT remained unrelated for OS, but significant for PFS.

### V085

Auswirkungen des Bestrahlungszeitpunkts auf die Überlebensraten bei Glioblastom: Eine retrospektive Analyse Impact of Radiotherapy Timing on Survival Outcomes in Glioblastoma: A Retrospective Analysis

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### Objective

The timing of adjuvant radiotherapy (RT) after surgery in adult patients with wild-type glioblastoma remains debated. Early RT initiation is often preferred, but its impact on survival outcomes is uncertain. This unicentric retrospective study evaluates the association between RT timing and survival, alongside other clinical variables.

### Methods

Adult patients with histologically confirmed, IDH wild-type glioblastoma who underwent surgery between 2018 and 2021 were retrospectively analyzed. Patients were stratified into RT timing groups: <3 weeks, 3–6 weeks, and >6 weeks. Exclusions included missing survival data (23) or RT performed externally without available details (11), leaving 81 patients with complete data. Survival durations were defined as the time from surgery to death. Analyses included descriptive statistics, pairwise t-tests, and multivariable regression.

### Results

RT was initiated within <3 weeks for 41.0%, 3–6 weeks for 50.0%, and >6 weeks for 9.0% of patients. Mean survival durations were 2.1 years (SD = 0.3) for <3 weeks, 1.87 years (SD = 0.5) for 3–6 weeks, and 1.64 years (SD = 0.5) for >6 weeks. Pairwise t-tests showed no significant survival differences between timing groups (p-values: 0.174–0.937). Regression analysis identified age as a significant predictor of shorter survival (-10.05 days/year, p < 0.001), while RT timing and gender were not significant predictors.

### Conclusion

These findings suggest that moderate delays in initiating radiotherapy (3–6 weeks or >6 weeks) do not significantly compromise survival compared to earlier initiation (<3 weeks) in adult patients with wild-type glioblastoma. However, older age remains strongly associated with shorter survival. Tailored treatment approaches balancing clinical readiness and tumor progression risks are essential. Further studies in larger cohorts are warranted to confirm these results.

### V086

### BCL-Proteinfamilie moduliert die therapeutische Wirkung von Regorafenib in experimentellen Gliomen. BCL family members modulate the anti-glioma efficacy of regorafenib in experimental glioma

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### Objective

The multi-tyrosine kinase inhibitor regorafenib led to improved median overall survival compared with lomustine in the phase 2 REGOMA trial. However, this signal was not confirmed by the GBM AGILE trial. Here, we aimed at identifying functionally instructed modulators of the anti-glioma efficacy of regorafenib in experimental glioma.

### Methods

In this preclinical setting, we used a genome-wide CRISPR-Cas9-based functional genomics approach followed by genetic, pharmacological and functional validations. Furthermore, we investigated Regorafenib-induced molecular alterations using RNA sequencing and DigiWest. We selected functionally-instructed combination therapies for further investigations *in vivo* using three orthotopic glioma *mouse models in vivo*, including the syngeneic SMA560/VM/Dk model and two xenograft models.

### Results

We discovered potential modifiers of regorafenib response including *BCL2*, *BCL2L1*, *ITGB3*, *FOXC1*, *SERAC1*, *ARAF*, and *PLCE1*. The combination of regorafenib with Bcl-2/Bcl-XL inhibitor Navitoclax was superior to both monotherapies *in vitro*, *ex vivo* and *in vivo*. RNA sequencing revealed regorafenib-induced regulation of the Bcl-2 downstream target chemokine receptor 1 (CCR1). We further investigated CCR1"s role as a functional modulator of the synergistic effect of BCL family member inhibition. Additionally, regorafenib-induced alterations in the myeloid compartment of the glioma-associated microenvironment were detected in post-treatment brain tissue.

### Conclusion

In this preclinical study using a functional genomics-based target discovery approach with subsequent validations involving regorafenib, we identified modulators of regorafenib efficacy and provide biological rationales for clinical trial designs. Particularly the combination treatment of regorafenib plus navitoclax warrants clinical translation.

### V087

Automatisiertes Tumor-Microtube-Tracing zur Hochdurchsatzanalyse der morphologischen Netzwerkkonnektivität beim Glioblastom Automated Tumor Microtube Tracing for High-Throughput Analysis of morphological Network Connectivity in Glioblastoma

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### Objective

Cellular tumor networks in glioblastoma are based on ultralong cellular membrane protrusions, known as tumor microtubes (TMs). Tumor networks are directly associated with resistance to cytotoxic therapies. Targeting this malignant connectivity has demonstrated promise in preclinical studies and is currently being explored in early clinical trials. TM length and the extent of TM-based cell-cell contacts serve as surrogate markers of morphological network connectivity, making them highly valuable readouts for high-throughput drug screening. However, existing image analysis tools struggle to accurately delineate individual TMs within densely interconnected multicellular networks. In this study, we aimed at developing two fully automated image analysis pipelines to enable precise TM identification and comprehensive assessment of morphological network connectivity.

#### Methods

We utilized five primary glioblastoma cell populations that were lentivirally transduced with ZsGreen. These cells were seeded into well plates and incubated for 144 hours. Fluorescence images were captured every six hours using live-cell imaging microscopy. To analyze TM lengths, we developed two fully automated image processing pipelines. These pipelines include pre-processing, thresholding, speckle removal, nuclei selection, skeletonization, tracing measurement, and nuclear counting. One pipeline was implemented using the scikit-image library in Python, while the other utilized built-in tools in ImageJ. The results were compared to manual measurements obtained using the Simple Neurite Tracer (SNT) tool in ImageJ.

### Results

Both automated pipelines demonstrated high accuracy when compared to manual TM tracing. Spearman"s correlation coefficient indicated a strong agreement between manual and automated results, with values ranging from 0.89 to 0.95 across the five primary glioblastoma cell populations. Correlation coefficients were highest at earlier time points, when the tumor network density was lower. Notably, the median correlation coefficient was slightly higher for the Python-based pipeline compared to the ImageJ-based pipeline (0.91 vs. 0.89).

### Conclusion

We have developed simple, effective, and fully automated tools for processing data from high-throughput imaging experiments. These pipelines provide an efficient approach for analyzing TM-based network connectivity and hold potential to facilitate preclinical research focused on identifying therapeutic candidates targeting tumor networks.

### V088

Entwicklung einer personalisierten T-Zelltherapie für Glioblastompatienten Developing Personalized T-cell therapy for glioblastoma patient

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#### Objective

Despite the availability of various treatment modalities for glioblastoma (GBM) patients, the GBM remains one of the most challenging to treat, with poor prognosis, resistance to conventional therapies, and rapid recurrence in the majority of cases. Recent findings have highlighted the role of the innate immune system, particularly T-cells, in targeting GBM cells, including the discovery of a T-cell reservoir within the skull bone. However, these T-cells undergo rapid exhaustion, even when enhanced to more effectively identify and target GBM cells. The regulatory mechanisms underlying this exhaustion phenotype remain poorly understood. Our study aims to identify and target key regulatory networks that drive T-cell exhaustion in tumor-reactive, skull-resident T-cells, ensuring a sustained cytotoxic response. This approach seeks to address the challenges of T-cell exhaustion and immunogenicity in immune cell therapies for GBM.

#### Methods

Bone plates from GBM patients, available during surgery, were flushed with phosphate-buffered saline to extract embedded cells from the skull bone. Matched brain tumor samples were also collected from the same patients. Various cellular components were identified, purified. We injected T cells into the GBM slices. We employed 3D spatial transcriptomics, enabling the reconstruction of gene expression profiles in consecutive tissue slices to gain insight into T-cell-GBM engagement and the gene regulatory mechanisms driving T-cell exhaustion.

#### Results

Our spatial transcriptomics approach allowed us to identify T-cells actively engaging with GBM cells and to quantify their reactive states. We successfully reconstructed the regulatory networks associated with T-cell exhaustion and identified key regulatory transcriptional factors involved in T-cell dysfunction during T-cell-GBM crosstalk.

#### Conclusion

Innate immune cell therapy presents a promising therapeutic strategy for GBM patients. By targeting the key regulatory networks driving T-cell exhaustion, this approach could restore and sustain T-cell cytotoxicity, thereby improving the efficacy of immune cell therapies. Our findings provide a deeper understanding of the molecular mechanisms behind T-cell dysfunction in GBM and offer potential avenues for overcoming the immunogenic barriers that limit the effectiveness of current treatments. Ultimately, this strategy could pave the way for more durable and personalized immune-based therapies for GBM.

### V089

### Core2Edge: Ein humanes Glioblastom-Organoid-Hirnschnitt-Kokulturmodell zur Beschreibung von Tumorinfiltration und transkriptioneller Heterogenität vom Tumorbulk bis zur Einzelzellmigration *Core2Edge: A Human Glioblastoma Organoid and Brain Slice Co-Culture Model Capturing Tumor Infiltration and Transcriptional Heterogeneity from Core to Single-Cell Dispersion*

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#### Objective

Glioblastomas function as intricate cellular networks that extend into the surrounding brain tissue enabling long distance communication. This malignant connectivity spans from the tumor core to remote infiltration zones, supporting the concept of glioblastoma as a whole-brain disease. With growing ethical considerations in biomedical research and the limitations inherent in cross-species comparisons between animal studies and human glioblastoma models, human tumor platforms remain constrained in their ability to replicate the full infiltration spectrum from the tumor core to single-cell dispersion. Here, we present a three-dimensional, fully human ex-vivo glioblastoma model ("Core2Edge") that replicates this extensive infiltration range while preserving the intratumoral heterogeneity of the original tumor.

#### Methods

The Core2Edge model utilizes fluorescently labeled human glioblastoma organoids (GBOs) implanted into organotypic human brain slices. The workflow spans 7–12 days. Key steps include brain slice preparation (~4-6 hours, depending on quantity), one day for initial culture before GBO staining and transplantation, a variable culture period (up to ten days), and fixation with different techniques (~8 hours). Following model preparation, downstream analyses such as imaging, sequencing, and proteomics were performed.

#### Results

Multiplex immunofluorescence confirmed cell composition consistent with histological staining. Spatial transcriptomics enabled detailed glioblastoma cell subtyping based on Neftel states. Advanced imaging, combining tissue expansion and light-sheet fluorescence microscopy, facilitated super-resolution, three-dimensional visualization of the whole GBO-brain slice system. This approach allows for the study of initial infiltration steps, in-depth analysis of the invasive front, exploration of cell-cell interactions between tumor cells and the tumor microenvironment, and offers a platform for drug screening and testing, reducing the need for animal models.

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### Conclusion

The "Core2Edge" model represents a innovative ex-vivo platform replicating glioblastoma infiltration and heterogeneity. By preserving genetic integrity and cytoarchitecture, this fully human model bridges critical gaps in glioblastoma research, offering unparalleled insights into tumor behavior and potential therapeutic interventions.

### V090

Einfluss von Depression und Antidepressiver Therapie auf das Überleben und die Tumordynamik bei RTK2-Glioblastomen

Impact of Depression and Antidepressant Treatment on Survival and Tumor Dynamics in RTK2 Glioblastomas

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### Objective

**Objective:** Depressive symptoms are common in glioma patients and are associated with poorer survival, though mechanisms remain unclear. Building on prior findings linking the DNA-methylation subgroup RTK2 with glioblastoma-associated depression, this study examines the effects of depression and antidepressant therapy on malignant cell states and tumor invasiveness, both broadly and within the RTK2 subgroup.

### Methods

**Methods:** A retrospective cohort of glioblastoma patients was analyzed, comparing those with tumor-associated depression to non-depressive patients using propensity-matched survival analysis. DNA methylation profiling (EPIC 850k) and differential methylated position (DMP) analyses identified hypomethylated CpGs (P < 0.05, logFC < -0.1). Deconvolution methods estimated malignant cell state frequencies (Silverbush et al.) and cell types (Moss et al.). TCGA samples (n = 66) were dichotomized into a depression-like and non-depression-like group based on hypomethylated CpGs. Gene Ontology (GO) analysis explored altered pathways.

### Results

**Results:** Among 246 glioblastoma patients, 23 had tumor-associated depression and were on antidepressants (14 SSRI, 3 NaSSA, 4 TCA, 2 unknown). Depressed patients had a shorter median overall survival (OS: 8 vs. 17 months; HR = 2.09; p < 0.01). Methylation subclass analysis revealed a higher proportion of RTK2 glioblastoma in the depression group (n = 14; 60.9%). DMP analysis identified 276 hypomethylated CpGs in the depression group, with 64 in transcription start sites (TSS). GO analysis showed upregulated pathways for connectivity, neural support, and development, and downregulated responses to EGFR stimuli. Cellular composition deconvolution revealed no overall differences between the depression group and non-depression group, however a higher stem-like malignant cell component in RTK2-depression tumors (36.2%) in comparison to the RTK2-non-depression group (18.6%), indicating a shift from differentiated- to stem-like states.

### Conclusion

**Conclusion:** Glioblastoma-associated depression, particularly in RTK2 tumors, correlates with worse outcomes and increased stem-like malignant cells, which may drive aggressive tumor behavior. These findings highlight methylation-dependent mechanisms linking depression, glioblastoma progression, and antidepressant therapy, emphasizing the need for tailored treatment strategies.

### V091

Die Wundheilungsanalogie bei der Reaktion von Medulloblastomzellen auf Gap-Junction-Inhibition und zytotoxische Therapien

Wound Healing Analogy in Medulloblastoma Response to Gap Junction Inhibition and Cytotoxic Therapy

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### Objective

Intercellular communication is a significant factor in chemotherapy resistance in malignant brain tumors. Connexin-43 (Cx43)-based gap junctions (GJs) facilitate this communication by allowing intercellular ion transfer and small molecule exchange. The impact of GJs in medulloblastoma as the most common malignant pediatric brain tumor is unknown. In the present study, we analyzed the potential of GJs as a putative novel therapeutic target in medulloblastoma. Here, we utilized meclofenamate (MFA), an FDA-approved drug with gap junction-inhibitory properties, which had never been used in medulloblastoma research before.

### Methods

Two medulloblastoma cell lines were used. A CRISPR/Cas9 gene knockdown of Cx43 was used to explore cellular effects related to the inhibition of GJs. Realtime-imaging fluorescence-guided measurements of GJ-mediated cell-to-cell cytoplasm transfer was performed for the CRISPR/Cas9 Cx43 knockdown model and MFA treatment. We used RNA-sequencing to study downstream signalling cascades in response to GJ inhibition. DNA-fragmentation served as readout for cell death and was assessed by flow cytometric analysis of propidium iodide-stained nuclei.

### Results

All medulloblastoma group 3 and 4 cell lines showed an expression of intercellular Cx43-based GJs. We observed a significant reduction of intercellular cytoplasm transfer via GJs in both the CRISPR/Cas9 Cx43 knockdown model and in MFA-treated medulloblastoma cells. MFA-mediated inhibition of GJs profoundly rendered medulloblastoma cells susceptible for lomustine-mediated cell death. Cytotoxic effects were similar to those observed in CRISPR/Cas9 Cx43 cells. In RNA sequencing, we observed not only an upregulation of programmed cell death pathways but also a significant upregulation of wound healing pathways when MFA was combined with lomustine treatment.

### Conclusion

This study suggests that inhibiting intercellular connectivity makes medulloblastoma cells more susceptible to lomustine-induced cytotoxic effects. This disruption of tumor networks can be compared to the initial phase of wound healing, where the cellular network is broken apart. Understanding these processes provides insight into therapeutic strategies that target both the destruction and regrowth phases of tumor cell networks. Consequently, gap junction-targeted approaches might offer a novel treatment strategy for this malignant pediatric brain tumor.

### RC027

Zwei Generationen von Gravitationsventilen bei Kindern - eine monozentrischer Vergleich. Two generations of gravitational shunt valves in pediatric patients – a single center comparison of real-life performance.

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### Objective

Adjustable gravitational valves are designed to avoid overdrainage and allow age-dependent adaptions. While a previous generation combined an adjustable differential pressure valve with a fixed gravitational unit (Miethke proGAV2), in a later model adjustability was switched (Miethke M.Blue), accounting for predominantly upright position in most periods of life and thus theoretically more relevant adjustability in this dimension. We provide a single-center comparison of both valves.

#### Methods

We performed a retrospective study of patients <18 years, who received shunt insertion/revision with implantation of proGAV2 or M.Blue between 2017-2023. Primary outcomes were non-infectious shunt revisions within 30 days and within overall follow-up. Secondary outcome was number of valve adjustments for over/underdrainage. Descriptive statistics and Fisher's exact test with two-tailed P value were applied. Level of significance was determined at 0.05.

### Results

The proGAV2 cohort comprises 36 shunt operations with mean age of 13 months (range 0-60 months). M.Blue was implanted in 37 cases with mean age of 11 months (0-75). Indications were posthemorrhagic (42% and 46%) and congenital hydrocephalus (33% and 41%). 54% and 53% were de novo shunt insertions. Shunt revision within 30 days occurred in 11% and 5% (P=0.4297) and within a mean overall follow up of 42 months (12-84) in 31% and 27% (P=0.1570). Valve adjustments were performed 11 and 16 times, respectively. In proGAV2 patients, 3 (27%) adjustments were made for over- and 8 (73%) for underdrainage. In M.Blue patients, 6 (38%) adjustments were made for over- and 10 (62%) for underdrainage.

### Conclusion

Both valves were applied in similar cohorts regarding age, etiology of hydrocephalus and proportion of de novo implantation versus revision. Differences in outcomes were not statistically significant. In our experience there is equipoise between both gravitational valves and further studies are required to explore clinically meaningful differences.

### BO-04

### Externe Validierung prädiktiver Modelle für postoperative Hydrozephalus bei pädiatrischen Patienten mit Tumoren der hinteren Schädelgrube

# External validation of predictive models for postoperative hydrocephalus in pediatric patients with posterior fossa tumors

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### Objective

Postoperative hydrocephalus (PH) after posterior fossa tumor (PFT) resection in children is common with incidences reported up to 40%. Adequate management of PH is highly consequential to patient-burden including commencement of adjuvant therapy. The (modified) Canadian Preoperative Prediction Rule for Hydrocephalus ((m)CPPRH) aims to preoperatively identify children at risk for PH. External validation is necessary before its clinical implementation in Europe. However, a comprehensive analysis is currently lacking. This study seeks to validate the (m)CPPRH in European children.

### Methods

We obtained data from retrospective registries at six university hospitals across four European countries. Children (<18 years) with newly diagnosed posterior fossa tumors who subsequently underwent resection were eligible for analyses. The predictor variables of the (m)CPPRH (age younger than 2 years, papilledema/presence of transependymal edema, severity of hydrocephalus, presence of intracranial metastases and the preoperative estimated tumor diagnosis) were collected in addition to need for either ventricular shunting or endoscopic third ventriculostomy within 6 months after tumor resection—i.e. PH. Performance of the (m)CPPRH was assessed with discrimination (*c*-statistic) and calibration (calibration-in-the-large, calibration slope and calibration plots) measures.

### Results

The combined cohorts consisted of 461 children of whom 53 (11.5%) developed PH. Mean age was  $92.5 \pm 56.2$  months. The *c*-statistic equaled 0.75 (0.58-0.86) and 0.74 (0.62-0.84) for the CPPRH and mCPPRH respectively. Both the CPPRH and mCPPRH showed some signs of overestimation of risk of PH and the calibration slope indicated too extreme predictor effects on average.

### Conclusion

The (m)CPPRH shows potential for preoperative identification of children at risk for PH following PFT surgery. Although additional model updating is needed, it may serve as an adjunct tool in Europe for data-driven personalized decision-making, patient counseling, and risk stratification in future research endeavors subjected to the first line treatment of PH in children with PFT.

### RC025

Neurochirurgische Entscheidungsfindung bei pädiatrischen Hirntraumata: Variabilität in Abwesenheit von Leitlinien

Neurosurgical Decision-Making in Pediatric Brain Trauma: Variability in the Absence of Guidelines

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### Objective

Pediatric patients requiring neurosurgical interventions, particularly those with severe brain injuries, often present as complex cases exceeding the scope of established guidlines. In practice, treatment strategies can vary widely among experts, resulting in divergent therapeutic decisions. This study aimed to explore the variability in treatment approaches among neurosurgical experts for pediatric patients with traumatic brain injuries and to identify potential patterns in decision-making for cases without established guidelines.

#### Methods

In our survey, 11 neurosurgical experts were presented with six pediatric neurosurgical cases. Each case required decisions on the appropriate surgical intervention regarding the use of decompressive hemicraniectomy (DHEC), craniotomy, external ventricular drainage (EVD), and intracranial pressure (ICP) monitoring. The responses were analyzed to assess variability and agreement among experts.

#### Results

6 cases were analyzed, and responses were collected from 11 neurosurgical experts. In 44 out of the 55 evaluated cases (80%), an indication for DHEC was established. A full consensus (100%) was reached for classical indications like severe traumatic brain injury (TBI), subarachnoid hemorrhage (SAH), and middle cerebral artery infarction. In more complex cases, such as empyema and sinus vein thrombosis, no unified consensus on the indication was achieved. The average consensus rate for indication was 80% (SD  $\pm$  12.7%). Regarding the procedural approach, a high consensus (> 81%) was observed in 55% of the cases (3 out of 6). For unilaterally localized bleeding, the average consensus rate was 87.7%, while in multifocal and more complex scenarios, it dropped to 39.3% (SD  $\pm$  35.6%). Regarding one case, 2 of 11 experts (18%) would retrospectively change their initial decision.

### Conclusion

The study highlights a substantial lack of consensus among neurosurgical experts in managing complex pediatric cases, particularly those with severe brain injuries, underscoring the urgent need for standardized guidelines. Establishing evidence-based protocols could improve consistency in therapeutic approaches and optimize outcomes for pediatric patients undergoing neurosurgical interventions.

### RC026

Atlantoaxiale Instabilität bei Patienten mit Down oder Morquio Syndrom: Empfehlungen des WFNS Spine Committee für Screening, sportliche Aktivität und Behandlung Atlanto-axial instability in Down's and Morquio's patients: Recommendations of the WFNS Spine Committee on screening, surveillance, sports clearance and treatment options

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### Objective

Disorders of the craniocervical junction pose a severe risk for tetraplegia, respiratory impairment or even sudden death. Patients with syndromic diseases, especially Morquio Syndrome and Down Syndrome, have a significantly higher risk of atlantoaxial instability due to changes of the bone structure and laxity of ligaments. As of now, there are no scientific evidence or recommendations for screening for spinal disorders in children with Down or Morquio Syndrome, treatment options or advice regarding sports activities.

#### Methods

A literature review on craniocervical junction disorders in Down and Morquio Syndrome published between 2012 and 2022 was performed and statements were worded. Two consensus meetings were held in Sao Paolo, Brazil, August 5th, 2022 and Porto, Portugal, Dezember 3rd, 2022, where spine experts voted on the statements anonymously on a Likert-type scale (5: strongly agree, 4: agree, 3: neutral, 2: disagree, 1: strongly disagree). When agreement or disagreement was  $\geq$  66%, a consensus was reached.

#### Results

A total of 146 articles were found, 16 were deemed relevant to formulate statements. The WFNS Spine Committee recommended close neurological screening in children with Down Syndrome from birth. Radiographic imaging was recommended for symptomatic children. Children with Morquio Syndrome should receive yearly neurological examinations from the age of five years and radiographic imaging of the entire spine, at least with lateral x-ray in controlled flexion/extension projections. Even if atlantoaxial instability is asymptomatic, preventive surgery might be considered. If neurological symptoms occur from atlantoaxial instability, stabilizing surgery must be performed. The surgical approach is individual to each patient, with the most frequently described technique in literature being the Goel-Harms C1-C2 stabilization. In children with Down Syndrome, if atlantoaxial instability is ruled out, there are no limitations for sports activities. There is no evidence for Down's patients regarding sports clearance after decompressive or stabilizing surgery. Morquio patients should only participate in limited sports activity, such as swimming or hippotherapy.

### Conclusion

Due to the prevalence of atlantoaxial instability in Morquio's and Down's syndrome, screening for disorders of the craniocercival junction should be performed since early childhood. If neurological symptoms occur, surgery must be performed, but preventive surgery might also be considered.

### RC028

### Komplikationsrate der neuroendoskopischen Eingriffe bei Kindern Complication rate of neuroendoscopic procedures in the pediatric population

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### Objective

In recent decades, neuroendoscopic procedures have become the method of choice in the treatment of different forms of hydrocephalus and intraventricular pathologies in adults. However, there is still a debate about the benefit of these techniques in pediatric patients. Furthermore, the use of endoscopes in children is suspected of causing higher complication rates. The purpose of this study is to assess complications in the pediatric population.

### Methods

The authors performed a retrospective analysis of a series of pediatric patients who had undergone pure endoscopic intraventricular surgery from January 2011 to October 2018 at the Neurosurgical Department, Saarland University, Homburg. The mean follow-up period was 3.4 years. Special attention was paid to perioperative complications, revision surgeries and their correlation with the endoscopic technique.

### Results

Ninty-two children were treated via a pure endoscopic surgery because of intraventricular or cystic pathologies during this time peroid. The endoscopic procedures performed (alone or combined) included cyst or membrane fenestration (n=17), septostomy (n=13), endoscopic third ventriculostomy (n=26), tumor biopsy (n=6), tumor resection (n=4), aqueductal stenting (n=6), catheter placement with shuntscope (n=27). There was no mortality. Six patients (6.5%) presented a CSF leakage and subcutaneous CSF collection. Two of them needed a revision surgery. Two patients (2.1%) suffered from wound healing deficits, two patients had a shunt infection during follow up (2.1%) and one patient (1.1%) developed cerebral vasospasm after cyst fenestration. Three patients (3.2%) underwent a shunt revision surgery during and one patient (1.1%) needed further surgical treatment with shunt placement after an initial endoscopic procedure during the follow up time period.

### Conclusion

Neuroendoscopy plays an important role in the treatment of pediatric cases. There is a risk of CSF collection in the subcutaneous approach area. However, the revision surgery rate is not higher than in comparable studies in the literature with shunt treatment or other surgical procedures in children. Beside this, endoscopic techniques are safe and efficient procedures in the pediatric population.

### V092

### Die erste Erfahrung mit fetal-mikrochirurgischem Verschluss von 16 Myelomeningozelen in Deutschland The first experience with 16 open microsurgical fetal surgeries for Myelomeningocele in Germany

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### Objective

Fetal surgery for spina bifida aperta has achieved great advancement in last decade offering three possible methods for surgical repair. Open fetal microsurgical repair still remains the cornerstone considering long-term results available. Since 2016, we established a program offering this modality of treatment in Germany.

#### Methods

All patients who underwent interdisciplinary prenatal evaluation following a standardized protocol between June 2016 - June 2024. Sacral lesions were excluded. The surgical technique and protocol used were similar to that described in Management Of Myelomeningocele Study (MOMS).

#### Results

Sixteen patients underwent surgery for spina bifida aperta without fetal nor maternal deaths. Microsurgical fetal repair was performed between 24th and 25th week of gestation age (GA) (Mean: 24+5 weeks GA). Lesion levels were mainly lumbosacral (n=15) and one thoracolumbar (n=1). Repair was successful in all 16 cases and with reversible hindbrain herniation at time of birth in 13/16 patients (81.3%). Average time of delivery was 33+5 weeks GA, with 8 preterm deliveries occurring before 37 weeks GA; average birth weight was 2193 grams. Maternal complications included 2 patients with uterine scar thinning. Hydrocephalus management was needed in 5/16 patients (31.25%) via ventriculo-peritoneal shunting.

#### Conclusion

Open fetal repair of spina bifida aperta in selected fetuses is safe and offers the unborn child a better quality of life but does not cure the disease and is not without risks or complications. Collaboration within the pediatric community is recommended to compile data in a common registry to develop standardized treatment and follow-up protocols.

### V093

Prospektive Einblicke in die pädiatrische Neurochirurgie: Verbesserung der Versorgung durch Analyse unerwünschter Ereignisse

Prospective Insights into Pediatric Neurosurgery: Transforming Care Through Adverse Event Analysis

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### Objective

Recent advancements in pediatric neurosurgery have significantly enhanced patient care and monitoring. Despite these improvements, the complexity of these procedures continues to pose a high risk of adverse events (AEs). Current literature lacks comprehensive AE data, underscoring a critical gap in research. This study addresses this void by utilizing a prospectively collected database from a premier neurosurgical tertiary center, aiming to develop critical care guidelines, optimize resource allocation, and foster interdisciplinary collaborations to mitigate AEs.

### Methods

This prospective study enrolled pediatric patients undergoing neurosurgery between January 2020 and December 2023. AEs were defined as any undesirable outcomes occurring within 30 days post-operation, with each event peer-reviewed at discharge.

### Results

Among the 1,008 patients studied, ranging from newborns to 17 years (mean age 10.5 years), 82.5% underwent elective procedures and 14.4% emergency procedures. The overall incidence of surgery-related AEs was 9.2%, with 5.2% requiring revision surgery. Cranial pathologies, accounting for 37.5% of interventions, were the most common, with wound infections and cerebrospinal fluid (CSF) leaks being most prevalent. The mortality rate was notably low at 0.4%, primarily attributable to severe underlying conditions like medulloblastoma progression and severe traumatic brain injuries. Non-surgery-related AEs occurred at a rate of 2.4%. Logistic regression analysis identified age as a significant protective factor against postoperative complications, with each additional year reducing the odds of complications by approximately 5.4% (OR = 0.946, p = 0.002). Gender, however, was not a significant predictor of adverse outcomes.

### Conclusion

The study highlights a significantly low incidence of AEs in pediatric neurosurgery, demonstrating the effectiveness of systematic AE documentation and continuous data monitoring. Logistic regression analysis identified age as a significant protective factor against complications, while gender showed no significant association, underscoring the multifactorial nature of adverse event development. These findings provide actionable insights into patient risk stratification, particularly emphasizing the role of age, and contribute to enhancing patient education, guiding quality-based healthcare reforms, and supporting the implementation of prospective AE tracking systems to improve patient safety and care standards in pediatric neurosurgery.

### RC029

patients with pineal cysts

Prospektive Untersuchung der Beziehung zwischen präoperativen Melatoninspiegeln und typischen Symptomen bei Patientinnen mit Pinealzysten Prospective investigation of the relationship between preoperative melatonin levels and typical symptoms in

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### Objective

Melatonin (ML) is synthesized in the pineal gland and is subject to a circadian rhythm. Patients with symptomatic pineal cysts (PC) - who do not have hydrocephalus - suffer from a variety of symptoms in addition to cephalgias and sleep disorders. However, the pathomechanism is still unclear - a disturbed ML secretion is being discussed. However, the data regarding melatonin levels in patients with PC is still insufficient.

### Methods

As part of a prospective study in patients with symptomatic PC, we examined the preoperative ML level in the saliva in a half-hour rhythm between 08:30 p.m. and 01:00 a.m.. Symptoms were recorded over a week with the help of a diary. We analyzed the relationship between symptoms and the ML level using Spearman's correlation and the deviation of the melatonin level from the normal values using a Wilcoxon test and a binominal test.

### Results

A total of ten female patients have been included. The average age was 37.8 years. The average size of the PC was 11mm. The patients had been suffering from symptoms for an average of 4.5 years. They were able to sleep on 2.5 out of 7 days, problems falling asleep occurred on 3.6 out of 7 days. Headaches occurred on an average of 5.5 out of 7 days. The severity of the headaches was on average 3 to 7 on the VAS. 40% of the patients (n=4) reported nausea. Visual disturbances and fatigue were only present in 20% (n=2).

There was no significant correlation between the size of the PC and the ML level. A longer time since onset of symptoms correlated significantly with a decreased ML concentration at 22:30 (p= 0.031). There was no significant correlation between ML levels and the symptoms recorded. However, according to binominal testing, the ML values significantly deviated from the reference values, particularly due to a lack of increase during the night (Fig. 1). While six patients were still within the normal range at 8:30 p.m. (p=0.001), from 10:00 p.m. only two were (p<0.0001), and from 00:30 a.m. all patients were outside the normal range (p<0.0001). Only two were above and eight were below the normal range. The deviation from the mean reference value was statistically significant for the measurements at 8:30 p.m. (p=0.039) and 01:00 a.m. (p= 0.023).

### Conclusion

The ML level in patients with symptomatic PC deviates significantly from normal ML levels, in particular due to a lack of increase during the night.





### RC030

Endoskopische Lavage bei zerebraler Ventrikulitis im Kindesalter: Ein minimalinvasiver Ansatz zur CSF-Infektionsbehandlung Endoscopic Lavage Versus Conventional Management in Pediatric Cerebral Ventriculitis: A Prospective Controlled Study

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### Objective

Cerebral ventriculitis continues to be a complex neurosurgical challenge, often associated with prolonged treatment durations, extended hospital stays, and poor patient outcomes. Although conventional treatment strategies, including antibiotic therapy combined with cerebrospinal fluid (CSF) drainage, are widely used, results can still be suboptimal in certain cases, with no universally established treatment guidelines. This study seeks to evaluate and compare the effectiveness of ventricular irrigation or lavage versus the standard approach of CSF drainage with antibiotic administration.

### Methods

33 patients diagnosed with cerebral ventriculitis, with the majority of cases arising as complications from cerebrospinal fluid (CSF) shunt procedures. The patients were divided into two groups. In both groups, any existing ventricular catheter was removed. The first group underwent treatment using ventricular lavage, while the second group received conventional management involving the placement of an external ventricular drain. Both groups were administered systemic and intraventricular antibiotics. The study compared outcomes between the groups, focusing on mortality rates, modified Rankin Scale (mRS) scores, and length of hospital stay.

### Results

The average age of the study participants was  $5.98 \pm 7.02$  years. The mean follow-up period was  $7.6 \pm 3.2$  months for the conventional treatment group and  $5.7 \pm 3.4$  months for the lavage group. The mortality rate was 25% (4 out of 16) in the lavage group compared to 52.9% (9 out of 17) in the conventional group, with a p-value of 0.1, indicating no statistically significant difference. However, a mRS< 3, reflecting a favorable outcome, was observed in 68.8% (11 out of 16) of the lavage group compared to only 23.5% (4 out of 17) in the conventional group, showing a statistically significant difference (p < 0.05). The average hospital stay was significantly shorter in the lavage group (20.5  $\pm$  14.2 days) compared to the conventional group (39.7  $\pm$  16.9 days) with a p-value of less than 0.05.

### Conclusion

Endoscopic lavage can be an effective approach for managing cerebral ventriculitis. This method is associated with improved patient outcomes and a significantly shorter hospital stay duration compared to conventional treatment strategies, making it a promising alternative in the care of this challenging condition.

### V094

### Unterschiede in der perioperativen Dexamethason-Eindosierung und deren Zusammenhang mit dem Patineten-Outcome bei der Resektion von Hirnmetastasen Practice Variation in Peri-Operative Dexamethasone and Association with Outcomes in Brain Metastasis Resection

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#### Objective

Patients with symptomatic brain metastases undergoing brain metastasis resection routinely receive perioperative dexamethasone. This study aimed to evaluate the variations in pre-and post-operative dexamethasone dosing and its association with patient outcomes.

### Methods

Retrospective data on daily dexamethasone administration over 27 days were collected from eight neurosurgical centers in Germany and Austria. Statistical analyses included determining cutpoints for patient dichotomization using maximally selected rank statistics. Propensity score matching (PSM) was employed to reduce bias and adjust for potential confounders such as tumor and edema volume, localization of the dominant brain metastasis, disease-specific GPA score, presence of other non-oncological diseases, and post-operative adjuvant treatment. Dose-response assessment was conducted via spline regression and quintile calculation.

#### Results

A total of 1064 patients were included, with a median follow-up time of 53.9 months (95% CI: 48.7 - 59.2). After PSM, patients below the 122 mg cumulative dexamethasone cutpoint had an overall survival (OS) of 19.1 months (95% CI: 15.2 - 22.4) compared to 12.0 months (95% CI: 9.1 - 14.7) for those above the cutpoint (p=0.0021). In a multivariable model for the matched data, cumulative peri-operative dexamethasone dose above the cutpoint of 122 mg was independently associated with OS (hazard ratio [HR]: 1.3, 95% CI: 1.1 - 1.5, p=0.009). The dose-response assessment further supported this finding.

### Conclusion

Higher cumulative peri-operative dexamethasone doses may be associated with reduced OS in patients undergoing brain metastasis resection. Clinical practice should consider stricter dexamethasone dosing to minimize cumulative exposure. Prospective trials are necessary to inform evidence-based decision-making.

			Hazard ratio			
dexa_group	Below Cutpoint (Ne389)	reference				
	Equal to or Above Cutpoint (N=289)	(1.10 - 1.56)				0.002 **
tumor_vol	(N=738)	(1.00 (1.00 - 1.01)		1		0.043 *
edema_vol	(N≈738)	1.00 (1.00 - 1.00)				0.459
ds_GPA_group	2 and above (N#462)	reference			-	
	Below 2 (N=275)	1.56 (1.30 - 1.88)			<b>⊢</b> ∎−	-0.001
other_diseases	0 (N=306)	reference			-	
	1 (N#422)	(0.85 - 1.22)			<b></b>	0.837
adjuvant_therapy	DSC (NatSB)	reference				
	chemotherapy 4-radiation therapy (N#142)	0.53 (0.37 - 0.75)	÷			<0.001 ···
	immunotherapy +/- chemotherapy +/- radiation ther (N=176)	0.30 (0.21 - 0.43)				-0.001 ***
	radiation therapy (N=252)	0.36 (0.26 - 0.50)	· •	-		-0.001 ***
	targeted therapy 4- chemotherapy 4- radiation the (Net10)	0.31 (0.22 - 0.46)				-0.001 ***
# Events: 525; Olobal p-value (Log-Rank): 1.8308e-16 AIC : 6059.93; Concordance Index: 0.64	0.1	0	2	0.5	1	2

### Abb. 2

### V095

### Kraniale Eingriffe bei knochenmarktransplantierten Patienten Cranial surgeries in patients with a history of bone marrow transplantation: a monocentric experience

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### Objective

Neurosurgical procedures in patients with a history of bone marrow transplantation (BMT) pose unique challenges due to the fragility of this group and the complexity of their underlying conditions. Despite the clinical significance, this subject remains underexplored in the literature. This study aims to investigate complication rates and postoperative outcome associated with neurosurgical procedures in this patient population.

### Methods

This retrospective study analyzes clinical and outcome data in patients with a history of BMT who underwent neurosurgical procedures in our center from 2007 to 2024. The obtained results were analyzed using descriptive statistics.

#### Results

Thirty-six patients with BMT (mean age 40 years) underwent a total of 72 neurosurgical procedures, including 43 craniotomies and 19 burr-hole trepanations. Surgical indications were tumor (19 patients, 52.8%), intracranial hemorrhage (4 patients, 11.1%), infections (4 patients, 11.1%), hydrocephalus: (4 patients, 11.1%), cerebral infarction (1 patient 2.8%), and other indications (4 patients 11.1%). At the time of surgery, 9 out of 36 patients were taking immunosuppression medication. Postoperative complications were more prevalent in immunosuppressed patients (p<0.05), who experienced higher rates of systemic infections (36.7%), wound healing issues (26.7%), and intracranial bleeding (16.7%), compared to their non-immunosuppressed counterparts (11.1%, 7.4%, and 11.1%, respectively). The 30 day mortality was 11% and was primarily attributed to systemic infections (50%), tumor progression (25%) or related to the primary pathology (25%). Tumor patients showed the highest rates of wound healing issues (31.6%), while intracranial hemorrhage in patients had the highest rates of cerebrospinal fluid leakage (75%). The outcome in long-term follow-up (median 6.4 years) was significantly related to the primary disease rather than the surgical procedure.

### Conclusion

Complication rates after neurosurgical procedures are high in this fragile group, especially among those with immunosuppression. Tumors remain the leading indication for surgery and contribute to increased mortality in BMT patients. Additional measures should be implemented to reduce the risk of complications in this patient population.

### V096

M2 Spine Registry- vorläufige Ergebnisse zur Bewertung der Lebensqualität von Patienten mit multiplem Myelom Manifestationen an der Wirbelsäule M2spine registry – preliminary results from a multidisciplinary, multicenter registry to assess the quality of life of patients with multiple myeloma and vertebral column lesions

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### Objective

Spinal lesions occur in 50% of patients with multiple myeloma (MM), yet there is no standardized treatment strategy. The prospective M2 Spine Registry aims to assess patient-reported outcome measures (PROMs) such as the NRS and SOSGOQ2.0 in MM patients with vertebral lesions treated conservatively and surgically in order to compare how these treatment strategies impact patients" long-term quality of life. Here we report the initial single-center findings from this registry.

### Methods

Adult patients with newly diagnosed vertebral column lesions caused by MM were included via the departments for radiotherapy, neurosurgery or oncology. At the inclusion oncological, clinical, radiological and surgical assessments were performed and repeated year wise. Moreover, patients completed a standardized questionnaire assessing NRS, WHO pain scheme and SOSGOQ2.0 (according to SOSGOQ2.0\_GER by Datzmann et al. 2021) every three months. All data were entered in a pseudonymized manner to a REDCap database. Ethical approval was granted.

### Results

31 patients of which 15% were female have been included at baseline assessment. Median age at inclusion was 61 years. There were no significant differences in the mean KPS or SINS at inclusion. Vertebral lesions were affecting the spine between C1 and S3. 17 Patients completed the three-month follow-up. After 90 days the overall SOSGOQ2.0 showed a mean fold change of 1.25 in the surgical group compared to 1.03 in the conservative group. An average decrease of 1 point on the NRS scale could be shown in the surgical group, whilst it decreased 0.4 points in the conservative group. A WHO pain scheme reduction was reported from 60% of the surgical cohort and could not be observed within the non-surgical group. Within 6 patients that completed 360 days of follow-up no significant SOSGOQ2.0 changes between mean baseline and follow-up could be observed. Adverse events were reported in one patient within each group.

### Conclusion

Our preliminary results show an overall improvement in self-reported pain experience, increase of physical function as well as better results in mental wellbeing and social function in MM patients over the course of 3 months. The surgical subgroup showed a trend towards a higher increase of SOSGOQ2.0 and a greater decrease of pain. More comparative data on the development of PROMs in both groups is expected; currently there are seven centers actively including patients in the study.

### RC031

Stationäre neuroonkologische Hauptdiagnosen in Deutschland im Jahr 2035: Eine bevölkerungsbasierte Prognose Primary neurooncological hospital cases in Germany the year 2035: A population-based forecast from the FutureNOK study

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### Objective

Neuro-oncological diseases pose a significant burden on patients and their families, while remaining a cornerstone of neurosurgical care. This study aims to project the number of hospital cases with neuro-oncological main diagnoses through to 2035, providing insights for future healthcare planning.

### Methods

Data submitted under §136b SGB V to the Federal Joint Committee were analyzed using the Trinovis database (Trinovis, Hannover, Germany). Neuro-oncology cases were identified using ICD-10-GM codes C70, C71, C72, C75.1–3, D32, D33, D35.2–4, D42, D43, and D44.3–5, in accordance with the primary case definition set by the German Cancer Society (DKG). Population projections and demographic forecasts from the Federal Statistical Office were used to predict the future prevalence of neuro-oncological diagnoses, accounting for regional, age, and gender-specific factors. Expected case numbers were calculated for the state and individual districts by combining forecast population data with current case rates.

### Results

The adult population of Germany, totaling 69,373,865 people (35,432,664 women) in 2021, is projected to slightly increase to 69,816,920 people (35,519,490 women) by 2035. However, the proportion of individuals aged  $\geq$ 65 years will rise significantly from 22.1% to 27.1%.

Hospital cases with neuro-oncological diagnoses are expected to increase at an annual rate of 0.2% by 2035. The highest regional growth is anticipated in Frankfurt am Main, with case numbers reaching 113% of 2023 levels. Conversely, Suhl, Thuringia, is projected to experience a decline to 80% of baseline levels.

For malignant gliomas (ICD-10-GM code C71), cases are expected to rise from 20,695 in 2023 to 21,257 in 2035 (0.2% annual growth). Women are projected to see a 0.2% annual increase, while cases among individuals aged  $\geq$ 65 years will grow at a faster rate of 1.6% annually. Similarly, cases of benign meningeal tumors (D32) are forecast to rise from 9,081 in 2021 to 9,479 in 2035, reflecting a 0.3% annual increase overall, with growth rates of 0.3% for women and 1.5% for individuals aged  $\geq$ 65 years.

### Conclusion

This study predicts a modest increase in hospital cases with neuro-oncological diagnoses in Germany due to demographic shifts, with the most pronounced growth among older populations. These findings underscore the importance of tailoring future care planning to address the needs of an aging demographic.
### V097

Klinischer und wissenschaftlicher Einsatz von Instrumenten zur Erfassung von Patienten-berichteten Ergebnissen und externen Assessmentinstrumenten bei PatientInnen mit Hirntumor *Clinical use and scientific use of patient-reported outcome measures and external assessment tools in patients with brain tumours* 

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#### Objective

Patient-centred, neuro-oncological treatment strategies require a detailed picture of the patients" health-related quality of life (HRQoL) as well as their functional and neurocognitive status. However, extensive assessment is time-consuming, and only few standardised tools have been tailored to the special needs of brain tumour patients. The aim of this survey study was to draw a picture of the current clinical and scientific assessment practice in German interdisciplinary neuro-oncology tumour centres.

#### Methods

We surveyed the use of HRQoL, functional and neurocognitive status assessments regarding patient-reported outcome measures (PROMs) and external assessments in clinical routine (Clin) and registered clinical studies (Stud). Out of 123 approached interdisciplinary neuro-oncology centres, 79% responded with at least one discipline in the survey; 54% of them were university hospitals (total n=199). In addition, 60% (n=28) of the investigators of eligible, active clinical studies responded, which were identified using keyword search from the German clinical trials registry.

#### Results

66% of Clin respondents (n=120) and 79% of Stud respondents (n=22) stated to use PROMs regularly. In clinical routine, PROMs were mostly applied to assess psycho-oncological support needs (Clin: 81% vs. Stud: 50%) using the Distress Thermometer (DT; Clin 69% vs. Stud 67%), whereas HRQoL was the dominant PROM in clinical studies (Stud: 15% primary and 80% secondary outcome parameter vs. Clin: 35%). To assess sensorimotor and cognitive functions, PROMs play a negligible role compared to external assessment and screening tools. Here, mainly simplistic and fast tools are applied to assess the general health status (Barthel Index: Clin 79% vs. Stud 25%; KPS: Clin 87% vs. Stud 88%), sensorimotor (NANO scale: Clin 36% vs. Stud 20%) and cognitive functions (MMST: Clin 87% vs. Stud 67%; MoCA: Clin 53% vs. Stud 33%).

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#### Conclusion

The results reflect that ease of administration and duration of the test are essential to achieve a broad acceptance, especially in clinical settings. The relatively infrequent clinical use of rather comprehensive instruments to assess HRQoL and cognition highlights the need for instruments offering a better balance between test quality and feasibility. An interdisciplinary discussion is needed to integrate the valuable assessment of patient-related outcomes not only into scientific but also into routine clinical practice and to strive for the best possible harmonisation of the tools used.

### V098

Auswirkungen der Tumorresektion auf die verbale Gedächtnisleistung: Eine prospektive Längsschnittstudie zu postoperativen Veränderungen bei intrakraniellen Tumoren Impact of Surgery on Verbal Memory Performance: A Prospective Longitudinal Study of Postoperative Changes in Patients with Intracranial Tumors

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#### Objective

Intracranial tumors and related therapies are associated with memory deficits. Little is known about the nature, extent, and course of memory performance (MP) in relation to surgery. For this purpose, this prospective trial examines changes in verbal memory.

#### Methods

35 patients underwent surgery for the removal of an intracranial tumor. The Verbal Learning and Memory Test (Helmstaedter et al., 2001) was administered pre- and postop., and after 3 months. We examined impairments and changes in memory parameters and their association with clinical features.

#### Results

Mean KPS was 94.0 (SD 11.4), mean age was 58.8 (SD 12.7) years. Preop. memory deficits were most pronounced in delayed recall (DR: 20.6%) and recognition (REC: 17.6%), both linked to a lower KPS (KPS≤90% vs. 100%: DR 50.0% vs. 8.3%, p=.006; REC 60.0% vs 0.0%, p<.001). Impaired DR was associated with left hemisphere (40.0%, cf. right 6.3%, p=.025), while impaired REC was related to malignant tumors (31.6%, cf. benign 0.0%, p=.020). Age was not prognostic. One week postop., MP significantly deteriorated in 60.6% (DR) and 51.5% (REC) of patients, with 50.0% having a severe impairment of DR and 47.1% of REC. Preop. KPS was a predictor for decline in both parameters (KPI≤90% vs. 100%: DR 90.0% vs. 47.8%, p=.023; REC 90.0% vs. 34.8%, p=.004) and malignancy for REC (77.8% cf. benign 42.9%, p=.043). After 3 months, MP often recovered, but was still significantly below preop. levels in 29.4% (DR) and 17.5% (REC) of patients. Severe impairment remained in 25.7% (DR) and 20.0% (REC), and was associated with postop. radiotherapy (DR 46.2% cf. no RT 13.6%, p=.033; REC 38.5% cf. no RT 9.1%, p=.036) and systemic treatment (DR 60.0% cf. no ST 12.0%, p=.003; REC 50.0% cf. no ST 8.0%, p=.005) in addition to a/m preop. predictors. Short-term memory impairment, as measured by word span, was observed only in 11.4% preop., 20.6% postop., and 5.7% of the patients at 3 months, independent of clinical features. 17.1% performed significantly below preop. levels, which was associated with the right hemisphere (29.4% cf. left 0.0%, p=.022).

#### Conclusion

Our data suggest that a considerable number of patients – even those with excellent functional health – suffer from transient long-term memory deficits. This may be dangerously masked by intact short-term memory. In particular, patients with even minimal functional health impairment, dominant-side lesions, and malignant tumors are at risk, which may compromise their adherence to adjuvant therapy.

### RC032

Einsatz der Virtual Reality Technologie in Erkennung der zerebralen Anatomie und chirurgische Planung bei Patienten mit anterioren Schädelbasismeningeomen Application of virtual reality technology in the recognition of cerebral anatomy and surgical planning in patients with Anterior skull base meningiomas

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#### Objective

Anterior skull base meningiomas represent a wide cohort of tumors with different locations, extensions, configurations, and anatomical relationships. Diagnosis of these tumors and review of their therapies are inseparably connected with cranial imaging. We analyzed the influence of three-dimensional-virtual reality (3D-VR) reconstructions versus conventional computed tomography (CT) and magnetic resonance imaging (MRI) images (two-dimensional (2D) and screen 3D) on the identification of anatomical structures and on the surgical planning in patients with anterior skull base meningiomas.

#### Methods

Medical files were retrospectively analyzed regarding patient- and disease-related data. Preoperative 2D-CT and 2D-MRI scans were retrospectively reconstructed to 3D-VR images and visualized via VR software to detect the characteristics of tumors. A questionnaire of experienced neurosurgeons evaluated the influence of the VR visualization technique on identification of tumor morphology and relevant anatomy and on surgical strategy.

#### Results

Thirty patients were included and 600 answer sheets were evaluated. The 3D-VR modality significantly influenced the detection of tumor-related anatomical structures (p=0.002), recommended head positioning (p=0.005), and surgical approach (p=0.03).

#### Conclusion

The reconstruction of conventional preoperative 2D scans into3D images and the spatial and anatomical presentation in VR models enabled greater understanding of anatomy and pathology, and thus influenced operation planning and strategy.



(a)





(¢)



(e)



(d)



(f)

Abb. 2



(a)

(b)

### V099

# Besonderheiten der idiopathischen intrakraniellen Hypertension bei Neugeborenen, Säuglingen und Kleinkindern

Peculiarities of idiopathic intracranial hypertension in neonates, infants and toddlers

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#### Objective

Idiopathic intracranial hypertension (IIH) with (IIHWP) and without papilledema (IIHWOP) is characterized by increased cerebrospinal fluid (CSF) pressure and no evident cause, mostly affecting obese women of childbearing age and possibly leading up to vision loss. In neonates, infancy and toddlerhood, they constitute under-studied entities. We focus on this age group and aim to examine the literature for clinical picture, risk factors, treatment and outcome, in order to provide new data applicable to and potentially guiding clinical practice.

#### Methods

A systematic literature search was conducted finding 2,245 publications in PubMed, 2,932 in Scopus and 1,660 in Web of Science Core Collection databases, which resulted in 103 relevant articles for analysis.

#### Results

48.2% of 299 included cases up to 36 months of age were male and 26.1% female. 42.8% of them met the modified Dandy criteria. The signs and symptoms, beside papilledema in 22.7% and its absence in 49.2% of cases, included bulging fontanelle in 67.9%, irritability in 34.5%, vomiting in 32.8%, fever in 18.4%, apathy in 10.4%, abducens nerve palsy in 10%, suture diastasis in 8%, strabismus in 7%, failure to thrive in 5.7%, macrocephaly in 4% and headache in 3% (**Fig. 1**). Except for one patient aged 14 months, patients with a bulging fontanelle were infants. The average number of signs and symptoms was 3. Triggering factors were mainly medication in 35.5%, infection in 15.1%, vitamin level disturbances in 7.7% and 4% vaccination. Mean CSF opening pressure was 35 cm H2O, with range 9.5-77 cm H2O. Separated to IIHWP and IIHWOP, an average of 37.2 cm H2O vs. 31.4 cm H2O was calculated. Main treatment options were lumbar punctures in 7.7%. Only 2.7% of cases needed some kind of shunt implantation.

#### Conclusion

In contrast to adults, males were affected more often than females and papilledema was significantly more rarely present. In majority, discontinuation of the triggering factor or treatment with lumbar punctures, acetazolamide and corticosteroids resolved the symptoms. Rarely a shunt system was necessary. Considering our findings and the deviating CSF pressure limits for this age group, new diagnostic criteria for neonates, infants and toddlers are proposed **(Table 1)**. The hypothesis of two nosologically distinct entities regarding IIHWP and IIHWOP seems unlikely.





Fig. 1. Signs and symptoms (in percentages) of patients

#### Abb. 2

1. < 36 months old
2. CSF pressure in:
a. Neonates: > 7.6 cm H2O
b. Infants: > 8.2 cm H2O
c. Toddlers: > 9.5 cm H2O
3. Normal age-appropriate CSF composition
4. If symptoms, reflecting intracranial hypertension
5. Normal neurological examination except for cranial nerve abnormalities
6. At least one of:
a. Papilledema
b. Sixth nerve palsy
c. Bulging fontanelle
d. Directly prior infection or new medication intake and regressive symptoms within
24 hours following discontinuation
7. No other identified cause of intracranial hypertension on MRI/MRV except for transverse
venous sinus stenosis

**Table 1.** Proposed diagnostic criteria for IIH in neonates, infants and toddlers.CSF: cerebrospinal fluid, MRI: magnetic resonance imaging, MRV: magnetic resonance venography

### V100

Klinische Ergebnisse von 111 Kindern mit Myelomeningozelen 9 Jahre nach komplett perkutanem, minimalinvasivem fetoskopischem Patchverschluss (Kohl-Verfahren) *Clinical outcome 9 years after fully percutaneous, minimally-invasive fetoscopic patch closure (Kohl technique) of* 111 children with myelomeningoceles

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#### Objective

This retrospective study evaluates long-term clinical outcomes of patients with myelomeningocele (MMC) treated with fully percutaneous, minimally-invasive fetoscopic patch closure (MIFPC; Kohl technique).

#### Methods

Data were collected from MMC patients who underwent MIFPC between 2009 and 2021. Clinical information was gathered through follow-up examinations, clinical reports, and detailed questionnaires. Clinical parameters, including rates of CSF-diversion, hindbrain herniation decompression, neurosurgical detethering, neurological function, and discrepancies between anatomical and functional lesion levels, were analyzed.

#### Results

Out of 156 contacted patients, 111 complete datasets were analyzed. Mean age at last follow-up was 109 months (range: 42-180 months). Key findings: 69 patients (62%) required CSF-diversion surgery (VP shunt: 57%, ETV: 5%). 6 patients (5%) underwent hindbrain decompressive surgery. 30 patients (27%) required surgical detethering. 10 patients (9%) were wheelchair-bound, while 55 patients (50%) achieved independent ambulation. Functional levels exceeded anatomical levels in 68% of patients (+1 level in 27%, +2 levels in 21%, +3 levels in 11%, +4 levels in 6%, and +5 levels in 4%). Functional levels were equivalent to anatomical levels in 27% of patients, and worse in 5% (-1 level in 4%, -2 levels in 1%).

#### Conclusion

Long-term outcome data (>3 years) for prenatal MMC treatments are only available for open prenatal surgery, particularly the MOMS trial, which reports a 90-month follow-up. In comparison to the MOMS prenatal cohort, our data demonstrate: A higher rate of CSF-diversion (63% vs. 49%), comparable rates of hindbrain decompression (5% vs. 4%) and detetherings (27% for both cohorts). A similar proportion of wheelchair-bound children (9% vs. 7%). Higher rates of independent ambulation (50% vs. 29%). More cases with higher functional levels than anatomical ones (69% vs. 64%). Fewer cases where functional levels were lower than anatomical levels (5% vs. 20%). These long-term functional outcomes suggest that the Kohl technique yields results comparable to open prenatal surgery, with slightly increased rates of hydrocephalus treatment but potential advantages in neurological function.

### V101

Arteriovenöse Malformationen bei pädiatrischen Patienten: eine umfassende monozentrische Analyse Arteriovenous malformations in pediatric patients: comprehensive single-center analysis

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#### Objective

Arteriovenous malformations (AVMs) of the central nervous system are the leading cause of non-traumatic intracerebral hemorrhage (ICH) in pediatric patients, posing significant risks for severe symptoms and life-threatening complications. Their unpredictable natural course and lack of definitive guidelines make them challenging in pediatric neurosurgery. Given the high lifetime bleeding risk, we conducted an institutional analysis to provide insights into pediatric AVM management.

#### Methods

We retrospectively analyzed 20 pediatric patients with AVMs treated surgically, with endovascular embolization or combined approaches at our institution from 2010 to 2024. Data included demographics, clinical presentation, imaging findings, treatment modalities and functional outcomes.

#### Results

The cohort included 20 patients (7 male) with a median age of 12.5 years (range, 4–16). Two patients had Osler-Weber-Rendu syndrome. Fifteen patients (75%) presented emergently with ICH (12 cerebral, 2 cerebellar, 1 brainstem), while five patients presented with epilepsy or focal neurological deficits. Twelve patients (60%) required intubation on admission. Diagnostic digital subtraction angiography (DSA) was performed in 17 patients (85%). The AVMs were located in the cerebrum (80%), cerebellum (10%) and brainstem (10%). The middle cerebral artery was the feeding vessel in eight patients (40%) and mixed arterial feeding was observed in six patients (30%). According to the Spetzler-Martin Grade (SMG), eight patients (40%) were classified as SMG 1, five (25%) as SMG 2, three (15%) as SMG 3 and two (10%) each as SMG 4 and SMG 5. Treatment included surgery (60%), embolization (20%) and combined therapy (20%). Six patients (30%) experienced AVM recurrence, detected via follow-up DSA with a median recurrence time of 21.5 months (range, 5–110). Complete obliteration of the AVM was achieved in 85% (17/20) of the patients. Two patients with permanent AVMs (SMG 5) underwent partial embolization. The modified Rankin Scale showed scores of 0–2 in 85% (17/20), indicating good to excellent functional recovery.

#### Conclusion

Total AVM obliteration is achievable in the majority (85%) of pediatric patients with SMG 1–4. Due to the risk of recurrence, long-term MRI and DSA follow-up is essential. Most patients achieved good functional outcomes, underscoring the high recovery potential in children. Individualized assessment and tailored therapeutic strategies remain crucial in managing pediatric AVMs effectively.

### V102

#### Externe Validierung des VALE-Punktesystems zur Bewertung des Blutungsrisikos bei pädiatrischen AVM-Patienten

#### External validation of the VALE scoring system for hemorrhage risk in pediatric AVM patients

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#### Objective

Brain arteriovenous malformations (AVMs) are a leading cause of spontaneous intracranial hemorrhage in children. Accurate prediction of hemorrhagic risk is critical for optimizing management strategies. While the VALE scoring system has been validated in adults, its utility in pediatric AVMs remains unexplored. This study aimed to evaluate the external validity of the VALE scoring system for predicting hemorrhage risk in pediatric AVM patients.

#### Methods

A retrospective review of 52 pediatric AVM patients ( $\leq$ 18 years) treated between 2005 and 2023 at University Hospital Frankfurt was conducted. VALE scores were assigned based on four factors: ventricular system involvement, venous aneurysm, deep location, and exclusively deep drainage. Rupture risk was categorized as low (score < -2), moderate (score -2 to 1), or high (score > 1). Statistical analysis included univariate and multivariate logistic regression, and the predictive performance was evaluated using the area under the receiver operating characteristic curve (AUC).

#### Results

Of the 52 patients, 60% (n = 31) presented with rupture. Multivariate analysis identified venous aneurysm as the only significant predictor of rupture (OR: 17.19, 95% CI 1.53–193.41, p = 0.021). The overall VALE score demonstrated suboptimal predictive performance (AUC: 0.608, 95% CI 0.454–0.762). Stratification into risk categories showed no significant increase in hemorrhage risk across groups (low: OR 3.85, p = 0.382; moderate: OR 0.729, p = 0.747; high: OR 0.792, p = 0.774). Additionally, 39% of patients in low to moderate risk groups experienced rupture, challenging the score"s clinical applicability in pediatric populations.

#### Conclusion

The findings highlight significant differences in rupture risk predictors between pediatric and adult AVMs, suggesting that the VALE score inadequately accounts for the unique characteristics of pediatric cases. Venous aneurysms emerged as a key risk factor, emphasizing the need for tailored scoring systems. The suboptimal AUC and poor risk stratification efficacy underscore the limitations of the VALE score in pediatric cohorts. This study provides the first external validation of the VALE score in pediatric AVMs, revealing its limited predictive capability. Future research should focus on developing pediatric-specific tools to better assess rupture risk and guide clinical decision-making.

### V103

Umfassende bundesweite Analyse der in neurochirurgischen Abteilungen behandelten bösartigen pädiatrischen ZNS Tumore in Deutschland, 2023 *Comprehensive Nationwide Analysis of Malignant Pediatric Brain Tumors treated in Neurosurgical Departments in Germany, 2023* 

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#### Objective

Pediatric CNS tumors demonstrate diverse clinical challenges resulting in varying rates in mortality and morbidity. Our study aims to evaluate in-hospital mortality and morbidity associated with these conditions in neurosurgical departments across Germany in 2023.

#### Methods

A cross-sectional analysis was conducted on pediatrics CNS tumor cases treated in German neurosurgical departments in 2023. Our study focused on patients below 18 years diagnosed with malignant CNS tumors (ICD-10-GM code C71). Data included demographics, primary and secondary diagnoses, as well as neurosurgical procedures. Mortality was defined as in-hospital fatality (discharge status: deceased).

#### Results

In 2023, 5,585 pediatric cases of malignant CNS tumors were reported in German neurosurgical departments, with 42.7% of patients being female. The highest incidence (28.4%, 1,586/5,585) occurred in children aged 6 to 9 years. A total of 39 patients died, corresponding to an overall mortality rate of 0.7%. Among the cases, 1,981 involved cerebellar tumors. A statistically significant male predominance was observed for cerebellar tumors (62.8% vs. 37.2%, p<.0001, Chi-square test). Notably, 33.3% of cerebellar tumors were diagnosed in children 10 to 15 years of age.

The most frequently performed neurosurgical procedures included excision and destruction of primary brain tumor tissue (5-015.0; 312/1,063 of encoded procedures), biopsies (open and stereotactic combined; 1-510 and 1-511; 90/1,063), and reoperations (5-983; 111/1,063). Advanced techniques were used in varying proportions: microsurgery in 77.9% (5-984), intraoperative navigation systems in 58.9% (5-988.0, 5-988.2, and 5-988.3), fluorescence guidance in 6% (5-989), and intraoperative neuro-monitoring (IONM) in 36.5% (8-925).

The mortality rate for primary tumor resections was 1.92% (6/312). No fatalities were reported for biopsies or reoperations.

#### Conclusion

This ongoing study offers valuable insights into the epidemiology and in-hospital outcomes of pediatric CNS tumors in Germany. A predominant incidence in males, particularly cerebellar tumors, was noted. The most frequently performed surgical procedures were tumor resections, biopsies, and reoperations. Mortality rates for tumor resections were up to 1.92%. However, advanced intraoperative techniques, such as microsurgical methods, intraoperative navigation systems, IONM, and fluorescence-guided surgeries, were less commonly encoded in the pediatric population compared to adults.

### RC034

Shuntinfektionen nach der Implantation antibiotikabeschichteter Katheter bei pädiatrischen Patienten mit Hydrozephalus

Shunt Infection after Implantation of Antibiotic-Impregnated Catheters in Pediatric Patients with Hydrocephalus

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#### Objective

Antibiotic-impregnated catheters (AIC) are commonly used in treating pediatric patients with hydrocephalus. The goal of this study was to investigate the differences in revision, infection and pathogenic agents causing infection in the group of pediatric patient with AIC and standard silicon catheters.

#### Methods

In this retrospective single center study, 186 patients under 18 years of age who received a shunt system for treatment of hydrocephalus between 2000 2024 were analyzed. AIC and standard catheters were compared. The primary outcomes were revision rate secondary to shunt infection and the type of pathogenic agent causing the infection. Mann-Whitney-U and chi-square-test was used for the statistical analysis.

#### Results

64 patients meeting all criteria regarding follow-up, revision and infection parameters could be included in the final analysis. In these patients, 110 surgeries were performed, that could be analyzed with a follow up of one to ten years. 64 surgeries were performed in the AIC group, 46 in the standard group. The revision rate was significantly higher in the AIC group (p=<0,001; Mann-Whitney U Test) but there was no significant difference in the infection rate in both groups, (13 infections in the AIC group compared to 10 in the standard group (p=0,86; chi-square test). The pathogenic agents causing infections were not significant difference between AIC and standard group (p=0,66; chi-square-test). The range of pathogenic agents is similar in both groups, with staph. epidermidis (n=8) and staph. capitis (n=4) being the most frequent ones. No significant differences in sex and age between the AIC and the standard group were found.

#### Conclusion

Despite the use of antibiotic impregned catheter there were no significant advantage in revision rate or infection numbers compared to non-AIC catheter systems. The range of pathogenic agents found is similar in both groups. Further prospective study should evaluate the advantage of using of AIC.

### RC033

#### Aktueller Status des ESPN Kraniektomie und Kranioplastie Registers (pedCCR) Current status of the ESPN craniectomy and cranioplasty registry (pedCCR)

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#### Objective

PedCCR was established under the auspices of the ESPN. Aim is to collect high-quality multicenter data on decompressive craniectomy (DC) and cranioplasty (CP) in children, which is currently a field with a strinking lack of high level evidence. Here we present the current status of the dataset to encourage further centers to join this international project.

#### Methods

PedCCR is a non-interventional, prospective, international, web-based registry. It can be found under pedccr.com and is recruiting patients since late 2022.

#### Results

Currently almost 30 centers are registered and 12 children (8 male, 4 female) with a mean age of 100 weeks (22-178) were enrolled. Indications for DC were TBI (N=4) and one case each of empyema, ICH due to ruptured AVM, encephalitis, PRES, asphyxia and 3 unspecified entities. DC was performed at mean day 3 after admission (0-5) at a mean GCS of 3 (3-11) and mydriatic/fixed pupils in 4 cases. Techniques comprised 5 unilateral hemicraniectomies, 2 bifrontal craniectomies and one bilateral hemicraniectomy. Specific surgical details were registered as well. Outcome was GCS 12 (3-15) and KOSCHI 4 (3-5), with one mortality. CP was performed after a mean of 91 days (14-653) using 4 autologous bone flaps, 3 fiber-reinforced composite-bioactive glass implants and one titanium implant. Again, surgical details and complications were registered. Long-term outcome data is pending.

#### Conclusion

An increasing number of centers is joining ESPN PedCCR and thus contributing to this joint project, which is on an excellent trajectory to improve the scientific data and evidence on DC and CP in children. Further centers will significantly enhance the value of this registry by contributing their high quality data and are thus very welcome to register on pedccr.com.

### V104

Klassifikation epigenetischer Ependymom-Subgruppen aus histologischen H&E-Schnitten mithilfe von neuronalen Netzwerken

Predicting Epigenetic Ependymoma Types from Histological Whole-Slide Images Using Neural Networks

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#### Objective

Ependymomas are neuroepithelial neoplasms of the central nervous system, classified into at least 10 clinically distinct subgroups based on DNA methylation profiles. Current diagnostics combine time-consuming epigenetic analyses with histological assessments and can lead to a delayed start of therapy. Pathologists typically evaluate histomorphology at various magnifications, considering both tissue architecture and single-cell morphology. This study employs the Hierarchical Image Pyramid Transformer (HIPT) (Chen et al. 2022, arXiv:2206.02647) to analyze H&E-stained whole-slide images (WSIs) at multiple levels, hypothesizing that HIPT can accurately predict the DNA methylation classes of Ependymomas, enhancing the consistency of histology-based diagnoses.

#### Methods

We collected sample-matched epigenetic profiles and H&E WSIs of over 500 ependymomas from various anatomical sites. Using HIPT with Multi-Grid Vision Transformers (ViTs), we processed gigapixel WSIs through hierarchical tokenization and aggregation. High-resolution WSIs were generated from H&E-stained sections scanned at 40x, and DNA was extracted for methylation analysis via the EPIC chip on the Illumina iScan. The WSIs were segmented into smaller patches, which were processed by the HIPT4k neural network to create image feature tensors and classify them according to tumor subtypes. A classifier was trained using stratified Monte Carlo cross-validation, optimizing hyperparameters for subgroup accuracy.

#### Results

We achieved reliable predictions of ependymoma subtypes from H&E-stained WSIs. Hyperparameter optimization resulted in a model (40 epochs, learning rate 1.00E-5) with 77.2% validation accuracy. The confusion matrix showed optimal classification for PF-EPN-A (86.39%) and ST/PF/SP-SE (85.49%), but lower accuracy for ST-EPN-RELA (19.64%) and PF-EPN-B (6.67%). A cutoff score of 0.9 yielded ~95% test accuracy while excluding 64% of test samples.

#### Conclusion

The HIPT architecture effectively classifies ependymoma subtypes from histological WSIs, achieving 77% overall test accuracy post-optimization. However, misclassifications highlight the need for further refinement in the patching process. Our method provides a fast, interpretable approach for predicting epigenetic ependymoma types, aiding rapid, patient-specific treatment decisions in the evolving field of digital pathology.

### V105

Integration von stimulierter Raman-Histologie und künstlicher Intelligenz zur schnellen Diagnose von primären ZNS-Lymphomen und zur Unterscheidung von anderen ZNS-Entitäten Integration of Stimulated Raman Histology and Artificial Intelligence for Rapid Primary CNS Lymphoma Diagnosis and Differentiation from other CNS Entities

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#### Objective

Accurate intraoperative differentiation between primary CNS lymphoma (PCNSL) and other CNS lesions during surgery and stereotactic biopsies is critical for decision-making but remains challenging due to similar histological features and time constraints. This study evaluates how combining stimulated Raman histology (SRH) with artificial intelligence can provide rapid intraoperative diagnostic support.

#### Methods

Using a portable fiber-laser-based microscopic SRH imager, we generated virtual H&E-like images from fresh tissue samples within three minutes without conventional tissue processing. We developed RapidLymphoma, a deep learning model utilizing self-supervised learning, trained on 54,000 SRH patch images from fresh brain tissue samples collected at four international medical centers during surgery and stereotactic biopsies. The intraoperative computer vision tool was designed to detect PCNSL and differentiate it from other (non)-neoplastic CNS entities, focusing on high-grade gliomas and metastases. The final histopathological diagnosis served as the reference standard.

#### Results

In a prospective multicenter validation cohort (n=160), RapidLymphoma achieved 97.81% balanced accuracy ( $\pm$ 0.91) in detecting and differentiating PCNSL from other CNS entities. For PCNSL detection specifically, the system demonstrated superior performance compared to frozen section analysis (100% vs. 77.77%). Additional validation studies focusing on distinguishing PCNSL from IDH-wildtype diffuse gliomas (n=420) and brain metastases (n=59) demonstrated robust performance with balanced accuracy rates of 95.44% ( $\pm$ 0.74) and 95.57% ( $\pm$ 2.47), respectively. The system generated interpretable heatmaps highlighting diagnostically relevant morphological features, providing visual feedback for surgeons and pathologists during surgery.

#### Conclusion

Integrating SRH with RapidLymphoma demonstrates reliable performance for rapid intraoperative PCNSL diagnosis and differentiation from challenging entities such as high-grade gliomas and metastases. This approach provides actionable diagnostic information and allows qualitative visual feedback through comprehensible heatmaps within three minutes, facilitating timely surgical decision-making and treatment planning.

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### V106

#### Die Simulierte Raman-Histologie Zeigt Eine Spezifische Aufnahme Von 5-ala Durch Elemente Der Mikroumgebung Des Tumors Stimulated Raman Histology Shows A Specific Uptake Of 5-ALA By Elements Of The Tumor Microenvironment

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#### Objective

Simulated Raman Histology (SRH), a technology which allows the rapid examination of fresh tissue directly during surgery. SRH can also integrate the protoporphirin IX (PpIX) signal actively converted from 5-ALA into fluorescence by metabolically active cells. Recent discoveries have shown that 5-ALA is not only taken up by cancerous cells but also by myeloid cells, specifically tumor-associated macrophages and microglia<sup>A</sup>. Through novel integrative analysis of imaging and spatial transcriptomic analysis, we investigated the diversity of 5-ALA uptake and metabolism.

#### Methods

Imaging analysis encompassing segmentation and unsupervised chemical fingerprint detection through latentspace clustering using self-supervised deep-learning algorithms. Cell type annotation was conducted by integration into multi-omic spatial transcriptomic and epigenetic profiling data and inferred to the full cohort.

#### Results

Our analysis successfully clustered cells based on their morphological features and SRH intensity, identifying clusters that correspond to microenvironmental cell types. PpIX was found to be cell specific for myeloid cells and oligodendrocytes, demonstrating high PpIX intensities in extracellular myelin structures. We identified a link between macrophages actively engulfing myelin and the PpIX signal. This finding supports the notion that not only tumor cells, but also immune cells with active metabolism and myelin uptake, contribute to the PpIX signal.

#### Conclusion

Our study highlights the potential of SRH combined with 5-ALA to provide a deeper understanding of the tumor microenvironment while identifying limitations in signal interpretation caused by immune cell activity.

### V107

Glioblastom-Zell-Infiltration induziert neuronale Hyperaktivität und Veränderung peritumorale Netzwerkkonnektivität Glioblastoma cell infiltration induces neuronal hyperexcitability and alter peritumoral network connectivity properties

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#### Objective

Recent advances in cancer neuroscience identified direct glioma-neuron interactions as pivotal for tumor growth and infiltration. However, the impact of tumor infiltration on the electrophysiological properties of local networks and neurons remains poorly understood. Here we used a co-culturing model of human brain slice cultures and infiltrating glioma cells to characterize neuronal activity in the tumorinfiltration zone.

#### Methods

Isolated patient glioblastoma cells were transplanted to organotypic human brain slice cultures maintained in human CSF. Network activity was recorded using 252-channels microelectrode arrays at 10 kHz sampling rate. Using threshold-based spike detection, we analyzed simultaneous spiking activity in 100 ms bins to construct weighted graphs. Node properties from tumor-infiltrated areas were compared to control areas, border zone, and control slices without tumorinfiltration. Network dynamics were assessed under normal and high potassium (8mM) conditions. Statistical analysis used Kruskal Wallis test with post hoc Dunn's test and Bonferronie correction.

#### Results

Tumor infiltrated regions (n=431 nodes) showed a significant increased mean firing rate of 2.82 Hz compared to the border zone (n=404, 2.51 Hz, p < .001), control area (n=1000, 1.16 Hz, p < .001), and control slice (n = 1315, 2.15 Hz, p < .001). Under high-potassium conditions, tumor-infiltrated areas showed the highest degree centrality (DC = 0.47) compared to border zone (DC=0.41), control area (DC = 0.26, p < .001, and control slices (DC = 0.24, p < .001), indicating enhanced network synchronization.

#### Conclusion

We demonstrate robust hyperactivity and network synchronization in tumor-infiltrated areas, particularly during high-activation states. These altere network dynamics appear to be a hallmark in the pahtomechanism of tumor infiltration, potentially providing novel therapeutic targets. Future work will focus on the temporal evolution of these activity patterns and their mechanistic relationship to tumor infiltration.

### V108

Protoporphyrin IX und andere Fluorophore: Konzentration im Vergleich zur histologischen Zellularität bei der fluoreszenzgestützten Gliomchirurgie Protoporphyrin-XI and other Fluorophores: Abundance versus Histological Cellularity in Fluorescence-Guided Glioma Surgery

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#### Objective

Diffuse infiltration of malignant glioma cells in brain tissue complicates maximal safe resection. Fluorescenceguided surgery (FGS) with 5-ALA enhances tumor visualization via protoporphyrin IX (PpIX) fluorescence, but its relationship to cell density remains unclear. We investigate whether PpIX fluorescence correlates with histological cellularity in glioma tissue.

#### Methods

We analyzed 243 brain tumor biopsies from patients administered with 5-ALA. Ex vivo hyperspectral imaging captured fluorescence spectra, and a spectral unmixing algorithm quantified abundances of nine fluorophores, including PpIX. Cell density was measured from histopathological slides using an automated cell counting algorithm involving image segmentation and morphological filtering (Figure 1, *Segmentation of cells (C) and tissue (B) from a tissue slide (A)*). We focused on glioblastoma samples (n=209) to control for tissue-type variability. For comparison, other tumor types included anaplastic astrocytoma (n=10), gliosarcoma (n=9), metastasis (n=5), and radiation necrosis (n=10). Using linear and quadratic models, we assessed correlations between fluorophore abundances and cell density.

#### Results

In glioblastoma samples, weak but statistically significant positive correlations were found between cell density and fluorescence from PpIX634 (R=0.387, p<0.001) and collagen (R=0.403, p<0.001), with collagen showing a slightly stronger correlation. No strong correlation was observed between PpIX fluorescence intensity and cell density across all tumor types (R<sup>2</sup>=0.17, p<0.001). Quadratic models marginally improved the correlation (R<sup>2</sup>=0.28) but risked overfitting. Tissue type significantly influenced cellularity and fluorophore abundance (p<0.05), suggesting that factors beyond cell density affect PpIX accumulation. Glioblastoma samples exhibited higher PpIX fluorescence despite lower cell densities than other tumor types, indicating PpIX accumulation in the extracellular matrix or higher intracellular accumulation per cell.

#### Conclusion

PpIX fluorescence correlates weakly with cell density, suggesting accumulation in the extracellular matrix rather than within tumor cells or higher intracellular accumulation per cell. Collagen fluorescence shows a stronger correlation and may serve as an additional intraoperative biomarker. While PpIX aids tumor visualization, it does not directly reflect cell density. Incorporating biomarkers like collagen fluorescence could enhance tumor delineation and improve surgical outcomes.



Abb. 1

### RC036

Verbessert die 5-ALA-Fluoreszenz-Mikroskopie die vollständige Resektabilität in der zerebralen/zerebellären Metastasenchirurgie?

Does 5-ALA fluorescence microscopy improve complete resectability in cerebral/cerebellar metastatic surgery?

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#### Objective

This study aimed to analyze the intraoperative fluorescence behavior of brain metastases following the administration of 5-aminolevulinic acid (5-ALA) to determine if fluorescence-assisted resection leads to more complete tumor removal and prolonged survival.

#### Methods

Variables such as age, sex, number of metastases, localization, involvement of eloquent areas, correlation between fluorescence and primary tumor/subtype, resection rates, and survival time were assessed. The degree of resection was evaluated using postoperative CT scan and /or MRI within three days after surgery

#### Results

Fluorescence was observed in 57.5% of cases, with the highest rates seen in breast carcinoma metastases (73.3%) and the adenocarcinoma subtype (68.1%). No significant correlation was found between fluorescence behavior and tumor localization, primary tumor, or histological subtype. Complete resection was achieved in 82.5% of cases, 56.1% of which were fluorescence-positive. Fluorescence-positive cases showed improved resectability (12.1% increase) and significantly longer survival times (p = 0.009).

#### Conclusion

5-ALA-assisted extirpation enhances more complete resection and longer survival and can therefore represent a low-risk addition to modern surgery for brain metastases.







(C)



(E)

(D)



(F)

Abb. 2

Parameter	n (%)	
number of patients	73	
number of cases	80	
age:		
Mean	63 years	
age range	33-83 years	
gender:		
Female	35 (47.9%)	
Male	38 (52.1%)	
primary tumor:		
bronchial carcinoma	46 (57.5%)	
breast carcinoma	15 (18.8%)	
gastrointestinal carcinoma	9 (11.3%)	
renal cell carcinoma	5 (6.3%)	
malignant melanoma	4 (5.0%)	
gynecological carcinoma	1 (1.3%)	
Histology:		
Adenocarcinoma	47 (58.7%)	
squamous cell carcinoma	10 (12.5%)	
small cell carcinoma	8 (10.0%)	
malignant melanoma	4 (5.0%)	
clear cell carcinoma	4 (5.0%)	
giant cell carcinoma	2 (2.5%)	
poorly differentiated brain metastases from carcinoma	5 (6.3%)	
localization of the metastasis:	· · · · · · · · · · · · · · · · · · ·	
Supratentorial	60 (75.0%)	
Infratentorial	17 (21.2%)	
supra/infratentorial	3 (3.8%)	
eloguent area	39 (49.0%)	
non-eloquent area	41 (51.0%)	
number of metastases:		
singular	58 (72.6%)	
multiple	22 (27.4%)	
5-ALA fluorescence:		
positive	46 (57.5%)	
negative	34 (42.5%)	
degree of surgical resection:		
total	66 (82.5%)	
partial	14 (17.5%)	
incidence of complete resection of the metastasis:		
total extirpation	66 (82.5%)	
5-ALA positive	37 (56.1%)	
5-ALA negative	29 (43.9%)	
eloquent area	31 (46.9%)	
non-eloquent area	35 (53.11%)	

### V109

#### Langzeit-Follow-up bei Tourette-Syndrom-Patienten nach Tiefer Hirnstimulation Long-term Follow-Up in Tourette Syndrome Patients Treated with Deep Brain Stimulation

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#### Objective

Tourette syndrome (TS) is a chronic, still not fully understood neuropsychiatric disorder that presents with a combination of vocal and motor tics. Since 1999, for patients with treatment-refractory and disabling tics, deep brain stimulation (DBS) can be considered a therapeutic option. The aim of the study is to evaluate their long-term (>5 years) outcomes of TS patients who underwent DBS.

#### Methods

All TS patients who received DBS implantation at our institution within a 10-year time period from 1.1.2009 to 31.12.2018 were assessed retrospectively.

#### Results

A total of 22 TS patients (5 female, 17 male) were implanted for the treatment of severe tics. One patient received GPi DBS, while the targets for all remaining patients were located in the thalamus, predominantly in he centromedian nucleus/nucleus ventro-oralis internus (CM/V oi). The average age at the time of the initial implantation was 31.9 (SD = 11.2). 21 patients (95%) were available for long-term follow-up. The mean time interval since the initial implantation was 9.9 years (SD = 3.0). Of the 21 patients, 17 (81%) were responders with active stimulation. Three patients turned off the stimulation - one patient did not benefit, one patient's tics improved significantly even without stimulation and one patient's vocal tics disappeared completely, while motor tics showed little response to stimulation. In self-assessment, tics improved on average by 73% under stimulation compared to the preoperative condition, while the premonitory urge exhibited a 57% amelioration, and the quality of life experienced a 77% positive change. The Yale Global Tic Severity Scale (YGTSS), a gold standard for assessing tics in TS, was available for twelve patients during the long-term follow-up. The average YGTSS score ameliorated from 79.7 (SD = 16.4) preoperatively to 36.0 (SD = 24.3) after 12 months, and 24.2 (SD = 14.5) in the long-term follow-up, demonstrating persistent and even increasing significant improvement (p < 10.001). Complications leading to surgical revisions occurred in five patients. There were two instances of a short circuit due to a defect in the extension, one case of electrode dislocation following a fall during an epileptic seizure, and two cases of infection, each requiring the explantation of the entire DBS system, with reimplantation done in one instance.

#### Conclusion

DBS for Tourette patients with therapy-refractory tics remains an effective therapy for years after implantation, with a tendency for further improvement.

### V110

Die Geschlechterverteilung bei funktionellen neurochirurgischen Eingriffen – Tendieren Männer häufiger zur Operation?

Gender distribution in functional stereotactic neurosurgery - Are men more likely to undergo surgery?

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#### Objective

This study investigates the gender distribution among patients undergoing functional stereotactic neurosurgery, specifically deep brain stimulation (DBS) and radiofrequency lesioning. The aim is to determine whether men or women are more likely to undergo these procedures.

#### Methods

A retrospective analysis was conducted on 731 DBS procedures performed in recent years. Gender distribution within subgroups was assessed and compared to the expected distribution. Statistical analyses were conducted to identify differences and trends.

#### Results

The male-to-female (M:F) incidence ratio for Parkinson's disease typically ranges from 1.3 to 2.0, with a statistical value of 1.5 set for the analysis. In our cohort, there were 183 male (70.7%) and 76 female (29.3%) patients, resulting in a ratio of 2.41 (p = 0.0005). For dystonia, the M:F incidence ratio varies among its subtypes but is generally summarized as 0.4. We had 102 male (45.9%) and 120 female (54.1%) patients, yielding a ratio of 0.85 (p < 0.0001). For tremor, gender distribution typically shows no significant differences. In our cohort, there were 88 males (55.3%) and 71 females (44.7%), resulting in a ratio of 1.2 (p = 0.177).

#### Conclusion

This study reveals significant gender-related trends in the utilization of DBS surgery across various subgroups. The findings suggest that gender-specific factors may influence the decision-making process for undergoing surgery. These disparities warrant further investigation to ensure equitable access to treatment and to better understand the underlying causes of these trends.

## V112

Tiefe Hirnstimulation bei Bewegungsstörungen nach Schlaganfall: Eine Individual Participant Data (IPD) Metaanalyse

Deep brain stimulation for movement disorders after stroke: An Individual Participant Data (IPD) Meta-Analysis

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#### Objective

Post-stroke movement disorders consisting of complex movement patterns with dystonia, chorea and tremor represent a therapeutical challenge. Under these circumstances, deep brain stimulation should be considered as a potential effective treatment option, although it remains unclear whether thalamic or pallidal DBS should be applied.

#### Methods

We conducted an individual participant data (IPD) meta-analysis considering published studies analyzing the efficacy of deep brain stimulation (DBS) of the globus pallidus internus (GPi), the ventral intermediate nucleus (VIM) or both (GPi+VIM) for the treatment of mixed movement disorders after stroke. PubMed, Embase and the Cochrane Library were searched for relevant articles. The Burke Fahn Marsden Dystonia Rating Scale (BFMRS)-motor and BFMRS-disability as well as the Fahn-Tolosa-Marín scale (FTM) for tremor were analyzed. In addition, correlation and regression analyses were performed to identify predictive markers (age, duration of disease, frequency, amplitude, intensity, and contact configuration).

#### Results

A total of eighteen studies consisting of 32 patients met the inclusion criteria. Both DBS of the GPi and VIM and combined (GPi+VIM) significantly improved the outcome scores for dystonia (BFMRS) and tremor (FTM), even on long-term follow-ups (>12 months). Most data published were found for the GPi. There were only a few studies reporting the effect of combined (GPi+VIM) stimulation. The effect of DBS was not related to age, contact configuration, stimulation intensity, frequency, amplitude, or disease duration. Adverse events (19 %) were temporarily and related to stimulation side effects.

#### Conclusion

Our analysis indicates that DBS is effective in the treatment of post-stroke movement disorders with a low complication profile. Given the clinical improvement of both targets, GPi- and VIM-DBS, the authors advocate a combined (GPi+VIM) DBS approach along with a trial stimulation. However, the study heterogeneity, reporting bias, and potential placebo effects of the published data may limit the quality of evidence in favor or against a target.

### SFNC-06

#### Comparison between VIM targets for DBS, radiosurgery and MRgFUS using IA design algorithm.

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#### Objective

Targeting the VIM remains an issue for both deep brain stimulation (DBS) and lesion techniques. The position of the target remains debated, particularly for DBS between the VIM and the PSA. To assess the optimal location of treatment targets, we analyzed active contacts or lesions location in a cohort of patients with a good clinical outcome with machine-learning algorithms. The objective is to compare, in patients with severe essential tremor, the prediction of (i) active contacts of deep brain stimulation (DBS) electrodes and (ii) the center of lesions produced by radiosurgery (RS) and (iii) by focused ultrasound guided by MRI (MRgFUS).

#### Methods

A specific prediction model of the VIM target in RS was generated from a database of 46 patients successfully treated in Marseille using support vector machine regression (SVR). Three errors were computed while building the model. Training errors; leave-one-out cross-validation errors and testing errors. Another specific prediction model of the VIM in DBS developed by RebrAIn® was used. An external validation of these model was carried out by selecting two new series of patients selected after an effective left VIM lesion with an improvement of more than 66% on the tremor scale. Twelve patients successfully treated by RS in Marseille (France) and 15 patients treated by MRgFUS in Pampelona (Spain) were selected. On these two series of patients, we evaluated the accuracy of two targets: i) The target obtained from RebrAIn software based on DBS data (DBS-model target) ii) and the target obtained using the new RS model developed. Both targets were compared to the position of the lesion center and the diameter of the lesion.

#### Results

The mean values and the standard deviation of Errors computed during the construction of the algorithm were as follows: Training error  $0.8 \pm 0.6$  mm; leave-on-out cross validation error  $0.9\pm 0.6$  mm and the testing error is  $1.4 \pm 1.2$  mm. These errors are in the range of the image resolution. The mean distance between the RS-model target and the center of the RS lesion was  $1.8\pm 0.47$  mm and between the DBS-model target and the center of the RS lesions diameters of  $5.28 \pm 1.01$ mm. The mean distance between the RS-model target and the center of the MRgFUS lesion was 1.37mm  $\pm 0.3$ mm and between the DBS-model target and the center of  $4.9\pm 1.3$ mm All the RS-model targets are in the lesion for both RS and MRgFUS series of patients. The DBS model targets are more medial (x axis) and inferior (z axis) than the RS model.

#### Conclusion

The more medial and more inferior location of the DBS prediction model underlines the fact that the learning process takes into account patients who have been greatly improved by PSA stimulation. The algorithm developed for lesions is sufficiently accurate to be proposed for clinical use. A first trial in radiosurgery is about to begin, and a second trial in MRgFUS is currently being designed.

### V113

Radiofrequenz-Läsionierung bei Hemidystonie: Systematische Übersichtsarbeit und Meta-Analyse bei individuellen Patientendaten Radiofrequency lesioning for hemidystonia: a systematic review and meta-analysis with individual patient data

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#### Objective

Radiofrequency lesioning (RL) has been a mainstay in functional neurosurgery to treat dystonic movement disorders, which was replaced by deep brain stimulation (DBS) in the late 1990s. Studies on RL have shown variable benefit in patients with hemidystonia. The aim of this systematic review is to summarize published reports on RL for hemidystonia and to evaluate clinical outcome.

#### Methods

A systematic literature review was performed according to PRISMA guidelines in PubMed, Embase, and Web of Science using a customized software (UiPath, NY) to identify all case reports, case series, and cohort studies reporting patients with hemidystonia treated with RF. Manuscripts were then automatically searched for the search term "hemidystonia". The selected manuscripts were manually screened to identify appropriate reports. Clinical improvement was classified as follows: (III) significant improvement; (II) moderate improvement; (I) mild improvement; (0) no improvement.

#### Results

Twenty-eight reports totaling 101 cases published between 1962 and 2024 were included in our analysis in which individual patient data were available. Thalamotomy was performed in 80 cases, pallidotomy in 16 cases, and both in 5 cases. Overall, 18 patients (19.57%) had significant improvement at the last follow-up, while 41 (44.57%) patients had moderate improvement, 16 (17.39%) had mild improvement, and the remaining 18 patients (18.48%) had no clinical improvement. No significant difference was found between the outcome at immediate postoperative and last available follow-up. Similarly, there was no statistically significant difference between outcomes based on targets or based on etiology. However, trauma appeared to have a worse outcome. A significant negative linear correlation was found between percentage improvement and age at surgery. The lack of a standardized assessment of outcomes contributes to the difficulty in interpreting the result.

#### Conclusion

With recent advances in targeting methods, RL may be reconsidered as a treatment option for hemidystonia as an alternative to DBS. Further studies with standardized assessment of outcomes are needed to better characterize variability in outcome and to identify prognostic factors.

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### V114

### Die prognostische Rolle neuartiger Biomarker in der Pathophysiologie und Prognose von IDH-Wildtyp-Glioblastomen

The Roles of AGTRAP, ALKBH3, DIVERSIN, NEDD8 and RRM1 in Glioblastoma Pathophysiology and Prognosis

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#### Objective

Glioblastoma (GBM) is a highly aggressive brain tumor with dismal outcomes. This study aimed to evaluate the expression of five novel biomarkers—AGTRAP, ALKBH3, DIVERSIN, NEDD8, and RRM1—in IDH-wildtype GBM and their prognostic significance in overall survival (OS) and progression-free survival (PFS).

#### Methods

A retrospective analysis was performed on 186 IDH-wildtype GBM samples and 54 healthy brain tissue controls. Immunohistochemistry was used to quantify marker expression. Prognostic relevance was assessed using Kaplan–Meier survival analysis and multivariate Cox proportional hazard models, adjusted for confounding factors such as age, Karnofsky performance scale (KPS), surgical resection extent, and MGMT methylation status.

#### Results

AGTRAP, DIVERSIN, cytoplasmic NEDD8, and RRM1 were significantly overexpressed in GBM compared to healthy tissues, while ALKBH3 was downregulated. High AGTRAP expression correlated with poorer OS and PFS, and multivariate analysis identified it as an independent prognostic factor for both outcomes. RRM1 emerged as a significant independent predictor of poor OS. Combined marker analysis revealed that the AGTRAP/ALKBH3 and ALKBH3/NEDD8 combinations provided superior prognostic accuracy compared to individual markers.

#### Conclusion

This study highlights the prognostic value of AGTRAP and RRM1 in GBM, particularly in IDH-wildtype cases, and demonstrates the utility of combined marker analyses to improve prognostic precision. These findings provide insights into GBM pathophysiology and suggest potential therapeutic targets for improved patient outcomes.



Figure 1. Marker expression in healthy versus GBM tissues. Expression of (A) AGTRAP: (C) ALKDH3, (E) DIVERSIN, (G) NEDD8c and (I) RRM1 in GBM (n = 166) and tumour-free adjacent brain tissues (n = 54). The medians are shown as black lines and the percentiles (25th and 75th) as vertical boxes with error bars. The outliers are indicated by circles. Statistical analysis was performed with the Mann–Whitney U test, and the p-values are indicated in the upper-right corner of each plot. (B.D.F.H.J) Representative micrographs showing the expression of the markers in the solid tumour area (T) versus the adjacent, tumour-free tissue area (H)

#### Abb. 2



Figure 2. Marker expression and the overall survival of GBM patients—univariate analysis. (A-F) The expression levels of the markers were dichotomised into 'low' and 'high' according to the median-split method. Kaplan–Meier curves were generated for the 36-month overall survival, and statistical analysis was performed with the log-rank test. The p-values are indicated in the upper-right corner of each plot.

## V115

# Einfluss des Resektionsausmaßes in Bezug auf den MGMT-Status auf das Überleben bei rezidiviertem Glioblastom

#### Impact of extent of resection in relation to MGMT status on survival in recurrent glioblastoma

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#### Objective

The management of recurrent glioblastoma is mostly individualised, taking into consideration tumor localization, the patient"s functional status, and age. The role of repeated surgical resection in recurrent glioblastomas remains largely unclear. This study aims to evaluate the prognostic impact of MGMT promoter methylation status on progression-free survival (PFS) and overall survival (OS) in recurrent glioblastoma who have undergone re-resection.

#### Methods

This retrospective cohort study included patients with recurrent glioblastoma who underwent repeat resections between January 2016 and December 2021. Demographic, clinical, radiological and molecular data were collected. Extent of resection was classified in concordance with the Response Assessment in Neuro-Oncology (RANO) resection criteria. Kaplan-Meier and multivariate Cox regression analyses were used.

#### Results

This study included 95 patients with recurrent glioblastoma, 41 with MGMT promoter methylation and 54 without. Patients with MGMT methylation had significantly longer PFS compared to unmethylated patients (9.08 vs. 6.14 months). Multivariate Cox regression analysis revealed that submaximal resection was associated with a significantly increased risk of progression in methylated patients (HR 6.44, 95% CI 2.41–17.20, p<0.001), highlighting the importance of achieving maximal resection in this group. In unmethylated patients, no significant association between the extent of resection and progression was observed (HR 1.46, 95% CI 0.81–2.63, p=0.2). Additionally, higher ECOG scores at recurrence were associated with worse PFS in methylated patients (HR 2.82, 95% CI 1.15–6.89, p=0.02), while no significant impact of ECOG was found in the unmethylated group (p=0.7). Treatment modalities, including chemotherapy, surgery alone, and radiotherapy, did not show significant associations with PFS in either group.

#### Conclusion

Patients with MGMT promoter methylation showed significantly longer progression-free survival compared to those without methylation, emphasizing the prognostic value of MGMT status. Submaximal resection and higher ECOG scores were identified as adverse prognostic factors for progression in methylated patients, underscoring the importance of achieving maximal resection. In contrast, no significant impact of extent of resection or ECOG score was observed in unmethylated patients, highlighting potential differences in treatment strategies between these groups.





Figure 1. Kaplan-Meier Curve of Overall Survival by MGMT Status (A), Progression-Free Survival After First Re-Resection by MGMT Status (B), Overall Survival by Extent of Resection (C); Progression-Free Survival After First Re-Resection by Extent of Resection (D) and Overall Survival After First Re-Resection Stratified by MGMT Status and Extent of Resection (E), Progression-Free Survival After First Re-Resection Stratified by MGMT Status and Extent of Resection (F)

Age     41	0.11 0.37 0.02
gender_female     41     Image: Height content in the second seco	0.37
ECOQ_at_Relapse 41 2.82 (1.15, 6.89)	0.02
EOR_category_first_relapse Maximal Resection 22	
Submaximal Resection 19 6.44 (2.41, 17.20)	<0.001
treatment_options Chemotherapy Alone 30	
Radiotherapy + Chemotherapy 1 1 2.85 (0.29, 28.32)	0.37
Radiotherapy Alone 2 1 3.08 (0.61, 15.61)	0.17
Surgery alone 8 1.70 (0.58, 4.95)	0.33

Hazard ratio Variable N p 54 0.99 (0.97, 1.02) 0.7 É Age 0.94 (0.51, 1.71) gender\_female 54 8.0 H**H**H 1.14 (0.65, 1.98) ECOG\_at\_Relapse 54 -0.7 EOR\_category\_first\_relapse Maximal Resection 30 ÷. Reference Submaximal Resection 24 ii∎-i 1.46 (0.81. 2.63) 0.2 treatment\_options Chemotherapy Alone 42 Reference 4 Radiotherapy + Chemotherapy 0.61 (0.21, 1.76) 0.4 STUPP Protocol 1.72 (0.38, 7.83) 2 0.5 0.75 (0.28, 1.98) Surgery alone 6 0.6 F

Figure 2. Cox Regression Analysis of Progression-Free Survival in MGMT methylated (A) and unmethylated (B) recurrent Glioblastoma

0.5 1 2

Abb. 2

а

b

### V116

#### (Neo-)adjuvante Checkpoint-Inhibition bei Rezidiv-Glioblastom Role of (neo-)adjuvant checkpoint inhibition in recurrent glioblastoma

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#### Objective

Glioblastoma has a dismal prognosis. After recurrence treatment options are limited. Pembrolizumab, an anti-PD-1 monoclonal antibody, has demonstrated benefit as adjuvant monotherapy in multiple types of cancerexcept glioblastoma. It is stipulated that neo-adjuvant immune checkpoint inhibition together with reresection and adjuvant alkylating chemotherapy might lead to sustained anti-tumor immune responses and clinical benefit in patients with recurrent glioblastoma.

#### Methods

Patients aged 18 years and older with recurrent IDH wild-type glioblastoma (CNS WHO grade 4) scheduled for surgical debulking were included. Eligibility criteria included Eastern Conference Cooperative Oncology Group (ECOG) Score 0-2, first line therapy with at least radiotherapy, unequivocal evidence of tumor progression. Patients received pembrolizumab 200 mg intravenous infusions 14 days prior to- and every three weeks after resurgery additionally to CCNU (up to six-week cycles). NCI-CTCAE 5.0 was used to evaluate adverse events. To examine CPI response, transcriptome sequencing (RNAseq), T-cell receptor sequencing in tumor samples and detection of inflammatory cytokines in blood using ELISA and qPCR, was performed.

#### Results

A total of ten patients received neoadjuvant pembrolizumab prior to re-resection. Mean age was 54.7 years (33-68), female:male ratio was 8:2. Complete resection was achieved in 70.0%, gross total resection in 10.0%, partial resection in 10.0% and biopsy in 10.0%. A total of 10 neoadjuvant and 24 adjuvant cycles of CPI were given. Fever associated with CPI occurred in 2 patients. No severe adverse occurred. Overall PFS was 12.9-+3.6 months and OS 28.2-+6.5 months. After re-surgery, mean PFS was 5.0-+1.1 months, mean OS was 15.3-+4.9 months. 6 out of 10 patients are still alive. Lower levels of INF-y and Interleukine-6 and -8 after neoadjuvant CPI were associated with a longer OS (p=0.05) but not PFS (p=0.69). RNAseq revealed distinct longitudinal transcriptome changes in response to neoadjuvant CPI. Similar longitudinal changes were detected regarding the immune contexture, TCR diversity and clonality.

#### Conclusion

Neoadjuvant checkpoint inhibition is well tolerated and associated with distinct changes to tumor transcriptome and immune milieu. These findings suggest that the neoadjuvant administration of PD-1 blockade enhances the local and systemic anti-tumor immune response and may represent a more efficient approach to the salvage treatment of this uniformly lethal tumor.

### V117

#### Histologisch als Astrozytom WHO Grad 2/3 erscheinende Glioblastome Molecular Glioblastoma presenting histologically as diffuse astrocytic glioma WHO grade 2/3

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#### Objective

Glioblastomas are conventionally diagnosed based on histopathological, immunohistochemical, and molecular genetic characteristics. However, under the current WHO classification for CNS tumors, the presence of typical histopathological features such as necrosis and vascular proliferation in a malignant astrocytoma is no longer required for a glioblastoma diagnosis if a TERT mutation or EGFR amplification is detected in absence of IDH1/2 mutations. In this study, we compared the overall survival (OS) of histologically defined glioblastoma (GBM) with those lacking necrosis and vascular proliferation, referred to as molecular glioblastomas (molGBM).

#### Methods

We identified patients with histologically graded IDH-wildtype astrocytomas (WHO grade 2/3) harboring a TERT mutation or EGFR amplification (molGBM) and compared their demographic and clinical characteristics with those of a randomly selected control group of histologically defined glioblastoma (GBM) patients. The primary endpoint was OS in both groups. To further refine our analysis, we also compared molGBM to a second control group consisting of patients with IDH-mutant astrocytomas with similar histological grading (IDHmut-AST °2/3).

#### Results

A total of 31 patients with molGBM were identified, including 12 with WHO grade 2 (molGBM°2) and 19 with WHO grade 3 histology (molGBM°3). The control group consisted of 34 randomly selected GBM patients. No significant differences were observed between groups regarding sex (p = 0.44) or age (p = 0.67). The Karnofsky Performance Index was comparable across groups (p = 0.74). Although the median OS was longer in the molGBM group (516 days) compared to the GBM group (328 days), this difference did not reach significante (p = 0.07). Additionally, subgroup comparisons between molGBM°2, molGBM°3, and GBM did not reveal significant OS differences (molGBM°2 vs. GBM: p = 0.09; molGBM°3 vs. GBM: p = 0.19; molGBM°2 vs. molGBM°3: p = 0.24). However, OS in molGBM was significantly shorter than in IDHmut-AST of similar grades (molGBM °2 vs. IDHmut-AST °2: p = 0.004; molGBM °3 vs. IDHmut-AST °3: p < 0.0001).

#### Conclusion

Our data support the last WHO update on CNS tumor classification and confirm that astrocytomas with a TERT mutation or EGFR amplification, and without necrosis and vascular proliferation, exhibit clinical behavior similar to that of glioblastoma.

### V118

Interimsanalyse der Internationalen IM4-Studie: Klinischer Verlauf des primären IDH-mutierten Astrozytoms ZNS-WHO Grad 4 und des ehemals bekannten primären IDH-mutierten Glioblastoms WHO Grad IV Interim analysis of the International IM4 Study: Clinical course of primary IDH-mutant astrocytoma CNS-WHO grade 4 and formerly known primary IDH-mutant glioblastoma WHO grade IV

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#### Objective

The latest WHO classification of CNS tumors emphasizes the prominence of isocitrate dehydrogenase (IDH) mutation status. IDH-wildtype (wt) is now restricted to glioblastoma, while former IDH-mutant (mut) glioblastoma WHO grade IV has been reclassified as IDH-mutant astrocytoma CNS-WHO grade 4. The main objective of this study is to evaluate the clinical course of this particular new entity.

#### Methods

Data acquisition was conducted as a multi-center retrospective analysis at 11 leading international University Hospitals between 2013-2022. Patients older than 18 years with a primary IDH-mut glioblastoma WHO grade IV or IDH-mut astrocytoma CNS-WHO grade 4 were included. A cohort of IDH-wt glioblastoma from the lead institution was included for comparison. Outcome parameters were progression free survival (PFS), overall survival (OS) and time to next intervention. Extent of resection (EOR) was assessed according to the RANO 2.0 response criteria.

#### Results

So far, a total of 344 patients were enrolled- 141 with IDH-mut astrocytoma/glioblastoma (38.9 % female) and 203 patients with IDH-wt glioblastoma (43.8 % female). The mean age was 45.4 years (95%CI 39-47) in patients with IDH-mut tumors and 67.6 years (95%CI 67-71) in those with glioblastoma (p=<0.0001). PFS (IDH-mut: 21.1±3.0 month; IDH-wt: 9.2±0.7 month) and OS (IDH-mut: 75.1±3.1 months; IDH-wt: 10.7±0.7 months) were significantly longer in IDH-mut astrocytoma (p=<0.0001). Survival of IDH-mut astrocytoma was independent from MGMT methylation (p=0.4998). Complete resection (CR) was achieved more often in IDH-mut astrocytoma (56.8%) compared to those with IDH-wt glioblastoma 32.2% (p<0.0001). In IDH-mut astrocytoma, CR (101.0 months) and NTR (89.0 months) significantly prolonged OS, compared to PR (12.6 months) (p<0.0001). STR is not superior to PR, but biopsy alone (p=0.0251). 90.1% of all patients with IDH-mut astrocytoma were treated with radiochemotherapy. Multivariate analysis identified EOR as sole independent predictor of OS in IDH-mut astrocytoma (p=<0.0001).
### Conclusion

The presented data suggests that IDH-mut astrocytomas are a unique group of tumors with a distinct clinical course compared to IDH-wt glioblastoma. Resection prolongs OS and is of higher value than radiochemotherapy. Of note, STR also positively influences OS. These results underline the importance of surgical resection even if GTR is not achievable and thus mark a potential paradigm shift in clinical decision making.

### V119

Die Bedeutung der multimodalen Therapie während der Zweit- und Drittlinientherapie bei rezidivierendem IDHwt-Glioblastom

The importance of multimodal salvage therapy during 2nd and 3rd line therapy in recurrent IDH-wt glioblastoma

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### Objective

Virtually all glioblastoma recur. Progression free- (PFS) and overall survival (OS) after recurrence is poor. Evidence for efficacy of salvage therapies is scarce.

#### Methods

This is a multi-center retrospective analysis at 2 leading German University Hospitals between 2016-2022. Patients with recurrent IDH-wildtype glioblastoma (CNS WHO grade 4), prior first-line therapy according to STUPP and ECOG 0-2 at time of recurrence were included. Salvage therapy included re-resection, re-irradiation, Lomustine and/or procarbazine, temozolomide rechallenge as 2-line and regorafenib as 3-line therapy.

### Results

A total of 284 patients with recurrent IDH-wt glioblastoma were screened. 221 met the inclusion criteria, 104 were female (47.1%). The median age was 61 years (58.8-61.8). MGMT promotor methylation was found in 106 (47.9). 177 patients (80.1) received salvage therapy- either alone (chemotherapy: 56 (31.5), Re-surgery: 15 (8.4)), or in combination of different modalities (surgery/CTX: 78 (44.1), RT/CTX: 14 (8.0), surgery/RT/CTX: 14 (8.0)). Mean OS after recurrence was 10.2-+0.7 month in those receiving salvage therapy and 5.6-+0.9 month in those treated with best supportive care. In patients treated with a single modality, OS was 6.8-+1.7 month (95Cl 8.3-7.3) with re-resection alone and 10.8-+1.7 month (95Cl 7.3-14.2) in those with chemotherapy alone (p=0.502). In those treated with a combination of re-resection/CTX, OS was 13.7-+1.1 month (95Cl 11.5-15.8) and 14.7-+1.1 month with re-surgery/RT/CTX (95Cl 9.2-19.3)(p=0.91). A combination of more than one treatment modality (multimodal)was superior to mono-modal salvage therapy (HR: 0.7102, 95Cl 0.505-0.999). No difference in OS was detected between patients treated with re-surgery plus CCNU, compared to those with surgery plus PC (HR: 0.868 95Cl 0.45-1.65)(p=0.688). Switch to regorafenib after 2nd progression led to significantly prolonged survival (p<0.0001). Using multivariate logistic regression analysis multimodal salvage therapy (95Cl (0.409-0.991), p=0.004) and 3rd line chemotherapy with regorafenib (95 Cl 0.165-0.515), p<0.0001) were significant and independent predictors of OS after tumor recurrence.

### Conclusion

Multimodal salvage therapy significantly prolonged OS in patients with recurrent glioblastoma. The addition of procarbazine to CCNU is of no additional benefit. Switch to 3rd therapy further increased survival after recurrence. The data emphasize the effectiveness and value of salvage therapies in recurrent glioblastoma.

### SFNC-07

Endoscope-assisted transmastoid Infralabyrinthine approach: A new corridor to the petrous apex for multicompartmental jugular foramen tumors.

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### Objective

Multicompartmental jugular foramen tumors, such as large chondrosarcomas, may extend in various compartments including the jugular foramen, cervical region, petrous apex and intradurally. Critical sensory and neurovascular structures such as the semicircular canal and cochlear, are an anatomical obstacle to access the most anterior and superior extension into the petrous apex using a classic transmastoid approach. To address this challenge, we evaluated the feasibility of an endoscope- assisted transmastoid infralabyrinthine approach to reach the petrous apex.

### Methods

An anatomical study was conducted using two cadaveric specimens. To clarify the surgical target, a reference object was firstly placed transnasally at the superior petrous apex as a landmark. A surgical microscope was used for the first part of the approach and a 30° angled endoscope in the second part. Thin slice CT scans were obtained prior and after the dissections. Furthermore, we reviewed clinical and radiological data of two patients with multicompartmental jugular foramen chondrosarcoma extending to petrous apex in which this corridor was used.

#### Results

For cadaver dissection, a mastoidectomy was performed and the bone between the posterior semicircular canal and the jugular bulb was drilled, to expose internal auditory canal and cochlea. Then, a 30° angled endoscope and the chopstick technique were employed to continue drilling toward the internal carotid artery (ICA) and the superior aspect of the petrous apex. Meckel's cave and the intrapetrous segment of ICA were exposed. In our clinical series, one patient had a tumor"s cervical extension, the other had both intradural and cervical extensions. Near total resection was achieved in both cases using this corridor, with no new neurological complications.

#### Conclusion

The Endoscope-assisted transmastoid infralabyrinthine approach can effectively address the petrous apex for jugular foramen tumors extending in this area, without the need for an additional surgical approach. The use of angled endoscope and the chopstick technique optimize the visualization of anatomical structures and surgical maneuverability, enabling a tailored approach for multicompartmental tumors in this challenging anatomical region.

### V125

Klinische und radiologische Aspekte der lumbalen Spinalkanalstenose mit und ohne Nachweis von Amyloid Clinical and radiological aspects in lumbar spinal canal stenosis with amyloid deposition

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### Objective

Amyloidosis, particularly ATTR amyloidosis, is associated with conditions such as cardiomyopathy, polyneuropathy, carpal tunnel syndrome, and spinal stenosis. Previous studies have primarily focused on the prevalence and potential screening strategies for amyloid-related spinal conditions. However, there is limited information on the clinical and radiological distinctions between lumbar spinal canal stenosis (LSCS) with and without histopathologically confirmed amyloid deposition. This retrospective study aims to identify these differences to better understand their implications in clinical practice.

### Methods

A total of 88 patients (mean age  $64 \pm 15$  years) who underwent surgery for LSCS were included. The study population included 41 males (46.6%) and 47 females (53.4%).The primary indications for surgery were claudicatio spinalis and therapy-resistant lumbosciatica. Preoperative imaging included MRI and, in some cases, CT. The severity of stenosis was graded using the Schizas and Pfirrmann classifications. Excised ligamentum flavum samples were analyzed histologically using Congo red staining and immunohistochemistry to confirm amyloid deposition and subtype (e.g., ATTR amyloid).

### Results

Patients were categorized into three groups: no amyloid deposits (58%), ATTR amyloid (35%), and other amyloids (7%). Median age differed significantly (p < 0.001), with ATTR amyloid patients being older than the other groups. Although not significant males were more frequent in the no amyloid (31.8%), while females were more represented in the ATTR amyloid group (22.7%). No significant differences were observed in obesity prevalence (BMI > 30) or in the Schizas and Pfirrmann classifications. Interestingly, 4 out of 5 cases with facet cysts were found in the ATTR amyloid group. Spondylolisthesis showed no significant association with amyloid presence.

### Conclusion

This study highlights that amyloid deposition, particularly ATTR amyloid, is associated with an older patient population and may have unique clinical correlations, such as a potential link with facet cysts. While no significant radiological differences were observed, the findings underscore the need for further studies to validate these observations. The small sample size in this study limits the generalizability of the results. Larger studies are essential to confirm these findings and potentially classify this new entity within the spectrum of lumbar spinal canal stenosis.

### RC015

Vergleich der diagnostischen Effektivität der postoperativen MRT Untersuchungen bei zervikaler Spondylodiszitis mit Carbon Fiber-Reinforced PEEK - und Titan -PEEK-Implantaten *Comparison of Diagnostic Efficacy of Postoperative MRI in Cervical Spondylodiscitis Using Carbon Fiber-Reinforced PEEK and Titan - PEEK Implants* 

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### Objective

This study aimed to evaluate the diagnostic value of postoperative MRI scans in patients with cervical spondylodiscitis treated using Carbon Fiber-Reinforced PEEK (CFR-PEEK) and Titan –PEEK (Ti-PEEK) implants. The focus was on assessing MRI informational value in regions of surgical significance (ROI) for detecting reinfections and complications (figure 1).

### Methods

A comparative analysis of postoperative T1-weighted images with contrast enhancement and T2-weighted images was performed in two patient groups: those treated with CFR-PEEK and Ti-PEEK implants. ROI were defined and scored as either informative (1 point) or non-informative (0 points). The evaluations were conducted by two experienced neurosurgeons.

### Results

Postoperative cervical spine MRI was performed in 56.67% (average timing:  $76.12 \pm 48.56$  days). The CFR-PEEK group achieved maximum scores across (100%) all ROIs in T1-weighted MRI with contrast enhancement, demonstrating superior informational value compared to the Ti-PEEK group. In the Ti-PEEK group, artefacts due to titanium plate evaluation were not possible in the prevertebral area, disc space and ventral subarachnoid space. Spinal cord assessment was possible in 87,5%.

T2-weighted MRI scans showed limited informational value in the prevertebral and disc space areas in the Ti-PEEK group. The evaluation were in these regions not possible. However, other regions, including the ventral subarachnoid space, were equally informative in both groups. The CFR-PEEK group achieved maximum scores across (100%) all ROIs in T2 -weighted MRI scans. In the CFR-PEEK group, three cases demonstrated pathological findings: two cases of paravertebral abscess without healing and one case of suspected material dislocation.

### Conclusion

CFR-PEEK implants provide superior MRI imaging quality for postoperative monitoring compared to Ti-PEEK implants. The absence of significant artifacts with CFR-PEEK enhances diagnostic accuracy in critical areas, such as the prevertebral space and disc space, facilitating early detection of reinfections and complications. This study underscores the advantages of CFR-PEEK implants for postoperative imaging and their potential to improve patient outcomes.

Abb. 1



ROI (region of interest) on MRI T2-weighted sagital and axial images: 1. prevertebral are; 2. Intervertebral disc space; 3. ventral subarachnoid space; 4. Spinal cord; 5. Dorsal subarachnoid space; 6. Area of dorsal structures of the spine: bony, ligamentous, and muscular structures prevertebral space, disc space, and ventral subarachnoid space

### V127

Timing und Risikofaktoren bei der chirurgischen Versorgung von Densfrakturen im Alter: Eine retrospektive Analyse zu perioperativen Risiken und Prädiktoren für Komplikationen Timing and Risk Factors in Surgical Management of Odontoid Fractures in the Elderly: A Retrospective Analysis Highlighting Perioperative Risks and Predictors of Complications

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### Objective

Odontoid fractures (OF) are among the most common spinal injuries in the elderly population. Surgical stabilization of OF provides immediate stability restoration and pain relief but involves potential surgical complications. The optimal timing of surgery and its potential influence on these risks remains unclear.

### Methods

We analyzed consecutive patients aged  $\geq$ 70 undergoing dorsal stabilization for OF between 09/2008 and 06/2024 at a high-volume spine center. Statistical analysis was performed using custom scripts.

### Results

Surgery was performed in a total of 329patients with OF. Patients with concomitant subaxial spine fractures requiring multilevel stabilization were excluded from the analysis. Among the remaining 311 patients, 122 (39.2%) were male and 189 (60.8%) were female, with a median age of 83 years (range 70–102). The most common fracture type was type II (n=249, 80%), as classified by Anderson and D"Alonzo. On admission, 12.2% of patients (n=38) presented with neurological deficits, while the majority reported only neck pain. The median time from injury to surgery was 7 days (range: 0–545), and the median time from admission to surgery was 5 days (range: 0–33). The median duration of hospital stay was 12 days (range 1–48). Perioperative complications occurred in 46,6% of patients (n= 145); the in-hospital mortality rate was 5.1% (n=16). Overall 15.1% (n=47) required postoperative intensive care therapy with a median duration of ICU stay of 6 days (range 0–75). A longer interval between admission and surgery was associated with a higher complications rate of overall (p=0.014) and major complications including in-hospital mortality (p=0.029). Multivariate logistic regression identified longer interval between admission and surgery (p=0.026), higher age (p=0.003), higher ASA score (p=0.001), and neurological deficit at presentation (p=0.026) as significant independent predictors for the occurrence of complications after controlling for gender, extent of dislocation, type of fracture, surgery duration, and accompanying C1 fractures.

### Conclusion

Surgery for geriatric patients with OF carries significant perioperative risks, with delays linked to significantly higher complication rates. Advanced age, high ASA scores, and neurological deficits further predict these risks, emphasizing the need for individualized treatment.

### V128

Risikoscore für Cage-Absenkung nach anteriorer zervikaler Korporektomie ohne gleichzeitige dorsale Stabilisierung.

*Risk Score for Cage Subsidence after Anterior Cervical Corpectomy without concomitant dorsal stabilization.* 

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### Objective

Anterior cervical corpectomy and fusion (ACCF) is a widely performed procedure in spine surgery. Depending on the underlying pathology and the number of vertebral bodies removed, concomitant dorsal instrumentation may be required. Additionally, dorsal stabilization is indicated in cases of cage subsidence to restore cervical spine stability. This retrospective monocentric observational cohort study aimed to identify risk factors and develop a risk score for predicting cage subsidence after standalone ACCF.

### Methods

Consecutive patients undergoing ACCF without concomitant dorsal stabilization during the initial procedure were included in the analysis. Baseline characteristics, including comorbidities, preoperative computed tomography (CT)-based bone density measurements of upper and lower vertebral bodies (Hounsfield unit [HU], mean ± standard deviation [SD]), and surgery-related parameters, were collected. Cage subsidence was assessed during follow-up.

### Results

Between September 2008 and May 2024, 225 patients underwent ACCF, of whom 42 (18.7%) had concurrent dorsal stabilization during the initial treatment. Cage subsidence rates were 2.4% (1/42) in patients with and 7.1% (13/183) in those without primary dorsal stabilization. In the final cohort (n=183), independent predictors of cage subsidence included smoking (adjusted odds ratio [aOR] = 7.11, p = 0.047), arterial hypertension (aOR = 5.62, p = 0.037), lower vertebral body level (per-level decrease: aOR = 2.17, p = 0.034), increased distance between the endplates of the upper and lower vertebral bodies (per-mm increase: aOR = 1.11, p = 0.015), and reduced bone density of the upper vertebral body (HU-SD < 194.50: aOR = 10.96, p = 0.029). A risk score derived from these predictors demonstrated high diagnostic accuracy for cage subsidence (area under the curve = 0.837). Subsidence rates across the risk score quartiles were 0%, 2.3%, 6.5%, and 20.9%, respectively.

### Conclusion

Although rare, cage subsidence after ACCF poses a significant threat to spinal stability, often necessitating additional dorsal stabilization. This study highlights the critical role of patient comorbidities such as smoking, arterial hypertension, and osteopenia in cage subsidence. The proposed risk score may aid in identifying patients who would benefit from concomitant dorsal stabilization during ACCF. External validation of these findings is essential to confirm their applicability.

### V129

Langzeitergebnisse nach endoskopischer Resektion lumbaler Synovialzysten Long-term outcomes after endoscopic resection of lumbar synovial cysts

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### Objective

Synovial cysts of the lumbar spine, although relatively rare, are a significant source of radicular pain and neurological deficits. Traditional treatment involves open surgical approaches, such as laminectomy, which, despite their effectiveness, are associated with notable morbidity and prolonged recovery times. This study aims to evaluate the efficacy and safety of full-endoscopic resection as a minimally invasive alternative, focusing on long-term outcomes, including symptom relief, functional recovery, and complication rates.

### Methods

A retrospective analysis was conducted on 71 patients who underwent full-endoscopic resection of lumbar synovial cysts between 2012 and 2024. Of these, 69 patients were followed for an average of 42 months. Preoperative and postoperative pain levels were measured using the Numeric Pain Rating Scale (NPRS), while functional outcomes were assessed using the Oswestry Disability Index (ODI) and modified MacNab criteria.

### Results

Postoperatively, pain was significantly reduced from a mean NPRS score of 7.43 to 1.43 (p < 0.001). 77.4% of patients with preoperative muscle paresis showed improvement, and 91.3% of patients reported excellent or good outcomes based on the modified MacNab criteria. Complications, including intraoperative dura tears, occurred in 17.39% of cases, all of which were successfully managed endoscopically.

### Conclusion

This study demonstrates that full-endoscopic resection of lumbar synovial cysts is a safe and effective procedure with favorable long-term outcomes. The minimally invasive approach allows for complete cyst resection while preserving surrounding structures, leading to faster recovery and fewer complications compared to traditional open surgeries. These findings support the full-endoscopic technique as a viable standard treatment option for lumbar synovial cysts.



### V130

Vergleich von minimal-invasiver und offener monosegmentaler Lendenwirbelsäulenfusion und der Einfluss von Virtual Reality auf die chirurgische Planung und Strategie Comparison of Minimally Invasive and Open Monosegmental Lumbar Fusion, and Impact of Virtual Reality on Surgical Planning and Strategy

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### Objective

Spinal fusion for symptomatic lumbar spondylolisthesis can be accomplished using an open or minimally invasive surgical (MIS) technique. Evaluation of segmental spondylolisthesis and instabilities and review of their therapies are inseparably connected with lumbar tomographic imaging. We analyzed a cohort of patients who underwent MIS or open monosegmental dorsal fusion and compared surgical outcomes along with complication rates. We furthermore evaluated the influence of virtual reality (VR) visualization on surgical planning in lumbar fusion.

### Methods

Patient files were retrospectively analyzed regarding patient- and disease-related data, operative performance, surgical outcomes, and perioperative surgical complications. Preoperative computed tomography (CT) and magnetic resonance imaging (MRI) scans were retrospectively visualized via VR software. A questionnaire evaluated the influence of three-dimensional (3D) VR images versus two-dimensional CT and MRI scans on therapy planning, fusion method, and surgical technique and procedure.

### Results

Overall, 171 patients were included (MIS/open: 90/81). MIS was associated with less blood loss, shorter surgery time and hospital stay, lower complication rates, equivalent long-term patient-reported outcomes, but lower fusion rates and higher late reoperation rates than open surgery. Image presentation using VR significantly influenced the recommended surgical therapies (decompression only/decompression and fusion; p = 0.02), had no significant influence on the recommended fusion method (rigid/dynamic/stand-alone; p = 0.77), and, in cases of rigid fusion, a significant influence on the recommended technique (MIS/open; p = 0.03) and fusion procedure (p = 0.02).

### Conclusion

In patients with monosegmental degenerative or isthmic spondylolisthesis, MIS fusion was advantageous concerning perioperative complication rates and perioperative surgical outcomes, but disadvantageous regarding fusion and reoperation rates compared to open fusion. 3D-VR-based analysis of sectional images significantly influenced the recommended surgical planning.



(c)



(d)

### RC037

Der prognostische Wert von frühen NANO-Score Änderungen für das Gesamtüberleben bei 330 WHO Grad 4 Gliom-Patienten: Eine große monozentrische Analyse Prognostic Value of Early NANO-Score Changes for Overall Survival in 330 WHO Grade 4 Glioma Patients: A Large Single-Center Analysis

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### Objective

Resection is the cornerstone of glioma treatment, aiming for complete tumor removal while maintaining neurological function. Neurological deficits after surgery can gravely impact further treatment options. While ECOG scores are routinely used to evaluate treatment eligibility, we used the change in early postoperative NANO-score as predictor for overall survival (OS).

### Methods

We retrospectively analyzed a cohort of glioma patients with WHO grade 4 glioma that underwent resective surgery between 2006 and 2023. In 330 patients, complete NANO scores could be evaluated pre- and postoperatively before discharge. Patients were stratified into three groups based on score changes: improvement/stable (no change or decrease), mild deterioration (1-2 point increase), or severe deterioration ( $\geq$ 3 points increase). OS was analyzed using Kaplan-Meier estimates and log-rank tests. A Cox Proportional Hazards model assessed the impact of NANO score changes while adjusting for MGMT methylation, extent of resection, and sex.

### Results

Patients with stable NANO scores (n=153) showed a mean OS of 67.6 weeks, comparable to mild deterioration (n=136, 57.6 weeks, p=0.36). Severe deterioration (n=41) resulted in significantly shorter OS (41.5 weeks) compared to stable (p =0.0013) and mild deterioration (p=0.0425). Multivariate analysis confirmed NANO score change as independent prognostic factor (HR = 1.21, p = 0.008).

### Conclusion

Early postoperative change in NANO score demonstrates prognostic value for OS in grade 4 glioma patients. The lack of survival difference between stable and mild deterioration groups suggests that mild neurological deterioration may be prognostically less relevant than previously assumed. While the retrospective character of this study has limitations, these findings may foster the identification of subgroups that could benefit from more aggressive surgical concepts.

### V132

# Effekte von FLAIR-Läsionen des Frontal Aslant Trakts auf neurokognitive Funktionen Neurocognitive effects of FLAIR lesion on the frontal aslant tract

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### Objective

The frontal aslant tract (FAT) is a bi-hemispheric white matter bundle connecting the inferior frontal and superior frontal gyri. Due to its strong left-hemispheric dominance, investigations on this tract have focused mostly on language, revealing its role on language production and fluency. However, the non-dominant FAT has also been implicated in social and other cognitive skills. Regardless, the FAT is often not considered in individual surgical plannings of brain tumour resections. In this study, we set out to investigate the correlation between cognitive functions and tumour infiltration of bi-hemispheric FAT.

#### Methods

202 patients (79 males, 43 females, 116 right-handed, median age 62 years [36-83 years]) with a newly diagnosed unilateral glioblastoma underwent a preoperative cognitive assessment consisting of 11 subtests. Cognitive performance was expressed in percentile ranks (PR), normalised for age, gender, and education. Cluster analysis was used to define 7 cluster scores, each describing a specific neurocognitive domain. Cranial FLAIR/T2-weighted MR images were acquired on a Phillips 3T scanner, with the respective tumour/oedema volumes having been segmented using BrainLab Elements. The Yeh white matter atlas template was used to calculate the overlap of the lesion and the FAT in both hemispheres. Kendall-tau rank correlation coefficients between each of the cluster scores and the FAT-lesion overlap were calculated in MATLAB.

#### Results

Negative correlations were found between extent of left-hemispheric lesions of the FAT and language production and learning performance ( $\tau$ = -0.17; p= 0.002), as well as with extent of right-hemispheric lesions and spatial orientation ( $\tau$ = -0.15; p= 0.016). Interestingly, positive correlations were found also for right-hemispheric lesions, suggesting strong interhemispheric control / interaction.

### Conclusion

Our findings demonstrate a predominant role of the left, dominant FAT in verbal learning and memory, and suggest the involvement of the right FAT in non-language cognitive domains as well as its potential role in network reorganisation. Taken together, it is clear that this tract is functionally very relevant in both hemispheres and should be considered in the context of tumour resection. Therefore, integration of appropriate mapping and monitoring tasks within an awake surgery setting seems advisable, avoiding eliciting or worsening cognitive deficits and, thus, poorer quality-of-life.

### V133

### Kognitives Langzeitoutcome nach Glioblastomresektion mit betroffenem Fasciculus Arcuatus Long-term postoperative cognitive outcome in glioblastoma patients with lesion of the arcuate fasciculus

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#### Objective

A major objective of tumour surgery is to minimise postoperative cognitive decline. For risk assessment, emphasis should be put not only on the immediate, but rather on the long-term outcome. To date, there is limited evidence regarding the cognitive domain-specific rehabilitation potential. Here we investigate the risk of immediate and sustained cognitive decline in patients with glioblastoma affecting the arcuate fasciculus (AF).

### Methods

56 patients (n=43 males, n=13 females, median age 60 years [28-81 years]) with a newly diagnosed unilateral glioblastoma and the FLAIR/T2-lesion affecting the AF (n=30 located in the left hemisphere) underwent a preoperative cognitive assessment consisting of 11 subtests. Patients were tested right after surgery and 3-month later (3M). Cognitive performance was expressed in percentile ranks (PR), which were normalised for age, gender and education. Based on the PR and a data-driven cluster analysis, 7 different cluster scores were formed, each describing a specific neurocognitive domain. Postoperative cognitive performance was compared pairwise to preoperative and follow-up PR values for each cluster. Decline of PR greater than 1 standard deviation were considered significant. This cut-off served to binarise postoperative outcome and to assess percentages of postoperative decline in cluster scores (po-def). The risk of persisting postoperative deterioration at 3M (3M-persist) was expressed as a relative proportion.

#### Results

Preliminary analysis showed that significant attentional deficits occurred rather often postoperatively (po-def: 25%), but always resolved until 3M. In contrast, verbal fluency and learning were most prone to postoperative worsening (po-def: 35%) and recovered only partly (3M-persist: 21%). Memory access deficits as measured by recall velocity (po-def: 18%) were least likely to recover (3M-persist: 38%); interstingly, 2/3 of the patients with non-recovery had right-hemispheric lesions. Executive functions and working speed (po-def: 14%; 3M-persist: 29%), visuospatial memory (po-def: 18%; 3M-persist: 25%), visuospatial orientation (po-def: 20%; 3M-persist: 20%), and verbal working memory (po-def: 23%; 3M-persist: 15%) showed moderate recovery tendencies.

### Conclusion

Our findings demonstrate that memory and executive functions are least likely to recover from postoperative deficits, and point towards an underestimated involvement of the right AF in important and permanently vulnerable cognitive functions.

### V134

# Wirkt sich eine frühe palliative Versorgung auf die Kognition von Glioblastom Patient\*innen aus? Does early integration of palliative care impact on cognition in glioblastoma patients?

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### Objective

Glioblastoma (GB) patients often suffer from a high symptom burden during the course of their disease including cognitive decline, followed by a loss of autonomy. Here, early integration of palliative care (EIPC) is helpful in symptom control and improving quality of life (QoL) as already shown in solid malignant tumors. In this study we investigated the impact of EIPC on the cognition of GB patients and the relationship between cognition and survival.

### Methods

This study was carried out in the framework of a multicenter, rater-blinded, randomized, controlled, clinical trial. Patients in the intervention group (n=98, modified intention to treat set (mITT)) received standard care with additional structured specialized PC for 12 months beginning within four weeks after initial or recurrent diagnosis. Patients in the control group (n=89, mITT) received standard care. Cognition was tested using the "Montreal Cognitive Assessment" tool (MoCA, max.: 30 points). Patients with a score of <26 points were considered cognitively impaired. The total score and all subscores (visuospatial and executive, naming, attention, language, abstraction, delayed recall, orientation) were analyzed. Data were collected every three months for up to 24 months.

#### Results

MoCA at baseline showed impaired cognition in >60% of the patients. Moreover, cognition deteriorated in both groups after baseline. There was no significant difference between groups in the total MoCA-score. Subscoreanalyses also revealed no significant group effect. However, median survival times differed between groups and MoCA-scores (intervention, MoCA $\geq$ 26: 449 days [328,87; 569,13]; intervention, MoCA<26, 471 days [371,42; 570,58]; control, MoCA $\geq$ 26, 692 days (no confidence interval estimated); control, MoCA<26, 516 days [285,08; 746,92]), indicating a higher risk for death in the intervention group (and MoCA $\geq$ 26). Overall, higher MoCA-scores tend to be associated with a lower risk of death (HR=0.964 (0.927-1.002); p=0.061).

#### Conclusion

In our study cognitive decline was evident in GB patients regardless of EIPC. However, our data suggest that patients in the intervention group with good cognitive status had shorter survival. GB patients receiving EIPC who have a good cognitive status may rather focus on how to live rather than how long to live.

### RC038

### Deep Learning Modelle mit kranieller MRT zur Prädiktion der Wirksamkeit von Checkpoint-Inhibitoren bei Hirnmetastasen

### Deep Learning-Based Prediction of Checkpoint Inhibitor Efficacy in Brain Metastases Using Cranial MRI

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### Objective

Brain metastases (BM) are an emerging challenge in modern oncology due to increasing incidence and limited treatments. Immune checkpoint inhibitors (ICI) are a promising therapy for treatment-refractory BM of diverse histologies. However, given the high toxicity rate of ICI, there is a critical need to develop improved biomarkers for ICI response.

### Methods

We have curated a multi-institutional dataset of longitudinal multi-parametric MRI (mpMRI) for 860 patients with BM that underwent treatment with ICI. MRI sequences encompassed in our dataset included T1 precontrast, T1 post-contrast, T2, FLAIR, SWI, and ADC. Using standardized Response Assessment in Neuro-Oncology (RANO) criteria, we evaluated the response of a total of 2,542 BM by comparing pre-treatment MRIs to those taken 6 months post-treatment. We trained a convolutional neural network (CNN) on pre-treatment mpMRI sequences to predict 6-month ICI efficacy for each individual BM. To ensure class balance and demonstrate clinical utility, we converted the four RANO classes into a binary classification model, combining complete response (CR), partial response (PR), and stable disease (SD) into one class (intracranial benefit) and progressive disease (PD) as the other class (progression). Our custom CNN consists of three convolutional layers followed by two fully connected layers. We partitioned our dataset into 80% for training and 20% for validation. In parallel, we are employing self-supervised contrastive learning on a large dataset of more than 25,000 brain tumor mpMRI studies from more than 9,500 patients to develop a foundation model for brain tumors, which we will fine-tune to improve ICI efficacy prediction.

#### Results

Our initial model demonstrated an area under the receiver operating characteristics (AUROC) of 0.640 on the validation set. Model optimization, development of multi-response classification models (e.g., CR/PR vs. SD vs. PD) and subgroup analyses (e.g., histology-specific performance) are ongoing.

### Conclusion

Our study presents one of the first deep learning-based efforts to predict ICI efficacy for BM. Our work will serve as a baseline by which to trial fusion strategies integrating MRI with clinical metadata to improve predictive performance for ICI efficacy.

### RC039

# Ergebnisse und Risikofaktoren hämorrhagischer Hirnmetastasen: Analysen aus einer großen neurochirurgisch behandelten Kohorte

# Outcomes and Risk Factors in Hemorrhagic Brain Metastases: Insights from a Large Single-Center Brain Metastasis Cohort Undergoing Metastasis Resection

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### Objective

Brain metastases (BrMs) may present with hemorrhage or intracranial hemorrhage (ICH), yet understanding of risk factors and the influence on outcomes remains limited.

### Methods

This single-center retro- and prospective cohort study at one of Germany's largest neurosurgical clinics included 973 patients undergoing BrM resection (January 2010–July 2024), with histopathologically confirmed etiologies and known tumor burden including extracranial metastatic burden. We analyzed 880 patients, focusing on overall survival (OS) and progression-free survival (PFS) using Kaplan-Meier analysis. Based on pre-surgical cranial Computed Tomography and cranial Magnetic Resonance Imaging scans and reports, all patients were reviewed for the incidence of non-hemorrhagic brain metastases, at least one hemorrhagic brain metastasis, or ICH ( $\geq$ 30 mm diameter), and subsequently categorized into three groups. Risk factors for hemorrhage and ICH including tumor characteristics, clinical status and antithrombotic medication were assessed via logistic regression models.

### Results

560 patients (67.6%) had no hemorrhage, 243 patients (29.4%) had signs of hemorrhage, and 77 patients (9.3%) presented with ICH. ICH correlated with larger median tumor volume (21 cm<sup>3</sup>, IQR 13-34) vs. hemorrhage (14 cm<sup>3</sup>, IQR 6-28) and no hemorrhage (12 cm<sup>3</sup>, IQR 6-21) (padjust=0.017). Melanoma was a more frequent primary tumor in hemorrhage (27.8%) and ICH (38.0%) groups, predicting ICH (OR 2.95, p<0.001) alongside NSCLC (OR 1.64, p<0.001). ICH was not an independent OS predictor (HR 1.23, p=0.38). Predictors of worse OS included larger tumor volume (HR 1.35, p=0.002), extracranial metastases (HR 1.77, p<0.001), and higher age (HR 1.53, p<0.001). Improved OS was linked to KPS >80% (HR 0.77, p<0.01), solitary BrM (HR 0.62, p=0.002), and adjuvant treatments (p<0.001). ICH correlated with lower post-operative Karnofsky index (padjust=0.047), dsGPA score (padjust=0.032), and more BrMs (padjust=0.004). Pre-operative antithrombotic use was similar across groups (padjust =0.32).

### Conclusion

ICH is associated with larger tumors and melanoma but is not an independent predictor of OS. Tumor burden, extracranial metastases, and adjuvant treatments drive BrM survival outcomes.





### Abb. 2

### General Design of the Study



B Hemorrhage Characterization in Brain Metastases



### RC040

Einfluss der Patientenlagerung auf operative und postoperative Parameter bei neurochirurgischen Eingriffen in der hinteren Schädelgrube

Influence of patient positioning on operative and postoperative parameters in posterior fossa tumor surgery

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### Objective

The semi-sitting position (SP) is often used for surgical removal of tumors in the posterior fossa. Transesophageal echocardiography (TEE) is routinely used to exclude patent foramen ovale (PFO) because of the increased risk of pulmonary air embolism. If a PFO is detected, alternative positioning is required. The aim of this study was to analyze the influence of SP compared to alternatives on intra- and perioperative parameters.

### Methods

Data of patients who underwent craniotomy for a posterior fossa tumor with intraoperative TEE between 2020 and 2024 were retrospectively analyzed for the presence of PFO and correlation of length of surgery, intraoperative blood loss as well as total anaesthesia or ventilation times. TEE was performed after anesthesia induction prior to final patient positioning. AP was chosen when SP was deemed unsafe due to TEE findings.

### Results

Of 115 patients undergoing posterior fossa craniotomy who had TEE, 99 patients were treated for tumors and were included in the analysis. 69 patients (69.7%) were in the SP, and 30 (30.3.%) in an the AP group. PFO was detected in 27 patients (26.3%). PFO was ruled out in 67 patients in the SP group, while it was present in 2. Mean surgery time was significantly shorter in the SP than the AP group (240 vs. 263 min, p<0.024, Student"s t-test). The proportion of patients with blood loss >500ml was significantly higher in the AP compared to SP group (23.3 vs 5.8%, p=0.017, Fisher"s exact test). Mean total anesthesia time was shorter in the SP group, too, but not quite reaching significance (388 vs. 426 min, p=0.069, Student"s t-test). Median ventilation times were not different between the groups (SP 375 vs. AP 425 min, p=0.19, Mann-Whitney test).

### Conclusion

SP offers the advantages of shorter surgical times and less intraoperative blood loss compared to AP. PFO is not a rare finding and must be excluded prior to performing surgery. When SP is routinely used, this does not negatively affect total anesthesia time.

### V135

Neuropathische Schmerzen und Kleinfaserpathologie bei Patienten mit Neurofibromatose und Schwannomatose Neuropathic Pain and Small Fiber Dysfunction in Patients with Neurofibromatosis and Schwannomatosis

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### Objective

Pain is an often underestimated symptom in patients with neurofibromatosis (NF) and schwannomatosis (SWN), yet it has a profound impact on health-related quality of life. This study aimed to assess the characteristics of neuropathic pain and small nerve fiber impairment in patients with NF1, NF2-related schwannomatosis (SWN-NF2), and schwannomatosis-not otherwise specified (SWN-NOS).

### Methods

This case-control study enrolled 69 patients (34 male, 35 female) who fulfilled the diagnostic criteria for NF1, SWN-NF2, or SWN-NOS. Participants completed validated questionnaires assessing pain and health-related quality of life. Neurological examinations, nerve conduction studies, nerve sonography, and quantitative sensory testing (QST) were performed to evaluate large and small fiber function. Skin punch biopsies from distal and proximal sites were analyzed to assess intraepidermal nerve fiber density, while corneal confocal microscopy (CCM) was used to evaluate small fiber integrity. Statistical analyses were conducted to identify correlations between clinical symptoms, pain characteristics, and small fiber abnormalities.

### Results

Of the 69 patients, 36 (52%) reported experiencing pain, with 24 (35%) classified as having neuropathic pain. All patients with neuropathic pain described their pain as chronic ( $\geq$ 3 months duration). Over half of the skin punch biopsies demonstrated pathological reductions in intraepidermal nerve fiber density. 7 patients (10%) demonstrated at least two pathological findings in small fiber tests and were classified as having small fiber impairment. Despite these findings, no direct correlation was observed between the presence of neuropathic pain and pathological small fiber test results. Pain was associated with reduced health-related quality of life across the cohort.

### Conclusion

Neuropathic pain and small fiber abnormalities are common in patients with NF and SWN, highlighting the need for thorough clinical evaluation. The lack of a direct correlation between neuropathic pain and small fiber damage suggests that pain mechanisms in these conditions may involve complex interactions beyond small fiber pathology. Clinicians should consider comprehensive assessment and targeted analgesic strategies to address the multifaceted nature of pain in NF and SWN patients.

### V136

Subjektive und funktionelle Resultate nach Nervus massetericus Entnahme Subjective and Functional Outcomes Following Masseteric Nerve Harvest – a Relevant Denervation?

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### Objective

The most common technique for peripheral nerve transfer in facial nerve palsy is the NV to NVII transfer. Although techniques of nerve coaptation differ, the harvest technique is highly standardized at Zuckers' point below the zygomatic arch. Very limited literature exists evaluating the resulting defect and comlications for this nerve resection. From 2020 to 2024 a retrospective observational study was performed of all patients treated with NV-NII transfer.

### Methods

Observer-based analysis of facial (House-Brackmann-Score) and jaw function as well as pain level (NRS) was compared to patient reported outcome measures (PROM) gradings of the FACE-Q tool. Descriptive statistics for all assessed measurements were analyzed and correlations were calculated to compare observer-based grading and PROM.

### Results

Thirty one patients (68% female, median age 43 years) with acute and chronic facial palsy with completed questionnaires were included. Nerve harvest was performed as described 2011 by Borschel et al and coaptation performed by supercharging end-to-side transfer in 65%. To reach buccal and temporal branches as desired, an interpositional nerve graft was utilized in 48%. Regeneration was confirmed on average after 4 months with one missed reinnervation due to longstanding preoperative muscle denervation. PROM for eating and drinking, oral competence, drooling distress and speaking distress improved despite the masseter muscle denervation. No joint pain or weakness in occlusion was reported while cheek bite events were reduced compared to preoperatively.

### Conclusion

Masseteric to facial nerve transfer not only constitutes for a swift, robust and efficient reinnervation but also offers these results with very little morbidity. The use of a questionnaire for subjective assessment in neuromuscular recovery following nerve harvest yields outcomes information that is generally not considered in the traditional clinical patient assessment. Although muscle atrophy can occur in 11% of cases according to the literature, the majority of patients tolerate masseteric nerve harvest without reported muscular imbalance or weakness.

### RC042

Implantat in-situ Montage für den all-posterior lumbalen Wirbelkörperersatz: Vergleich einer neuen Technik mit der lateralen retroperitonealen Methode.

Implant in-situ assembly for all-posterior lumbar vertebral body replacement: Comparison of a new technique to the lateral retroperitoneal approach.

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### Objective

An all-posterior lumbar vertebral body replacement (VBR) may be less invasive compared to the alternative of a combined retroperitoneal and dorsal approach because it can be performed via a single surgical corridor. Achieving stable lumbar vertebral body replacement requires implants with a broad footprint to reduce the risk of implant subsidence. However, the narrow space between the lumbar nerve roots and dural sac complicates the placement of such implants through a purely posterior approach.

To address this challenge, we introduced a technique called implant in situ assembly, which facilitates all-posterior lumbar VBR with the use of large endplates.

### Methods

We compared 8 consecutive patients who underwent all-posterior lumbar VBR using implant in situ assembly to a consecutive case series of 10 patients managed with our previous standard: a combined lateral retroperitoneal and posterior approach.

#### Results

The all-posterior approach successfully allowed for the placement of large endplate implants to support adjacent vertebrae in all cases. No new neurological deficits occurred. One patient underwent revision surgery for screw loosening. A new neurological deficit occurred in one patient with a retroperitoneal approach. Implant subsidence occurred in 1 all-posterior and 3 retroperitoneal patients, respectively. The mean surgical time for all-posterior VBR was 349 (+/- 92) minutes and 502 (+/- 143) minutes for lateral VBR (p = 0.019).

### Conclusion

At the lumbar spine implant in-situ assembly enables vertebral body replacement with a large footprint implant using only one (dorsal) surgical corridor. This technique is a safe alternative to a combined lateral retroperitoneal and dorsal approach, may be less invasive and save time

### V137

Untersuchung des klinischen Verlaufs und Outcome von Patienten mit Wirbelsäulenläsionen bei Multiplem Myelom - Ergebnisse einer Kohorte von 704 Patienten aus der Europäischen M2Spine Studiengruppe. *Clinical course and outcome of Multiple Myeloma patients undergoing surgery for vertebral column lesions – results from a cohort of 704 patients of the European M2Spine Study Group.* 

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#### Objective

Vertebral column lesions are pathognomonic in Multiple Myeloma (MM), leading to chronic vertebral pain. Nonsurgical management is universally the preferred treatment due to the fear of surgical complications. However, there are several patients who fail non-surgical treatment and receive surgery with a certain delay. With this study we describe a large European cohort of patients with MM vertebral column lesions to identify factors that might indicate non-surgical treatment failure.

### Methods

Patients with MM vertebral column lesions were enrolled into the "European M2Spine Registry" at seven academic spine centers in Germany, Austria, and Italy between 2005-2020. Data was retrospectively analyzed regarding the categories epidemiological, clinical, oncological treatment, and outcome data. Univariate analysis was performed to identify factors at risk for a cross-over from intended non-surgical to surgical treatment. Ethical approval (EA4/063/20) was granted.

#### Results

704 patients were enrolled, with surgical treatment in 70% (n=493). Main indications for upfront surgery were pain (41%), suspected instability (30%), need for histology (21%), and neurological deficits (8%). Postoperative complication rate was 10%. Of all the patients who underwent surgical treatment, 25% (n=110) transitioned to surgery from initially planned non-surgical treatment after a median of 42 (range: 12-306) months. Univariate analysis revealed that younger age (p=0.039) and the new onset of neurological deficits (p=0.001) were significant risk factors for this delayed transition to surgery. Other clinical factors, like SINS or a worsening of SINS during follow-up, were not significant.

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### Conclusion

Of the 70% of patients with surgical treatment in this large European cohort, 25% received surgery in a delayed fashion, with clinical risk factors younger age, and the occurrence of new neurological deficits as main risk factors for this delayed transition to surgery. Given the diverse management approaches for MM patients, data from prospective studies that include structured radiological follow-up and assess patients` health-related quality of life are essential and will provide critical guidance as for decision-making regarding the indication and timing of surgery.

### RC044

# Klinische Profile spinaler Schwannome bei LZTR1-, SMARCB1- und NF2-assoziierter Schwannomatose Clinical Profiles of Spinal Schwannomas in LZTR1-, SMARCB1-, and NF2-related Schwannomatosis

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### Objective

Schwannomatosis is a rare neurocutaneous syndrome marked by the development of multiple schwannomas, particularly in the spine, often presenting with chronic pain or neurological deficits. While pathogenic variants in *LZTR1* and *SMARCB1* are key contributors, the relationship between clinical presentation, tumor distribution, and genetic alterations compared to sporadic schwannomas remains underexplored. In this study, the newly added *NF2*-related schwannomatosis is examined in more detail following the study by Plotkin et al.

### Methods

A monocentric retrospective study analyzed 130 histopathologically confirmed spinal schwannomas from 39 patients with clinically or genetically conformed schwannomatosis between 2014-2024. A control group of 147 patients with sporadic spinal schwannomas without diagnosis of schwannomatosis was included. Data on tumor size, location, clinical symptoms, and genetic findings were analyzed. Volumetric measurements were conducted on 64 tumors from the test group and 69 from the control group.

### Results

The schwannomatosis group exhibited an average of 3.33 spinal schwannomas per patient. 43.8% of the schwannomas being resected. Patients were significantly younger than the control group (mean 39.6 vs. 52.1 years, p<0.001). Intradural schwannomas comprised 96 of 130 tumors in the schwannomatosis group, with resected tumors significantly larger than non-resected ones (p<0.0001). Resected intradural schwannomas in schwannomatosis patients trended larger compared to the control group (p=0.0611). Genetic analysis of 28 patients" blood derived DNA revealed *LZTR1* mutations in 4, *NF2* mutations in 5, *SMARCB1* mutations in 2 patients and 17 suspected mosaics. *LZTR1*-related schwannomatosis was associated with older age at diagnosis (47.5 years), predominantly intradural tumors, and symptomatic presentations. *NF2*-related schwannomatosis patients were significantly younger and asymptomatic.

### Conclusion

This study is the first to analyze spinal schwannomas in schwannomatosis, considering clinical patterns related to distinct genetic subgroups. Intradural schwannomas in schwannomatosis are often asymptomatic unless significantly enlarged, suggesting a need for tailored management strategies. Early surgical intervention is advisable for thoracic lesions to prevent myelopathy, while conservative management is often appropriate for lumbar tumors. Genetic testing should be integrated into diagnostic workflows to improve management and refine therapeutic strategies for schwannomatosis.

### BO-06

Effekte eines intensiven Heimtrainings nach Karpaltunneloperation – erste Ergebnisse einer prospektiven randomisierten Multicenter-Studie Effekte eines intensiven Heimtrainings nach Karpaltunneloperation – erste Ergebnisse einer prospektiven randomisierten Multicenter-Studie

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### Objective

Die postoperative Rehabilitation ist von entscheidender Bedeutung für die Wiederherstellung der Handfunktion nach chirurgischen Eingriffen bei Nervenkompressionssyndromen, insbesondere dem häufigen Karpaltunnelsyndrom. Traditionelle Rehabilitationsmethoden variieren in Intensität und Struktur, oftmals findet allerdings überhaupt kein spezifisches Training statt. Es liegt nahe, dass ein intensives Heimtrainingsprogramm zur schnelleren Wiedererlangung der Funktionalität beitragen kann. In dieser Studie wird untersucht, ob solche Programme angenommen werden und zu besseren Ergebnissen führen als die Standardrehabilitation ("Warten und schonen").

### Methods

Aus drei neurochirurgischen Zentren wurden 51 Patienten mit chirurgisch behandeltem Karpaltunnelsyndrom rekrutiert und in zwei Gruppen randomisiert: eine Trainingsgruppe und eine Kontrollgruppe. Die Trainingsgruppe erhielt ab zwei Wochen nach der Operation ein Heimübungsprogramm, das täglich 5–10 Minuten lang durchgeführt wurde. Präoperativ und sechs Wochen nach der Operation (vier Wochen nach Trainingsbeginn) wurde eine standardisierte Untersuchung durchgeführt und die Handkraft mithilfe eines Dynamometers gemessen. Darüber hinaus bewerteten die Patienten den Nutzen des Trainings anhand eines modifizierten Patientenzufriedenheitsindex (mPSI).

### Results

Es wurde ein Zwei-Stichproben t-Test (einseitig) angewendet. Dabei zeigt sich, dass die mittlere Differenz der Handkraft der Trainingsgruppe zwischen den genannten Zeitpunkten größer ist als die mittlere Differenz der Kontrollgruppe. Wird dabei das Signifikanzniveau  $\alpha$ =0,1 zugrunde gelegt, ist der Unterschied signifikant.

Auf dem mPSI wurde von 30 Trainierenden 1 Punkt vergeben (hohe Zufriedenheit mit dem Trainingsprogramm), 2 Trainierende bewertete das Training mit 2 bzw. 3 Punkten als neutral bzw. nicht hilfreich.

### Conclusion

Heimübungen der Hand sind nach einer Karpaltunneloperation effektiv und werden gut angenommen. Patienten sollten zum Zeitpunkt der Wundkontrolle darauf hingewiesen werden und Übungen in ihre täglichen Aufgaben integrieren. Es verhilft ihnen zu einer schnelleren Wiederherstellung ihrer Handfunktionalität, sie sich unter anderem in der allgemeinen Handkraft objektivieren lässt.









### V138

Sinusthrombose nach Operationen mit retrosigmoidalem Zugang: Literaturübersicht und Fallserie von hämorrhagischen Sinusthrombosen Dural Venous Sinus Thrombosis (DVST) After Surgery with the Retrosigmoid Approach: Literature Review and Case Series of Hemorrhagic DVST

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### Objective

This study aims to explore the incidence, presentation, and management of dural venous sinus thrombosis (DVST) following surgery via a retrosigmoid approach, as documented in the literature, while also presenting three cases of DVST with subsequent cerebellar hemorrhage treated at our institution.

### Methods

Among over 3,000 patients who underwent surgery via the retrosigmoid approach at our clinic since 2000, we retrospectively analyzed three cases involving female patients aged 27, 51, and 54 years. These patients developed cerebellar hemorrhagic infarction in the context of DVST following retrosigmoid surgery. The primary pathologies included petroclival meningioma, a prepontine and premedullary neuroenteric cyst, and vestibular schwannoma. All patients underwent uneventful tumor resections without intraoperative injury to any significant venous structures. Neurological condition and imaging findings were reviewed both pre- and postoperatively, along with the surgical and medical interventions and associated outcomes.

### Results

All three patients were promptly extubated post-surgery without new neurological deficits. However, within half a day, they exhibited significant neurological deterioration and reduced levels of consciousness. Cranial imaging revealed hemorrhagic cerebellar infarctions due to DVST involving the transverse or sigmoid sinuses, accompanied by hydrocephalus and brainstem compression. Surgical interventions included hematoma evacuation, external ventricular drainage, and, in one case, decompressive craniectomy. Despite these severe complications, two patients achieved full recovery, while the third experienced only mild residual impairments.

### Conclusion

Based on the reviewed literature, DVST is a less rare complication of retrosigmoid approach surgery than previously assumed. It often remains asymptomatic and does not require specific treatment. However, when associated with cerebellar hematoma, it can lead to severe postoperative morbidity. At our institute, the incidence of cerebellar hemorrhage associated with DVST was below 0.1%. Further research is necessary to identify risk factors and refine perioperative prevention strategies.

### SFNC-09

### Repeated Gammaknife radiosurgery for vestibular schwannomas

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### Objective

Gammaknife radiosurgery (GKRS) is a well recognized treatment for vestibular schwannomas (VS) with high tumour control rate and low morbidity. When failure occasionally occurs, additional treatment is required and can either be performed by surgical resection or by repeated GKRS depending on the size of the tumour and clinical condition.

### Methods

From 1992 to 2018, 4,530 VS were treated in our institution. Of these, 110 (2.4%) patients underwent a second treatment because of tumour progression. Forty-nine (1.1%) patients including 47 patients with sporadic VS and 2 patients suffering from neurofibromatosis underwent repeated GKRS. Mean tumour volume was 0.6 cm<sup>3</sup> and 1.8 cm<sup>3</sup> at initial and second GKRS treatment, respectively. Mean delay between treatments was 61 months (range: 27-203; median: 55 months). Mean prescription dose was 12 Gy for both interventions.

#### Results

Mean radiological follow-up after repeated GKRS was 54 months (range: 4-132; median: 53 months). Tumour regression was achieved in 63.2% of cases. No additional treatment was required. Useful hearing ability was preserved in 7/13 (53.8%) patients who had serviceable hearing at the time of the second GKRS with a mean audiometric follow-up of 48 months (range: 6-132; median: 47 months). Mean clinical follow-up was 54 months (range: 3-132; median: 55 months). One patient experienced transient (6<sup>th</sup>-24<sup>th</sup> months) facial palsy and 2 patients transient hemifacial spasm. One patient reported transient (36<sup>th</sup>-60<sup>th</sup> months) facial hypoesthesia. No patient developed symptomatic adverse radiation effects.

#### Conclusion

Repeated GKRS is safe and effective for VS, and should be systematically considered before salvage surgical resection.

### RC045

Korreliert die Beteiligung der A. carotis interna mit dem Schlaganfallrisiko bei Sinus-cavernosus Meningiomen? *Assessing ischemic stroke risk in cavernous sinus meningiomas: The role of cavernous carotid involvement* 

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### Objective

Cavernous sinus meningiomas (CSMs) are among the most challenging skull base tumors to treat due to their tendency to involve the internal carotid artery (ICA), which, in rare cases, can lead to ischemic symptoms. However, data on the long-term risk of ischemic stroke remain limited. This study aims to analyze the long-term risk of ischemic stroke in patients with previously treated CSMs.

### Methods

We reviewed the database of our skull base center for cases of histologically confirmed primary CSMs treated between 2006 and 2022. Included patients underwent tailored microsurgical resection of the extracavernous tumor portion followed by fractionated stereotactic radiation therapy (FSRT) as a standard departmental procedure for symptomatic CSM. Medical records and neuroimaging were analyzed to collect clinical information and identify symptoms or radiological evidence of ischemic strokes during follow-up. Cavernous carotid artery involvement was classified according to the Hirsch grading system as partially encased, completely encased (with or without narrowing), or completely encased with obliteration.

#### Results

A total of 33 patients were identified, with a mean age of 55 years (range 22–77). The median clinical and radiological follow-up after FSRT was 102 months (range 12–212) and 88 months (range 12–209) respectively. At initial imaging, narrowing of the ICA was observed in 20 patients (60.6%), while occlusion was evident in 3 cases (9.1%). 14/33 patients (42.4%) exhibited subcortical arteriosclerotic leucencephalopathy, which did not progress during follow-up. None of the patients received prophylactic antiplatelet or anticoagulation therapy specifically for tumoral ICA involvement. In one case in which a benign CSM occluded the ipsilateral ICA, protective stent implantation on the contralateral side was performed prior salvage irradiation. Only one patient experienced an acute ischemic thalamic stroke ipsilateral to the CSM 8 years after FSRT, but this event was unrelated to the CSM.

#### Conclusion

Our study demonstrates that despite the high prevalence of ICA stenosis in patients with CSMs, the long-term risk of ischemic stroke is not increased, even after FSRT. Importantly, the absence of ischemic events directly attributable to tumoral ICA involvement suggests that prophylactic antiplatelet or anticoagulation therapies may not be necessary in this patient population.

### RC046

Schutzstenting der Arteria carotis interna mit "Flow Diverter" bei der Resektion komplexer Schädelbasistumoren Safety and feasibility of protective stenting with flow diversion devices for resection of complex skull base tumors involving the internal carotid artery

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### Objective

Skull base tumors involving the internal carotid artery (ICA) pose significant surgical challenges due to their complex anatomical relationships and the critical need to preserve cerebral blood flow. Vascular injuries, particularly of the ICA, can result in catastrophic consequences with severe morbidity or mortality. Flow diversion devices have emerged as an innovative strategy in the interventional treatment of various neurovascular diseases. This study is the first worldwide to investigate the safety, feasibility, and outcomes of protective stenting using flow diversion devices prior to the resection of skull base tumors encasing the ICA.

### Methods

A retrospective analysis was conducted on five patients treated at our departments between 2022 and 2024. The cohort consisted of five patients with complex skull base tumors encasing the ICA. All patients underwent preoperative protective stenting with flow diversion devices to reinforce the ICA (four patients with Pipeline Vantage<sup>™</sup> from Medtronic and one with FRED X<sup>™</sup> from Terumo Neuro). Data on procedural safety, complications, and surgical outcomes were collected and analyzed.

### Results

The study included four women and one man, aged between 18 and 60 years. Four patients had paragangliomas, and one had a neurofibroma associated with Neurofibromatosis Type II. Protective stenting was successfully performed in all five patients before surgery. There were no intraoperative vascular injuries, stent-related complications (such as thrombosis or hemorrhage), or postoperative neurological deficits. Complete tumor resection was achieved in all patients. One patient died during follow-up due to a pulmonary embolism unrelated to the primary tumor or the surgical procedure

#### Conclusion

Protective stenting using flow diversion devices is a safe and effective adjunct in the management of complex skull base tumors involving the ICA. This technique facilitated complete tumor resection in all patients without vascular injury. These findings underscore the significant potential of flow diverters in complex skull base surgeries. Further studies with larger patient cohorts are necessary to validate these results and expand the clinical applications of this approach.

# Funktionelle Neurochirurgie 3 | Functional neurosurgery 3

# SFNC-10

### Statistical Anatomical mapping of DBS of the anterior Nucleus of the Thalamus for intractable epilepsies.

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### Objective

The prospective trial SANTE have demonstrated the benefit of the stimulation of the anterior nucleus of the thalamus (ANT) in intractable epilepsies not remediable by resective surgery. The precise topography of the best target offering the optimum safety efficacy ratio is still a matter of debate.

### Methods

In 46 patients operated in the frame of the prospective multicentric trial « France » and followed at least 2 years with all the anatomical and clinical pre and postoperative data available. The topography of the stimulating contact, the volume of tissue activated (VTA), the recruited fiber tracts were cross matched with seizure reduction and side effects.

#### Results

Comparison between pre and postoperative seizure frequency is demonstrating at two years a mean seizure reduction rate of 35% with 17, 21 & 8 patients respectively responders, improved and not improved. The analyses of the position of the stimulating contact is showing that in the best responders its location is more posterior and inferior. The study of the VTA is demonstrating that the probability to be improved is correlating on the left with a larger coverage of MD (MedioDorsal nucleus) and on the right side with a larger coverage of AV (Ventral part of the ANT) and MD plus a lower coverage of IL (Internal medullary lamina). The dynamic of the response in time depends on the category of response to the stimulation. The site for the best response and the probability of best response seems to be depending on the location of the epileptogenic zone.

#### Conclusion

The white fibers postero-inferior at the AV and specially the mammilo-thalamic tract is turning out to be the main optimum target of DBS for intractable epilepsies. The ANT per se may not be the main target.

# Funktionelle Neurochirurgie 3 | Functional neurosurgery 3

# SFNC-11

### Thalamopontocerebellar epileptogenic circuit is disrupted by radiosurgery for hypothalamic hamartoma

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### Objective

Hypothalamic hamartomas (HHs) are disabling congenital lesions, responsible for gelastic seizures frequently associated with catastrophic epilepsies, epileptogenic encephalopathy, and cognitive and psychiatric severe comorbidities. Stereotactic radiosurgery (SRS) is a well-established minimally invasive therapeutic approach. We assessed here whether graymatter density (GMD) correlates with seizure outcome.

### Methods

We used voxel-based morphometry at whole-brain level, as depicted on pretherapeutic standard structural magnetic resonance neuroimaging. We examined 24 patients (10 male patients, 14 female patients; mean age, 12.7 yr; median, 9; range, 5.9-50) treated in Marseille University Hospital, France, between May 2001 and August 2018.

### Results

Most relevant anatomic area predicting postoperative Engel classes I and II vs III and IV after SRS for HHs was mesencephalic tegmentum. Higher pretherapeutic GMD in this area was associated with better outcomes for seizure cessation. The only other statistically significant clusters were right cerebellar lobule VIIIb and VIIIa. Lower pretherapeutic GMD in both clusters correlated with better Engel class outcomes. GMD decreased with age in the left mediodorsal thalamus.

### Conclusion

Seizure cessation after SRS for HHs was associated with higher GMD in mesencephalic tegmental area, acknowledged to be involved in the neural control of explosive vocal behavior in animals. This area is connected by the mamillotegmental bundle to the lateral tuberal nucleus area of the hypothalamus, where HHs are known to rise. In the future, the detection of more gray matter in this "laugh" tegmental area based on pretherapeutic routine structural neuroimaging might help in patient selection for minimally invasive radiosurgery for HH.
# Funktionelle Neurochirurgie 3 | Functional neurosurgery 3

## V140

Selektive Amgydalahippokampektomie(sAHE) nach Stereotaktischer Laser Thermoapplikation(sL-TA) führt zu einem funktionellen Shift für Nicht-verbale Gedächtnisinhalte Selective Amygdalohippocampectomy(sAHE) by Stereotactic Laser Thermoablation(sL-TA) results in Functional Shift in Non-Verbal Memory

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#### Objective

sL-TA is a minimall-invasive and effective procedure for treating drug-resistant epilepsy (1). It is increasingly used in the treatment of mesial temporal lobe epilepsy (mTLE) through sAHE (2). However the clinical extent and the network changes of postoperative cognitive function remains unclear (3,4). Functional mapping before and after sAHE allows for the evaluation of shifts in cognitive networks, particularly in non-verbal memory processing. This study investigates postoperative changes in non-verbal memory function using a validated fMRI memory paradigm (4,5,6) in a group of nine patients with right-sided ablations.

#### Methods

Pre- and postoperative assessments were conducted within two weeks before and after surgery, respectively. A non-verbal memory task was employed, where patients viewed 132 black-and-white images of indoor and outdoor scenes during an MRI scan. After a 70-minute interval, a recall task was administered, combining previously shown images with novel ones. Patients rated image familiarity on a scale from 1 to 5. Functional MRI data were preprocessed and analyzed using Statistical Parametric Mapping (SPM). A paired t-test was used to evaluate postoperative changes in hippocampal and amygdala activations, with resulting maps normalized into MNI space.

#### Results

The left superior temporal gyrus (Fig 1a) and the left anterior parahippocampal region (Fig 1b) showed a significant (p < 0.001) increase in activation. These findings indicate functional reorganization, with a prominent novelty effect observed in brain activity associated with non-verbal memory processing and suggests a shift in memory function networks following sAHE.

#### Conclusion

The results highlight neuroplastic adaptations following sL-TA. Further studies with larger cohorts and including patients with left-sided lesions are essential to explore the impact of e.g. language lateralization on non-verbalmemory function in mTLE patients. The applied method offers valuable insights into the interaction between surgical interventions and cognitive network reorganization, supporting the development of a step-by-step approach for improving postoperative outcomes and cognitive recovery in the individual patient.

#### Abb. 1



#### Abb. 2

Literature

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# Funktionelle Neurochirurgie 3 | Functional neurosurgery 3

## V141

Resektion dominanter MEG-Netzwerkknoten verbessert die Anfallskontrolle nach epilepsiechirurgischen Eingriffen bei Patienten mit extratemporaler Epilepsie Resection of dominant MEG network nodes improves outcomes of epilepsy surgery in patients with extratemporal lobe epilepsy

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#### Objective

In patients with focal epilepsy, interictal resting state MEG (rsMEG) contains subtle alterations of network characteristics. These could potentially be utilized for localization of the epileptic focus and thus contribute to successful epilepsy surgery. In the presented study, we investigate node degree (ND), a graph-theoretical parameter of functional connectivity, in relation to epilepsy surgery and postoperative seizure outcomes.

#### Methods

rsMEG from a series of 40 adult patients undergoing epilepsy surgery due to pharmacoresistant focal epilepsy (17 with temporal lobe epilepsy (TLE), 23 with extratemporal lobe epilepsy (ETLE)) and 30 healthy controls were analyzed retrospectively. Inclusion criteria for patients consisted of epilepsy surgery with known seizure outcome with a follow-up of at least 1 year and MEG evaluation as part of the presurgical workup.

Per subject, 20 minutes of rsMEG data were processed by whole brain, all-to-all connectivity analysis using imaginary part of coherence. Connectivity values of patients were transformed to z-scores referencing to control data. Z-scores were thresholded to generate graphs and calculate node degrees. Results were parcellated using the Automated Anatomical Labeling (AAL) atlas. Resection volumes were segmented manually based on pre- and postoperative MRI data. ND was compared between groups as wells as to the resection and postoperative seizure outcome using ANOVA and ROC-analysis

#### Results

All frequency bands showed significantly higher maximum ND in patients compared to controls (p < 0.01, ANOVA). Patients with ETLE, ND maxima had considerably better accuracy for the resection volume (p<0.05, ANOVA). AUC-values of ROC-analysis were 0.77, 0.70, 0.74, 0.75 and 0.733 for delta, theta, alpha, beta and gamma frequency bands for ETLE, compared to 0.69, 0.40, 0.35, 0.56 and 0.58 for TLE. In ETLE, but not TLE, high accuracy (AUC) for the resection volume was associated with better postoperative outcomes.

#### Conclusion

In patients with ETLE, localization of MEG node degree maxima in the resection volume is related to better postoperative seizure control after epilepsy surgery.



## Abb. 2



# Funktionelle Neurochirurgie 3 | Functional neurosurgery 3

## RC047

#### Stereo-EEG geführte Radiofrequenz-Thermokoagulation bei schwer behandelbarer fokaler Epilepsie – erste Ergebnisse an 15 Patient\*Innen an einem tertiären Epilepsie-Zentrum Stereo-EEG guided Radiofrequency Thermocoagulation for Drug-Resistant Focal Epilepsy: Initial Results from 15 Patients at a Tertiary Epilepsy Center

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#### Objective

Radiofrequency thermocoagulation (RFTC), as a minimally invasive treatment method, can serve as an alternative to resective epilepsy surgery for drug-resistant focal epilepsy. Using implanted EEG depth electrodes, the seizure-generating network components are first identified and then inactivated through thermal ablation using high-frequency electrical pulses. Here, we present our experiences and preliminary results following the implementation of this treatment method in our epilepsy center with a cohort of 15 patients. The aim of this study was to evaluate the introduction of RFTC and analyze the treated population with regard to technical aspects, underlying pathologies, treatment-associated complications, and seizure outcomes.

#### Methods

A retrospective observational study was conducted on 15 consecutive patients with pharmacoresistant focal epilepsy over 24 months. Dixi Medical depth electrodes (DE) were used for RFTC. Thermal ablation was performed by applying bipolar voltage between adjacent contacts (maximum power: 8.3 watts; maximum duration: 60 seconds). Seizure outcomes were evaluated using the ILAE classification. Patients were divided into two groups (seizure-free [SF] vs. non-seizure-free [non-SF]) for analysis.

#### Results

The study included 15 patients (8 male) with an average age of 31.8 years and a mean follow-up duration of 6.8 months (range: 1–20 months). A median of 9 DEs (4–16) were implanted per patient, and RFTC was performed on a median of 2.5 DEs (1–8), generating a median of 9.5 lesions (1–22). At the last follow-up, 7 patients (46.7%) were seizure-free. The responder rate, defined as  $\geq$ 50% reduction in seizures, was 80%. Two patients (13%) with ILAE Class 3 outcomes after RFTC underwent lesionectomy at 9 and 6 months, respectively, resulting in postoperative seizure freedom. The proportion of patients with distinct localized lesions (FCD, PVNH, and HH) was significantly higher in the SF group compared to the non-SF group (100% vs. 37.5%; p=0.01). No complications or neurological deficits were observed in any patient following RFTC.

#### Conclusion

Our initial experiences suggest that SEEG-guided RFTC is a promising and safe treatment option for carefully selected patients. In particular, patients with localized, well-defined lesions appear to have a higher likelihood of achieving seizure freedom. Further studies are needed, especially to identify patient-specific biomarkers or other predictors associated with higher rates of seizure freedom.

# Funktionelle Neurochirurgie 3 | Functional neurosurgery 3

## RC048

Patienten mit Temporallappenepilepsie (TLE) haben eine bessere vestibulär-abhängige räumliche Orientuierung nach stereotactischer Laser-Thermoablation (sL-TA) im Vergleich zu "klassischen" resektiven Verfahren und zu nicht-operierten Patienten

*Temporal lobe epilepsy (TLE) patients perform better in vestibulo-dependent spatial orientation after Stereotactic Laser-Thermoablation (sL-TA) compared to "classical" resective surgery and to non-operated patients* 

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#### Objective

Although open surgical approaches, such as temporal lobectomy, have been method of choice for almost a century, minimally invasive sL-TA demonstrated promising results concering postoeprative seizure outcome (1). Postoperatively some memory functions seem to be better after sL-TA in comparision to the "classical" resective procedures (2). However, it remains unkown wether patients who underwent one of these two approaches would show better performance on vestibulo-spatial tasks.

#### Methods

Twenty seven patients were included and divided in three evenly sized different groups: group I: after sL-TA (37.0  $\pm$  15.1 years; 2 females), group II: resective surgery (44  $\pm$  15.7 years, 5 females) and group III: no surgery (43  $\pm$  11.2 years, 3 females) with no significant differences in age, disease duration and number of antiseizure medication (ASM). Groups were compared on their performance in three vestibular-dependent tests: 1. the clinical balance test (CBT), 2. triangle completion test (TCT) for vestibular-dependent spatial orientation and 3. rotational memory (RM) test.

#### Results

Significantly better performance was found in Group 1 (sL-TA), in comparison to the other two groups (resective surgery and no surgery) was found on TCT (figure 1). Other tests revealed no significant differences between groups.

#### Conclusion

Even if the minimal-invasiveness with less removed tissue and collateral damage appear an evident explanation for the better performance in the sL-TA group compared to the resective group, the postsurgical increase in function compared to the non-operated patients remains intruiging. The reasons for this findings could be assessed in detail in a larger-scale prospective longitudinal study, so that confounding factors such as influence of operated side, timing of surgery, quantative and or qualitative drug load in respect to the vestibulo-spatial'functions (etc.).

Literature:

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(2) Drane DL. MRI-Guided stereotactic laser ablation for epilepsy surgery: Promising preliminary results forcognitive outcome. Epilepsy Res. 2018;142:170–175.

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#### Abb. 1

figure 1 - Errors on TCT on both conditions (Walk and Wheelchair) for three groups of patients - (group I) sL-TAoperated, (group II) operated with temporal resection and (group III) non-operated patients.



\*\* p<0.01, \*\*\*p<0.001; TCT - triangle completion test

# Neuroonkologie 10 | Neurooncology 10

## V142

Auswirkungen der supramarginalen Resektion bei neu diagnostizierten Glioblastomen. Eine RANO-resectbasierte Untersuchung

Effects of supramarginal resection in newly diagnosed glioblastomas. A RANO-resect-based study

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#### Objective

Surgical resection is a critical element in the management of newly diagnosed glioblastoma (GBM). Recent studies conducted by the RANO resect group established the importance of resection beyond the contrastenhancing (CE) area (supramarginal resection). Our study aims to employ this concept in our cohort and emphasize the importance of the EOR of FLAIR and non-CE tumor for survival outcome.

#### Methods

We analyzed 300 patients (119 female, 181 male) with a median age of 62.5 years (range: 26.9 – 86.6 years) and median presurgical Karnofsky index (KPI) of 80, who underwent surgical resection of newly diagnosed glioblastoma. The MGMT status was unmethylated in 52%. Fluorescence guidance (FG) was used in 57.7%. Supramarginal resection was determined by volumetry of the pre-and postsurgical FLAIR- or non-contrast enhancing (non-CE) tumor volume as previously defined. Outcome analysis included progression-free (PFS) and overall survival (OS).

#### Results

95 (31.6%) patients underwent complete resection of the contrast-enhancing tumor (CE); of these, 74 (62.1%) received a supramarginal resection. Preoperative CE tumor volume correlated with preoperative FLAIR volume (p=0.0001); a higher FLAIR volume was associated with a lower KPI (p=0.021). The extent of supramarginal resection was significantly higher in the FG group (p=0.046). Patients undergoing supramarginal resections showed better OS (p=0.0001) and PFS (p=0.017). Postoperative FLAIR volume significantly correlated negatively with OS (p=0.004). Multivariate Cox regression analysis revealed a progressive decrease in the hazard of death (p=0.00001, HR:0.74) and progression (p=0.012, HR:0.82) for each RANO resect category from incomplete to supramarginal resection. Moreover, supramarginal resection (p=0.024) was found to be an independent positive prognostic factor for OS, next to preoperative KPI (p=0.0001), age (p=0.0001), and MGMT status (p=0.0001).

#### Conclusion

Supramarginal resection was beneficial for both, PFS and OS in patients with newly diagnosed GBM. The hazard of death and progression decreased steadily with each RANO resect category. In addition, fluorescence guidance significantly increased the extent of supramarginal resection.











# Neuroonkologie 10 | Neurooncology 10

## V143

Vakzinierung mit lysatbeladenen, reifen dendritischen Zellen integriert in die Standard-Radiochemotherapie bei neu diagnostiziertem Glioblastom - Interimalyse der GlioVax-Studie Vaccination with lysate-loaded, mature dendritic cells integrated into standard radiochemotherapy in newly diagnosed glioblastoma - Interim analysis of the GlioVax trial

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#### Objective

In the phase II GlioVax trial, patients with newly diagnosed, IDH wildtype glioblastoma are treated either with autologous dendritic cell vaccination as add-on to standard radiochemotherapy after fluorescence-guided surgery or with standard radiochemotherapy alone. Here, we present data from the first interim analysis.

#### Methods

In the multicentric, prospective, randomized GlioVax trial, 136 patients are randomized 1:1 into the vaccination or control arms, stratified for MGMT promotor methylation. Primary endpoint is overall survival (OS), secondary endpoints are progression free survival (PFS), OS and PFS rates at 6,12 and 24 months after surgery as well as safety, quality of life and neurological performance. The follow-up is 2 years. The study design is illustrated in Figure 1.

#### Results

This interim analysis presents data from 96 patients (n=47 control group, n=49 vaccination group, 61% male, 35% female, mean age 61.5 years, range: 27-82 years). Median OS in the vaccination and control groups is 1.7 years [1.4, -] and 1.3 years [1.2 - 1.9], respectively (p=0.14), with a median study length of 1.6 and 1.5 years (Figure 2). There was no difference in the frequency and severity of adverse events between the two groups.

#### Conclusion

Based on the interim analysis, dendritic cell vaccination of GBM patients is feasible and overall well tolerated. Moreover, there is a trend for increased OS, which needs to be substantiated in the final analysis. Meanwhile, recruitment was concluded. Final data analysis is expected for mid-2027.



Abb. 2

Abb. 1



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## V144

#### Ein integrativer Risikoscore für das post-operative Überleben von neudiagnostizierten Glioblastomen: interaktive Effekte zwischen der chirurgischen Resektion mit klinischen und molekularen Prognosefaktoren Interactive effects of clinical, molecular, and surgical factors on postoperative outcome in newly diagnosed glioblastoma: development and validation of a clinical risk score

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#### Objective

Following resection or biopsy, individuals with newly diagnosed glioblastoma frequently enter clinical trials. Nuanced risk assessment is warranted to reduce imbalances between study arms. Here, we aim (I) to analyze the interactive effects of residual tumor with clinical and molecular factors on outcome and (II) to define a prognostic postoperative risk score.

#### Methods

We retrospectively compiled an international, seven-center training cohort of newly diagnosed glioblastoma. The combined associations of residual tumor with molecular or clinical factors and survival were analyzed, and recursive partitioning analysis was performed for risk modeling. Terminal regression tree nodes were combined into risk classes and a numerical score. The resulting model was prognostically verified in a separate external validation cohort.

#### Results

Our training cohort compromised 1003 patients with newly diagnosed *IDH*-wildtype glioblastoma, including 744 patients who underwent adjuvant radiochemotherapy per EORTC-NCIC (TMZ/RT $\rightarrow$ TMZ). Residual tumor per RANO classification, MGMT promotor methylation status, age (as continuous variable; optimal cutoff: <65 years), and KPS (as continuous variable; optimal cutoff: <80) were prognostic of overall survival and forwarded into regression tree analysis. By integrating eleven terminal nodes and individually weighting the prognostic factors, an additive scale (range, 0-9 points) integrating these four variables distinguished patients with low (0-2 points), intermediate (3-5 points), and high risk (6-9 points) for poor postoperative outcome (median overall survival: 24 vs. 16 vs. 6 months; p < 0.01). Adjustment of the regression tree for adjuvant therapy was applied, and the

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presence of the three risk groups was confirmed in the patient subgroups treated with or without RT/TMZ $\rightarrow$ TMZ. The prognostic value of the risk score was verified in a external single-center validation cohort (*n* = 231, *p* < 0.01). Compared to previously postulated risk models, our score was superior in concordance between predicted with observed survival (c-index; development cohort: 0.7, validation cohorts: 0.6).

#### Conclusion

The risk score integrates molecular and clinical factors to serve as an easy-to-use, yet highly prognostic tool to stratify patients after resection or biopsy of newly diagnosed glioblastoma. The score may serve to inform patient management and minimize imbalances between study arms in prospective interventional trials.

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## V145

Prognostische Implikationen molekularer Merkmale bei IDH-Wildtyp-Astrozytomen: eine vergleichende Analyse von molekularen und klassischen Glioblastomen Prognostic implications of molecular features in IDH wild-type astrocytoma: a comparative analysis of molecular glioblastoma and classical glioblastoma

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#### Objective

The 2021 CNS classification introduced the identification of glioblastoma (GBM) in histologically low-grade but *IDH* wild-type (*IDH*-WT) astrocytomas that exhibit a *TERT* promoter (*TERT*p) mutation. This study aims to evaluate the outcomes of histologically low-grade astrocytomas with molecular high-grade features (referred to as molecular GBM) and compare their outcomes to those of patients with histologically "classical" GBM.

#### Methods

We analyzed 48 tumor samples from patients with *IDH*-WT histologically low-grade astrocytomas (WHO grades 2–3, molecular GBM cohort) and compared them to 55 patients with classical GBM (classical GBM cohort). Molecular profiling was conducted using whole-exome and Sanger sequencing. Data on progression-free survival (PFS), overall survival (OS), and tumor characteristics were collected and analyzed across the two cohorts.

#### Results

In the molecular GBM cohort (20 females and 28 males), 75% of tumors (n=36) harbored a *TERT*p mutation (*TERT*p-mut), while 25% (n=12) were *TERT*p wild-type (*TERT*p-WT). The median age at diagnosis for this cohort was 67 years (range: 24–86 years), with a median OS of 20 months and PFS of 15 months. *TERT*p status did not correlate with age at diagnosis (*TERT*p-mut: 67 years; *TERT*p-WT: 61 years). However, *TERT*p-mut patients had significantly shorter OS (19 months) compared to *TERT*p-WT patients (56 months; p=0.0003). Remarkably, *TERT*p-WT astrocytoma were enriched with *ATRX* and *NF1* mutations (n= 5/12, 41.6%). The classical GBM cohort consisted of 22 females and 33 males, with 76.3% of tumors (n=42) harboring a *TERT*p mutation, while 23.7% were classified as *TERT*p-WT (n=13). The median age at diagnosis was 57.8 years (range: 33-79 years), with a median OS of 13.2 months. When comparing outcomes between cohorts, OS in molecular GBM patients with *TERT*p-mut (19 months) was similar to that of classical GBM patients with *TERT*p-mut (13.2 months). However, *TERT*p-WT patients in the molecular GBM cohort demonstrated significantly longer OS (56 months) compared to *TERT*p-WT patients in the classical GBM cohort (14.3 months; p=0.0013).

#### Conclusion

Our findings confirm that the presence of a *TERT*p mutation is consistently associated with poor survival in *IDH* wild-type gliomas, regardless of histological appearance. In contrast, *IDH*-WT/*TERT*p-WT astrocytomas with lowgrade histological features exhibit significantly better OS compared to *TERT*p-WT classical GBM. These results highlight the heterogeneity within *IDH*-WT gliomas.

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## V146

Retrospektive monozentrische Analyse von Carmustin-Wafer-Implantation im Rahmen der Behandlung des Glioblastom - Rezidivs: Auswirkungen auf das Überleben und die wichtigsten prognostischen Faktoren Retrospective Monocentric Analysis of Carmustine Wafer Implantation in Recurrent Glioblastoma: Impact on Survival and Key Prognostic Factors

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#### Objective

The implantation of biodegradable carmustine (BCNU) wafers is a treatment option for recurrent high-grade glioma (HGG), but its efficacy is debated. We evaluated its impact on overall survival (OS) and survival after recurrence (SAR), considering the recurrence timing after first-line treatment.

#### Methods

In this single-center retrospective study, we analyzed patients who underwent surgery for glioblastoma (GBM) recurrence following initial diagnosis (pre- and post- WHO classification 2016) between 2007 and 2022. Patients received standard first-line therapy per Stupp protocol, including maximal safe resection, radiotherapy with concomitant and adjuvant temozolomide. Recurrent GBM treatment involved resection, with or without adjuvant chemo- and/or radiotherapy. Patients who received carmustine wafer implantation (CWI) during resection were compared to those without wafer placement. Recurrences were classified by timing relative to first-line therapy: 1) post-radiochemotherapy, pre-adjuvant temozolomide; 2) during adjuvant temozolomide; 3) during prolonged temozolomide; 4) >1 month after completion of therapy. Primary endpoints are OS and SAR, with prognostic factors analyzed.

#### Results

A total of 176 patients were enrolled, with 59.7% (105/176) receiving CWI. Recurrence treatment included surgery without adjuvant therapy in 23.3% (41/176) of cases (26.7% of CWI+ and 18.3% of CWI-), adjuvant chemotherapy in 39.8% (70/176) (41% of CWI+ and 38% of CWI-), radiotherapy in 7.4% (13/176) (7.6% of CWI+ and 7% of CWI-), and combined radiochemotherapy in 29.5% (52/176) (24.8% of CWI+ and 36.6% of CWI-). No significant differences were found between groups in age (p=0,684), residual tumor volume after initial (p=0,988) or recurrence surgery (p=0,356), MGMT status (p= 0.766) or KPS post 1st-line-therapy (p=0,833). Median OS was 20 months [18–24] for CWI+ and 22 months [20–27] for CWI- (p=0.487). Median SAR was 10 months [8–12] for CWI+ and 12 months [10–13] for CWI- (p=0.252). Recurrence type 4 significantly correlates with prolonged OS (HR 0.16, 95% CI: 0.04–0.66, p=0.011), as well as, age (p<0.001), MGMT methylation (p=0.017) and smaller residual tumor volume post-recurrence surgery (p=0.008).

#### Conclusion

CWI did not significantly improve OS or SAR in recurrent GBM patients. However, younger age, MGMT methylation, smaller residual tumor volume, and later recurrence were linked to better survival outcomes, underscoring their prognostic importance.

## V147

Überlebensraten und neurologische Ergebnisse nach atlanto-okzipitaler Dislokation: Ergebnisse einer multizentrischen Studie

Survival Rates and Neurological Outcomes After Atlantooccipital Dislocation: Findings from a Multicenter Study

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#### Objective

Traumatic atlanto-occipital dislocation (AOD) is a rare and severe condition resulting from high-energy trauma. Owing to improved prehospital management and increased awareness of craniocervical junction injuries, AOD is now considered potentially survivable. Additionally, surgical stabilization is crucial, and prehospital immobilization without traction is essential for later outcomes. This study aimed to present the current management and outcomes of AOD.

#### Methods

A multicenter retrospective analysis of AOD in six level I trauma centers in Germany was conducted between 2007 and 2023. Data on road traffic accident (RTA) fatalities autopsied at one Institute of Forensic Medicine between 2003 and 2023 were also examined.

#### Results

Between 2007 and 2023, data from 19 patients with AOD were recorded. The cohort"s mean age was 37 (range 9–86) years. The AODs were classified according to Traynelis (types I: 3; II: 14; III: 2). The mean Glasgow Coma Scale (GCS) score at hospital arrival was 6 (range 3–15). Two patients died before surgery could be performed. The remaining 17 patients were stabilized from the occiput to C2/3. With respect to outcomes, four (23.5%) patients died postoperatively during their hospital stay, leading to a mortality rate of 31.5%. A total of 10/13 (76.9%) surviving patients had improved neurological outcomes after surgery; six were discharged home.Among the 48 RTAs associated with death at the scene and AOD without cervical spinal cord injury, the most frequent accompanying injuries were brainstem lacerations (65%), injuries to the aorta (48%), and severe injuries to the rib cage, lung, and heart. Polytrauma was the leading cause of death (52%), followed by central regulation failure (42%).

#### Conclusion

AOD is a condition with high mortality and morbidity rates and is still frequently overlooked or diagnosed too late. Therefore, the mechanism of injury, such as high-speed motorcycle accidents, should raise suspicion for AOD. Early surgery (fusion of C0-C2) is essential to stabilize these patients.

## V148

Die Effektivität der täglichen lokalen Antibiotikaspülung mittels epiduraler Saug-Spül-Drainage-Technik bei Spondylodiszitis und isoliertem spinalem epiduralem Empyem: 20 Jahre Erfahrung in einem Wirbelsäulenzentrum

The Efficacy of Daily Local Antibiotic Lavage via an Epidural Suction-Irrigation Drainage Technique in Spondylodiscitis and Isolated Spinal Epidural Empyema: A 20-Year Experience of a Single Spine Center

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#### Objective

Various treatment modalities are available for local antibiotic therapy in spondylodiscitis (SD) and isolated spinal epidural empyema (ISEE), but there is no evidence-based recommendation. We evaluated the efficacy of epidural suction-irrigation drainage (ESID) over 20 years on disease progression and outcome.

#### Methods

Detailed demographic, clinical, imaging, laboratory, and microbiological characteristics were examined in our cohorts of 208 SD and ISEE patients treated with and without ESID at a university spine center in Germany between 2002 and 2022. Between-group comparisons were performed to identify meaningful differences for the procedure.

#### Results

We included data from 208 patients (142 SD, 68.3% vs. 66 ISEE, 31.7%) of whom 146 were ESID patients (87 SD, 59.6% vs. 59 ISEE, 40.4%) and 62 were NON-ESID patients (55 SD, 88.7% vs. 7 ISEE, 11.3%). ESID patients with SD showed more frequent SSI (ESID: 22, 25.3% vs. NON-ESID: 3, 5.5%, p = 0.003), reoperations due to empyema persistence or instability (ESID: 37, 42.5% vs. NON-ESID: 12, 21.8%, p = 0.012), and a higher relapse rate (ESID: 21, 37.5% vs. NON-ESID: 6, 16.7%, p = 0.037) than NON-ESID patients with SD. The success rate in NON-ESID patients with SD was higher than in ESID patients with SD (ESID: 26, 29.9% vs. NON-ESID: 36, 65.6%, p < 0.001). Multivariate binary logistic regression analysis showed that ESID therapy (p < 0.001; OR: 0.201; 95% CI: 0.089-0.451) was a significant independent risk factor for treatment failure in patients with SD.

#### Conclusion

Our retrospective cohort study with more than 20 years of experience in ESID technique shows a negative effect in patients with SD in terms of surgical site infections and relapse rate.















## V149

#### Gutartig oder aggressiv? Das Verständnis von spinalen Melanozytomen im Vergleich zu malignen Melanommetastasen

Benign or Aggressive? Understanding Spinal Melanocytomas in Comparison to Malignant Melanoma Metastases

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#### Objective

Spinal melanocytic tumors are rare entities of the spine and so far, little is known about their clinical course and aggressiveness. This study aimed to consolidate multicenter data to better understand the biology and course of these exceptionally rare melanocytomas (MC) and compare them with those of malignant melanoma metastases (MMM).

#### Methods

We retrospectively analyzed data from 56 patients with intradural or intramedullary spinal melanocytic tumors (2010–2024) from seven neurosurgical university hospitals. The clinical, radiological, histological, and surgical features were analyzed. Univariate and multivariate analyses were performed to identify the prognostic risk factors.

#### Results

The study included 22 patients with MC and 34 with spinal MMM. The median age was similar between the two groups (61 vs. 58 years, p=0.09). Preoperatively, patients with melanocytomas (MC) experienced a significantly longer duration of symptoms than those with MMM (13 vs. 1.3 months, p=0.0001). The intramedullary location was more frequent in MC than in MMM (72.7% vs. 2.9%, p<0.0001). Gross total resection was achieved in 40.9% of MC cases and 61.8% of MMM cases (p=0.07), with stabilization procedures being more often required for MMM (p=0.0022). Ki-67 proliferation index was significantly higher in MMM than MC (26.70 vs. 6.66, p<0.0001). Postoperative deficits were more common in MCs than in MMMs (54.6% vs. 14.7%, p=0.002), whereas postoperative improvement was observed more frequently in MMMs (64.7% vs. 22.7%, p=0.001). Specifically, we identified significantly more postoperative ataxia in MCs patients (36.4% vs. 11.8%, p=0.04). However, during the long-term follow-up, no significant difference was found in the McCormick scale scores (p=0.4985). Additionally, MMM required more adjuvant therapy (88.2% vs. 31.8%, p=0.001) and local recurrence was slightly more frequent in MMM than in MC (26.5% vs. 14.7%, p=0.31). Furthermore, the mortality rate was significantly higher in the MMM group (41.2% vs. 4.5%, p=0.06).

#### Conclusion

Our study demonstrates that despite being considered a benign tumor, melanocytoma (MC) carries a significant risk of postoperative neurological deficits. Furthermore, gross total resection was achieved in only 40% of the cases, underscoring the locally infiltrative nature of these tumors and their potential for semi-benign biology.

## RC049

Kooperatives duales Robotersystem Minaro: Eine Usability-Studie zur Roboter-unterstützten lumbalen Hemilaminektomie

Cooperative Dual Robotic System Minaro: A Usability Study on Robot-Assisted Lumbar Hemilaminectomy

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#### Objective

Robotics is becoming increasingly important in spinal surgery, but it is currently utilized by only a minority of spine centers. A common concern is the potential loss of control to robotic technology. Many existing commercial robotic solutions use large robotic arms, which occupy significant space and pose safety risks when in contact with patients or operating room personnel. To address these limitations, we developed a modular, cooperative dual robotic system (DRS), consisting of an ultra-lightweight carrier robot for coarse pre-adjustment and small, highly dynamic, application-specific, and interchangeable tool robots.

#### Methods

A formative usability study was conducted with N = 10 neurosurgeons to evaluate the usability of this novel cooperative robotic system in the context of lumbar hemilaminectomy. The participants performed three experiments with the robotic system: pre-positioning using the carrier robot and milling on both a block phantom and a spinal model.

#### Results

All neurosurgeons successfully performed a simulated hemilaminectomy on a spinal phantom using the robotic system. On average, they rated the usability of the first prototype as good to excellent (System Usability Score exceeding 75%). Eight out of ten participants preferred robotic-assisted milling over manual milling. For prepositioning, the developed haptic guidance demonstrated significantly higher effectiveness and efficiency compared to visual navigation.

#### Conclusion

The innovative dual robotic system has the potential to enhance safety, effectiveness, and efficiency in the operating room through its synergistic hands-on control and the ultra-lightweight design of the carrier robot. The modular design enables easy adaptation to various surgical procedures. However, improvements in the ergonomics of the tooling robot and the complexity of virtual fixtures are necessary.

## V150

Komplikationen und Risikofaktoren bei C1-2-Frakturoperationen Complications and Risk Factors in C1-2 Fracture Surgery

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#### Objective

C1 and C2 vertebral fractures pose significant challenges due to the intricate anatomy and biomechanics of the upper cervical spine. Surgical intervention is frequently necessary to restore stability and safeguard neurological function, yet it is accompanied by a notable risk of complications. This study explores inpatient complications, uncovers key risk factors, and proposes strategies for optimizing outcomes based on an extensive review of patient data over ten years.

#### Methods

A retrospective cohort analysis was conducted on 130 patients who underwent surgical treatment for C1-2 fractures between 2012 and 2022. Data collected included patient demographics, clinical comorbidities, injury characteristics, and treatment details. Complications were categorized as major or minor, encompassing both surgical and non-surgical adverse events occurring during hospitalization. Statistical analyses were conducted to identify predictors of adverse outcomes, emphasizing both modifiable risk factors and inherent patient characteristics.

#### Results

This study evaluated 130 patients (mean age 69.4 ± 17.6 years, 52.3% female) who underwent surgery for C1-2 fractures. Of these procedures, 86.2% involved rigid stabilization. Overall, 43% of patients developed complications, with 25.3% experiencing major events, including respiratory insufficiency requiring tracheotomy (15.4%), wound debridement (4.6%), and iatrogenic pneumothorax (4.6%). Minor complications included postoperative delirium and pneumonia (4.6% each), as well as dysphagia (3.8%). Simple logistic regression identified operation time as a significant risk factor for complications, with an odds ratio of 1.006 (95% CI: 1.001–1.012, p=0.025). Chi-square and Mann-Whitney tests revealed significant associations with complications for the following factors: body mass index (BMI) (p=0.065), hypertension (p<0.001), polytrauma (p<0.003), and extensive spinal stabilization (involving  $\geq$  levels) (p<0.001).

#### Conclusion

C1-2 fracture surgery involves significant risks, particularly in patients with prolonged operative times, hypertension, or polytrauma. While factors like BMI and injury severity are non-modifiable, preoperative optimization and tailored perioperative care can reduce complications. Attention to non-surgical issues, such as respiratory insufficiency and postoperative delirium, is also crucial. These findings emphasize the importance of individualized surgical strategies and vigilant perioperative management to improve patient outcomes.

## RC050

Ergebnisse der chirurgischen Behandlung von osteoporotischen Wirbelfrakturen: Eine prospektive Studie Outcomes of Surgical Management for Osteoporotic Vertebral Fractures: A prospective Study

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#### Objective

Osteoporotic vertebral fractures are a common finding in patients with osteoporosis. Around the world, almost 200 million people suffer from osteoporosis, with the disease having a higher incidence in older people and women. Approximately one in three women and one in five men over the age of 50 will suffer an osteoporotic fracture. Globally, more than 500,000 vertebral fractures occur each year. This study aims to describe the clinical, demographic, and radiological characteristics of patients with osteoporotic vertebral fractures and assess surgical outcomes.

#### Methods

A prospective study of 63 patients diagnosed with osteoporotic vertebral fractures, treated between January 2020 and December 2023. Demographic, clinical and radiological data were collected. The fractures were classified using the AO Spine system. Patients were treated with cementation or arthrodesis techniques, as indicated. Functional assessment was carried out using the Oswestry Disability Index (ODI) pre- and post-operatively (30 days). The results were compared using statistical tests, considering p<0.05 to be significant.

#### Results

Of the 63 patients, 46 were female (73%) and 17 were male (27%). Ages ranged from 38 to 91, with 60% of the patients aged between 61 and 80. Falls from their own height were the main cause of fractures (85%), followed by car accidents (7%). Most injuries occurred in the lumbar region (65%), with L1 being the most affected vertebra (32%), followed by T12 (16%) and L5 (32%). The most common fractures were A1 fractures (49%), followed by A4 fractures (33%), A3 fractures (14%) and A2 fractures (1.5%). The majority, 71%, of the patients underwent cementing treatments, and the other 29% underwent arthrodesis. The preoperative Oswestry ranged from 26 to 77, with an average of 38.9. At 30 days post-surgery, the value of this index had improved by an average of 20 points, with this variation being statistically significant (p<0.05), indicating significant functional improvement.

#### Conclusion

Osteoporotic vertebral fractures are common, especially in elderly women, and tend to increase as the population ages. However, treatment with arthrodesis and cementing techniques, such as kyphoplasty and vertebroplasty, provides good clinical results, with significant improvement in pain and functionality.

## V151

# Auswirkung unbeabsichtigter Kopfbewegungen auf die Neuronavigation während der Nutzung von Kopffixationssystemen

Effect of unintended head movement on neuronavigation using a head fixation device

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#### Objective

Unintended head movement (slippage) using a head fixation device (HFD) may lead to injuries [1], [2]. A reduction in target registration error (TRE) has been observed during neurosurgical procedures [3]. We quantified the resistance of different head positions against external forces using HFDs and their impact on slippage, which could influence TRE.

#### Methods

Three 3D-printed head phantoms (4.3 kg each) were equipped with navigation tracker (phantom tracker). An additional tracker was directly placed on HFD (HFD tracker) as known in OR workflow. We analyzed the following head positions: supine 0°, prone 0° and 60° rotated, using a standard HFD with a pin force of 270 N. A force actuator with a measurement system applied force until slippage (n=12 per position). This application simulated external forces during operational workflow such as trephination. A stereoscopic camera detected shifted distance of phantom after applied force.

#### Results

We observed an average force until slippage of 806 N (SD: 35 N) for supine 0° and a significant lower force p=0.02 with M: 573 N (SD:132 N) for prone 0° and  $p=2\times10^{-6}$ , M: 438 N (SD:57 N) for prone 60° compared with bifrontal (Fig. 1). Average shifted distance of phantom was 0.80 mm (SD: 0.64 mm) for supine 0° and significantly higher (p=0.03) with M: 2.47 mm (SD:1.89 mm) for prone 0° and  $p=1\times10^{-4}$  with M: 5.25 mm (SD: 4.72 mm) for prone 60° compared with supine 0° (Fig. 2). No major shifts were observed on HFD tracker.

Fig 1.: Maximum applied force until slippage (n=12).

Fig 2.: Shifted distance (slippage) of head phantom within HFD using phantom tracker (n=12).

#### Conclusion

We identified three major points:

- 1. Hidden slippage may increase TRE.
- 2. Supine 0° has highest resistance against external forces.
- 3. Prone 60° has lowest resistance against external forces.

Experiments with cadaveric specimens will follow to verify the points.

[1] U.S. Food and Drug Administration. *Neurosurgical Head Holders (Skull Clamps) and Device Slippage: FDA Safety Communication*. 2016

[2] Sakakura K, Fujimoto A, Ishikawa E, Enoki H, Okanishi T. Intraoperative head slippage with the head clamp system can occur during epileptic surgery. *World Neurosurg.* 2020.

[3] Stieglitz LH, Fichtner J, Andres R, Schucht P, Krähenbühl AK, Raabe A, Beck J. The silent loss of neuronavigation accuracy: a systematic retrospective analysis of factors influencing the mismatch of frameless stereotactic systems in cranial neurosurgery. Neurosurgery. 2013



Abb. 1

Abb. 2



## V152

Arbeitsbelastung und Krankheitsmuster in einer universitären Neurochirurgie: Eine vergleichende Analyse zwischen Berufsgruppen Workload and Sick Leave Patterns in a University Neurosurgical Department: A Comparative Analysis Across Professional Groups

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#### Objective

This study investigates the workload and its potential correlation with sick leave patterns among residents, specialists, and consultants in a university neurosurgical department. The aim was to evaluate the impact of overtime on health and explore differences in workload dynamics across professional groups.

#### Methods

Retrospective workload and sick leave data from January 1, 2023, to December 31, 2023, were analyzed. Weekly working hours were calculated based on regular shifts, weekend shifts, and on-call duties. Statistical analyses assessed correlations and temporal relationships between overtime and sick leave occurrences.

#### Results

Residents reported the highest frequency of sick leaves, averaging 4.5 days annually, compared to specialists (1.6 days) and consultants (1.2 days). A strong correlation (r>0.98) was observed between overtime and sick leave for residents, with sick leaves typically occurring 2.38 days after overtime. Sick leaves among residents were preceded by an average of 1.74 hours of overtime in the prior week. No significant correlation between overtime and sick leave was found for specialists and consultants.

Residents and specialists averaged 60.5 hours per week, including regular shifts, weekend shifts, and formal oncall duties (Bereitschaftsdienste). Consultants worked 68.5 hours per week, primarily through regular hours and weekend shifts, and performed on-call availability (Rufbereitschaften) rather than formal on-call duties. Despite similar schedules for residents and specialists, residents showed greater vulnerability, potentially due to differences in experience, coping mechanisms, or task demands during on-call duties.

#### Conclusion

The results highlight distinct workload effects on health across professional groups. Residents are particularly vulnerable to acute workload surges, suggesting a need for targeted interventions, such as shorter shifts and additional support during on-call duties. Specialists and consultants, less impacted by immediate workload stressors, may benefit from strategies addressing chronic stress and optimizing long-term workload distribution. Tailored approaches are essential to promote sustainability and well-being in neurosurgical teams.

## V153

Postoperative Nebenwirkungen bei Verwendung künstlicher Duraersatzmaterialen im Rahmen der dekompressiven Hemikraniektomie Surgical side effects on the usage of artificial dural substitutes in decompressive hemicraniectomy

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#### Objective

Decompressive hemicraniectomy (DHC) is a treatment option in refractory ICP elevation in cerebral infarction, hemorrhage and traumatic brain injury. Several operative techniques regarding musculocutaneous, bony and dural exposure exist. The technique of dural closure by expanding duraplasty with and without artificial dural substitutes still remains unclear with the focus on the occurence of postoperative surgical side effects.

#### Methods

A total of 258 patients (mean age 52.8  $\pm$  16.7 years; 140 male, 118 female, 79 infarctions, 57 traumatic brain injuries, 55 subarachnoid hemorrhages, 32 intracranial hemorrhages, 30 subdural hematomas, 5 other indications) who underwent DHC between 2015 and 2024 at our institution were reviewed. Complete clinical and radiological data were available for all patients. The patient population was divided into two groups: **Group A**: 201 patients who received the artificial dural substitute Lyoplant (Aesculap), **Group B**: 57 patients who did not receive a dural substitute.

#### Results

Baseline demographics (age, gender, underlying pathology) were comparable in both groups. No significant differences were found related to the duration of DHC surgery (A vs. B: 102.0 vs. 108.0 min; p = 0.26), postoperative CSF leakage (A vs. B: 3.5% [7/201] vs. 3.6% [2/55]; p = 0.99), postoperative shunt dependency (A vs. B: 17.7% [35/198] vs. 16.4% [9/55]; p = 0.99), postoperative bleedings (A vs. B: 7.1% [7/198] vs. 5.5% [3/55]; p = 0.99) or postoperative wound infections (A vs. B: 7.1% [14/198] vs. 1.8% [1/55]; p = 0.20). Cranioplasty was performed in 55.8% (110/197) of the patients receiving Lyoplant and in 44.4% (24/54) of the patients without dural substitute. The use of Lyoplant had no significant effect on the duration of cranioplasty surgery (114.2 vs 117.6 min; p = 0.72) and cranioplasty results, but the combined infection rate among DHC surgery and cranioplasty showed a trend for increased infection rates in patients which received Lyoplant (A vs. B: 11.6% [23/198] vs. 3.5% [2/57]; p = 0.08).

#### Conclusion

In our study we could show that there is no statistical significant difference for the use of artificial dural substitutes for the prevention of postoperative CSF fistulas and for the need of permanent shunt implantation after decompressive hemicraniectomy. Noteworthy we could detect a trend to higher postoperative infectious complications using artificial dural substitutes.

## RC051

Der Wert der frühen postoperativen Bildgebung nach elektiven kraniellen Eingriffen. *The Value of Early Postoperative Imaging After Selective Cranial Procedures.* 

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#### Objective

Routine early postoperative cranial computer tomography is common practice to detect potential complications early. However, there is increasing debate about whether this approach is necessary in all cases, especially for stable patients without clinical abnormalities.

#### Methods

A retrospective analysis of documented data from medical records has been conducted. Included were patients who underwent elective cranial procedures from November 2023, to October 2024, in a tertiary neurosurgical department.

#### Results

78 consecutive patients were analyzed (48,7% women, 51,3% men, 22-91 years old). 44,9% had intraaxial lesions, 29,5% extraaxial lesions, 5,1% a vascular lesion and 20,5% had hydrocephalus. 66,7% of the patients received postoperative cranial CT scan (mean time to imaging 22,6  $\pm$  5 hours), 23,1% thereof ultra-early due to unforeseen clinical factors (mean time to imaging 11,4  $\pm$  12,2 hours).

In 56,9% of the imaging there were no specific pathologic findings. In 43,1% there were signs of a postoperative hemorrhage, localized extraaxialy (18,2%) or intraaxially (81,8% - mean volume 7,9ml). Of those with pathological CT findings, only in 13,6% (n=3) was it space occupying or symptomatic (mean volume: 41,3ml) necessitating further intervention. The mean time to imaging for those patients was 2,58 hours postoperatively. One further patient, without early imaging, showed a delayed clinical deterioration and underwent a CT-scan 70,4 hours postoperatively, which demonstrated a space occupying hemorrhage necessitating reoperation.

Median postoperative ICU/IMC as well as overall hospital stay were not significantly different in the patients with and without early postoperative imaging (1,08 vs 1,04 days in the ICU/IMC [p= 0,30] and 12,0 vs 13,1 days overall [p=0,80] respectively). The mean effective dose of the exposure due to the ionizing radiation in the patients with postoperative imaging was 1,51mSv.

#### Conclusion

The presented data do not support the value of routine postoperative imaging after selective cranial neurosurgery, as in most cases, the possible abnormal findings do not lead to intervention. In those cases where an intervention is indeed needed, imaging is usually performed sooner, as dictated by the clinical state of the patient.

## RC052

Evaluation von Resting Motor Thresholds von oberer und unterer Extremität bei Patienten mit malignen Hirntumoren unter Zuhilfenahme von navigierter transkranieller Magnetstimulation Evaluating resting motor thresholds of upper and lower limb extremity muscles in patients with malignant brain tumors using navigated transcranial magnetic stimulation

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#### Objective

Navigated transcranial magnetic stimulation (nTMS) is a commonly used tool to evaluate the motor status of patients with intracranial tumors. The resting motor threshold (rMT) is one key parameter in nTMS motor mapping. Factors which contribute to alterations in rMT of upper and lower limb muscles are not fully investigated yet.

#### Methods

Patients with histologically confirmed gliomas or cerebral metastases undergoing bilateral nTMS mapping for motor function (Nexstim NBS 5, Nexstim Oy, Helsinki, Finland) were evaluated.

Clinical examinations, imaging studies, histopathology, nTMS examinations and tractography were analyzed. We evaluated factors which contributed to alterations in motor thresholds for the upper and lower limb. An intrahemispheric ratio between the rMT of the upper and the lower limb muscles for both hemispheres was calculated as (rMT lower limb/rMT upper limb)\*100.

#### Results

65 patients were evaluated, mean age was 59.4 years and 30 (46.2%) were female. 17 (26.2%) had cerebral metastases, 34 (56.3%) glioblastomas, 6 (9.2%) gliomas CNS WHO grade 3 and 8 (12.3%) gliomas WHO CNS grade 2.

The mean rMT of the lower limb was 170% of the rMT of the ipsilateral hand muscle on the tumor hemisphere and 184% of the rMT of the ipsilateral hand muscles of the non-affected hemisphere.

The intra-hemispheric ratio inversely correlated with the rMT of the upper limb (rs=-0.32, p=0.009 for the affected hemisphere and rs=-0.36, p=0.003 for the non-affected hemisphere). On the contrary, the intra-hemispheric ratio correlated with the rMT of the lower limb (rs=0.56, p=0.001 for the affected hemisphere and rs=0.36, p=0.004 for the non-affected hemisphere). The intra-hemispheric rMT-ratio inversely correlated with the size of the lesion (rs=-0.35, p=0.005), but was not altered in concerns of different tumor histology, motor status or tumor location. Intra-hemispheric rMT ratios showed moderate correlation between both hemispheres (rs=0.31, p=0.012)

#### Conclusion

The ratio between motor thresholds of upper and lower limb muscles within one hemisphere remains stable in most tumor patients and is mostly affected by patient-individual alterations in rMT and the size of the tumorous lesion.

## RC053

Konfokale Laser-Endomikroskopie zur intraoperativen-Visualisierung und Charakterisierung von intrakraniellen Aneurysmen

Confocal laser endomicroscopy for real-time visualization and characterization of intracranial aneurysms during surgical clipping

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#### Objective

Confocal laser endomicroscopy (CLE) offers high-resolution, real-time imaging enabeling visualization of tissue microarchitecture and clinical systems are able to address tissue autofluorescence (AF). Investigations on tissue sections of intracranial aneurysms proved that AF visualizes the hallmarks of vessel wall remodeling (Sehm et al, Sci Rep. 2020;10(1):12359). This study aims to investigate the feasibility of CLE as a real-time imaging tool for the visualization of microstructural features of intracranial aneurysms during surgical clipping.

#### Methods

CLE was performed during aneurysm clipping procedure in seven patients (MCA n=5, A. pericallosa n=1, PICA n=1). AF imaging was performed on the aneurysm wall, the transition zone and adjacent vasculature using a fiber-optic CLE probe and 488 nm excitation. Z-stacks spanning 70-200  $\mu$ m were acquired. Reference histology and AF microscopy was performed on resected aneurysm domes (n=4).

#### Results

In normal regions of the arteries, the tunica adventitia was identified by the characteristic diffuse AF signal of collagen while the external elastic lamina showed more intense and fiber-like AF of elastin. The tunica media was visualized ~80  $\mu$ m beneath and presented with a patchy AF pattern. The penetration depth was limited to maximal 120  $\mu$ m, and restricted imaging to superficial layers. Movement artifacts caused by pulsation and intraoperative handling, along with weak signal intensity, strongly impacted image quality and interpretability. As a consequence, detection of all three layers was possible in only one of the seven cases investigated. CLE imaging of aneurysms showed interspersed strong punctuate AF signal in the tunica adventitia which was confirmed by ex vivo AF microscopy. No AF signal of elastin of the external elastic lamina was detected. Clusters of strong AF were visualized in four cases, representing cells or calcifications in comparison to reference histology.

#### Conclusion

Label-free CLE allowed intraoperative, in situ visualization of histopathological aspects of the intact and pathological vessel wall. Current technical limitations, such as restricted penetration depth, motion artifacts, and weak signal intensity need to be addressed before it can be used as real-time intraoperative tool. Conceptually, in situ AF imaging holds great promise for comprehensive visualization of the entire vessel wall. This might enable surgeons to adapt to individual aneurysm morphology, therefore minimizing risk of intraoperative rupture.

## RC054

Verbesserte Verfügbarkeit der Fluoreszenz-gestützten Resektion maligner Gliome: ein Kopflampen-Lupenbrillensystem mit generischem 5-ALA ersetzt das Mikroskop. Eine monozentrische Machbarkeitsstudie Improved availability of fluorescence guided surgery of malignant brain tumors: a headlamp-loupe system combined with generic 5-ALA replaces the microscope. A monocentric feasibility study

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#### Objective

5-ALA based fluorescence guided surgery (FGS) is an important adjunct in neurooncological surgery. Until recently, a prerequisite for FGS was the use of a specialized microscope. With the availability of a system, that combines surgical loupes with an FGS enabled-headlamp, the standard approach to FGS of gliomas is challenged. We therefore investigated the potential change in practice of FGS for gliomas, if the surgeon had the choice between both systems.

#### Methods

Patients in this consecutive case series study were included in a time period from August 2023 to December 2024. All patients with a lesion indicating FGS were included. Surgery was performed by three specialized neurooncological neurosurgeons (>1000 glioma surgeries as lead neurosurgeon), who were provided with a headlamp-loupe system (HLLS) consisting of a 5-ALA headlamp and surgeon adapted loupes (3.5X, customized fitted, Designs for Vision, USA). A prerequisite for the inclusion was unrestricted availability of HLLS and the surgical microscope (Zeiss Kinevo) at the time of the planning and execution of the procedure. We recorded the choice between both methods and semiquantified the statements 1. "superior visualization of HLLS vs microscope regarding white light and PpIX signal",2. "superior handling of HLLS vs microscope" and 3. "no disadvantage of HLLS vs micr. In one case specifity and sensitivity of various PpIX fluorescence (PpIX-f) detected by the HLLS but not by microscope were histopathologically evaluated. 5-ALA HCl was supplied as a preparation by the Hospital Pharmacy (Chiracon GmbH, distributor Caesar & Lorenz GmbH).

#### Results

We report 206 procedures in 198 patients. The central finding of our study is, that the surgeons opted in 194 (94%) of the cases for the HLLS and did not switch from HLLS to microscope. All surgeons agreed to statement 1-3. The 3 biopsies taken from areas with negative-faint- and highly positive PpIX-f as revealed by the HLLS but not by the microscope correspond to normal brain tissue (negative PpIX-f), infiltration zone (faint PpIX-f) and highly cellular tumor tissue with microvascular proliferation (strong PpIX-f) of Glioblastoma, IDH-wt.

#### Conclusion

Our centre changed the practice of FGS by switching from microscopes to loupes. Our experience might have an important impact on the general use and availability of FGS, as the HLLS and the in-house preparation of 5-ALA come at a fraction of the costs of the commonly practiced approach.

# Neurotrauma und Intensivmedizin 2 | Neurotrauma and intensive care medicine 2

## V154

Postoperative prolongierte mechanische Beatmung als Prädiktor für die innerklinische Mortalität bei der Chirurgie des chronischen Subduralhämatoms Postoperative prolonged mechanical ventilation as a predictor of in-hospital mortality in surgery for chronic subdural hematoma

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#### Objective

Burr hole trepanation is a common surgical procedure for treating symptomatic chronic subdural hematomas (cSDH). However, in elderly patients with increasing comorbidity burden, surgical intervention may necessitate prolonged postoperative intensive care, potentially offsetting its intended benefits. Postoperative prolonged mechanical ventilation (PMV) may serve as an early surrogate marker for prolonged intensive care management and its potential impact on patient outcomes. This study aimed to evaluate the relationship between PMV and in-hospital mortality in patients with cSDH.

#### Methods

Between 2015 and 2020, 283 consecutive patients underwent burr hole evacuation for cSDH at the authors" institution. PMV was defined as ventilation lasting more than 24 hours postoperatively. Preoperative neurological severity was assessed using the Markwalder grading scale (MGS), with the Charlson Comorbidity Index (CCI) serving to quantify comorbidity burden at admission. Radiological SDH characteristics, such as bilateral presence, septation, and midline shift, were collected. A multivariable regression analysis was performed to identify pre- and early postoperative predictors of in-hospital mortality in patients with cSDH.

#### Results

PMV occurred in 15 of 283 patients (5%) with surgically treated cSDH. The median age of the entire study cohort at the time of surgery was 79 years (interquartile range [IQR] 73–85), with a median CCl of 5 (IQR 3–6). Inhospital mortality was observed in 8 of 15 patients with PMV (53%) compared to 5 of 268 patients without PMV (2%) (p < 0.001). No significant differences were found in MGS scores at admission, preoperative CCl, or radiological findings between patients with and without PMV. Multivariable analysis identified PMV as a significant and independent predictor of in-hospital mortality (p < 0.0001, OR 0.02, 95% Cl 0.004–0.06).

#### Conclusion

This study highlights PMV as a previously unrecognized risk factor for in-hospital mortality in patients with cSDH. Assessing the risk of PMV prior to initial burr hole evacuation may aid in optimizing treatment strategies and guiding discussions with patients and their families.

# Neurotrauma und Intensivmedizin 2 | Neurotrauma and intensive care medicine 2

## V155

KEPPRA: Radiomics-gestützte Epilepsievorhersage bei akuten Subduralhämatomen vor Kraniotomie KEPPRA: Key Epilepsy Prognostic Parameters with Radiomics in aSDH Before Craniotomy

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#### Objective

Acute subdural hematoma (aSDH) carries a significant risk of epilepsy, a serious complication that often results in poor outcomes for patients. Despite advancements in neuroimaging and surgical techniques, current methods for predicting epilepsy risk remain limited. Craniotomy is a well-known risk factor for epilepsy, with an incidence of approximating 25%. This study investigates whether radiomic features derived from preoperative CT scans can assess epilepsy risk in patients undergoing craniotomy for aSDH.

#### Methods

We conducted a retrospective analysis of 178 adult aSDH patients treated at our institution between 2016 and 2022. Of these, 64 patients who underwent craniotomy met the inclusion criteria. Radiomic features, including Feret diameter, elongation, sphericity, flatness, surface area, and volume, were extracted from preoperative CT scans acquired within 24 hours prior to surgery. Additional variables, such as comorbidities, pupillary response, SOFA score, age, and anticoagulation status, were also analyzed. Statistical evaluations were conducted to assess the predictive value of these parameters for epilepsy risk.

#### Results

Among the 64 craniotomy patients, 18 (28%) developed generalized seizures. Univariate analysis identified significant associations with Feret diameter (p = 0.045), elongation (p = 0.005), cardiac comorbidities (p = 0.042), and SOFA scores (p = 0.036). ROC analysis demonstrated an AUC of 0.645 for Feret diameter and 0.728 for elongation. In the multivariate analysis, preoperative elongation remained a significant predictor of generalized seizure risk (p = 0.003). Patients with a preoperative elongation >1.45 had a 7.78-fold increased risk of generalized seizures (OR = 7.778; 95% CI = 1.969–30.723).

#### Conclusion

Radiomic features derived from preoperative CT scans, particularly elongation, may serve as valuable predictors of epilepsy risk in patients with acute subdural hematoma undergoing craniotomy. Further validation in larger, prospective cohorts is warranted to confirm their clinical utility.
## BO-05

### Ergebnisse der europäischen Kranioplastieumfrage A shift to alloplastic cranioplasty in Europe – results from the European cranioplasty survey

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### Objective

Cranioplasty, a surgical procedure to restore skull integrity and aesthetic contour following decompressive craniectomy, poses challenges in material selection and timing, driven by the lack of guidelines and ongoing regulatory changes. This study aimed to provide an overview of current cranioplasty preferences and practices in Europe, specifically addressing a potential shift towards alloplastic materials and the management of patients with concomitant hydrocephalus.

### Methods

An online survey was conducted among European neurosurgical centers from January to March 2024, collecting data on material preferences, timing of procedures, and management strategies for cranioplasty. Descriptive and statistical analyses were performed on 110 complete responses.

### Results

Respondents favored alloplastic materials over autologous bone for cranioplasty, citing regulatory constraints and reduced infection risk as primary reasons. Centers have become increasingly aware of the regulatory burden associated with autologous bone flap storage and its medicolegal implications. In pediatric patients, a higher number of centers still preferred autologous cranioplasty. Variability was observed in the timing of procedures and the management of patients with hydrocephalus, with most centers adopting staged approaches.

### Conclusion

The shift towards alloplastic materials in cranioplasty observed here likely reflects regulatory pressures rather than material-specific considerations. In light of the high variability in practice, our findings underscore the need for standardized guidelines and further research to optimize patient outcomes. This study provides valuable insights into current practices and highlights areas for future investigation in cranioplasty.

## RC055

Behandlung des chronischen Subduralhämatoms mit oder ohne Embolisation der Arteria meningea media. Treatment of chronic subdural hematoma with or without endovascular embolization of the middle meningeal artery. A single center experience.

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### Objective

Chronic subdural hematoma (CSDH) is an increasingly relevant pathology with an incidence of up to 20/100.000. Surgical evacuation either via burr hole or craniotomy is the standard treatment of CSDH if mass effect or neurological symptoms occur. CSDH can be complicated by recurrent hematoma in up to 20% or the dilemma of oral anticoagulation/antiplatelet drugs that are often prescribed in the elderly patient population. Recently, endovascular embolization of the middle meningeal artery (MMA) was proposed to reduce the recurrence rate of CSDH. Aim of this study is to compare the postinterventional adverse events and outcome in patients undergoing surgery with or without consecutive MMA embolization.

### Methods

We performed a retrospective single center analysis of patients undergoing evacuation of CSDH with or without MMA embolization. Age, functional status, adverse events (AE) according to the Clavien-Dindo grading (CDG), the Charlson comorbidity index (CCI), the Markwalder score, length of hospitalization and the recurrence rate were compared.

### Results

77 patients received in total 108 interventions (MMA-embo n=42, no-embo n=66). Patients receiving MMA embolization had significantly lower CSDH recurrence rates (n=4 vs n=21; p<0.01) compared to patients receiving surgery alone. This resulted in a number needed to treat (NNT) of 4 in favor of MMA embolization to avoid recurrence of CSDH. No difference in the rate of AE (p=0.09) or revision surgery (p=0.36) was found. Patients undergoing re-do surgery had significantly lower levels of rheologic medication and lower recurrence rates than patients at the initial surgery.

### Conclusion

Our results indicate that MMA embolization can be helpful to prevent recurrence in CSDH with a NNT of 4. However, the rate of revision surgery and adverse events (including recurrent hematoma) do not indicate a higher periprocedural risk than for surgery alone.

## RC056

Postoperativer Pneumozephalus als Prädiktor für das Rezidiv eines chronischen subduralen Hämatoms: Eine retrospektive Kohortenanalyse Postoperative Pneumocephalus as a Predictor of Chronic Subdural Hematoma Recurrence: A Retrospective Cohort Analysis

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### Objective

Chronic subdural hematoma (CSDH) is a common neurosurgical condition in the elderly, typically diagnosed by a cranial CT scan and treated surgically. Burr-hole craniotomy with closed-system drainage is the standard approach, though recurrence rates range from 0.35% to 33%, often requiring additional surgeries. Postoperative pneumocephalus is a potential risk factor for recurrence. This study examines the prognostic significance of postoperative pneumocephalus, defining a relevant volume threshold of postoperative pneumocephalus in comparison to other patient-specific factors in predicting recurrence and repeat surgeries.

### Methods

This retrospective study analyses clinical data from 229 patients with chronic subdural hematoma (CSDH) who underwent burr-hole craniotomy with drainage between 2016 and 2021. Beside the measurement of postoperative pneumocephalus, it evaluates factors such as age, gender, CSDH location (unilateral or bilateral), anticoagulation therapy, neurosurgical outcomes, hospital readmissions, and repeat surgeries. Continuous data were presented as mean ± standard deviation, and categorical variables as absolute and relative frequencies. An unpaired two-tailed t-test analysed continuous data, while Fisher''s exact test was used for categorical data. ROC analysis assessed the association between postoperative pneumocephalus and recurrence, with Youden's J statistic identifying the optimal cut-off. P-values <0.05 were considered significant.

### Results

The final analysis included 229 patients, of whom 47 (20.5%) experienced symptomatic recurrent subdural hematoma necessitating reoperation. Postoperative pneumocephalus exceeding a defined volumetric threshold of 5.2 cm3 was identified as the only significant predictor of CSDH recurrence. This recurrence was also linked to a notable increase in hospitalization duration, highlighting its clinical and logistical impact.

### Conclusion

Postoperative pneumocephalus is almost unavoidable. However, optimizing surgical techniques to limit its volume to less than 5.2 cm<sup>3</sup> significantly reduces the recurrence rate.

## V156

Outcome nach spontaner Subarachnoidalblutung vor und nach Einführung der kontinuierlichen intraarteriellen Vasospasmolyse

Outcome after spontaneous subarachnoid hemorrhage before and after introduction of continuous intraarterial vasospasmolysis

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### Objective

In patients with delayed cerebral ischemia (DCI) after spontaneous subarachnoid hemorrhage (SAH) that does not respond to induced hypertension, endovascular therapy of cerebral vasospasms is an option to improve cerebral perfusion. In our center, continuous intra-arterial vasospasmolysis with nimodipine (ciaN) has been introduced as the standard endovascular therapy for cerebral vasospasms since 2016. Previously, angioplasties and single shot intra-arterial nimodipine infusions were performed. The aim of this study was to compare the neurological outcome after SAH in the years before and after the introduction of ciaN.

### Methods

All patients who were treated for SAH in the neurosurgical intensive care unit between 01/2011 and 06/2021 were recorded retrospectively. Inclusion criteria were the availability of clinical outcome data (mRS score) and the availability of a cranial CT scan 14-28 days after SAH onset to detect the occurrence of DCI-associated infarctions.

### Results

Of 479 patients, 292 patients met the inclusion criteria, 145 in the period before (pre-ciaN) and 147 after (postciaN) the introduction of ciaN. While clinical outcome data were available for all patients at the time of discharge, follow-up data were available for 84.1% in the pre- ciaN group and 82.9% in the post-ciaN group. In the pre-ciaN group, 36 patients (24.8%) received endovascular vasospasm treatment, and in the post-ciaN group, 51 (34.7%). There were no significant differences in the occurrence of DCI-associated infarctions. At the time of discharge, there was a trend towards an improved outcome in the post-ciaN group. After 6 months, there was a significantly improved outcome in the post-ciaN group (mRS 0-2, pre-ciaN vs. post-ciaN: 46.7% vs. 60.7%, p=0.0397, Fisher's exact test). This difference was most pronounced in the subgroups of patients treated endovascularly (mRS 0-2, endovascular therapy, pre-ciaN vs. post-ciaN: 36.7% vs. 63.0%, p=0.0345) and patients with an H&H score of 1-3 (mRS 0-2, H&H 1-3, pre-ciaN vs. post-ciaN: 56.0% vs. 78.2%, p=0.0032).

### Conclusion

The outcome after spontaneous subarachnoid hemorrhage has improved since the introduction of ciaN in our center, especially in patients with an H&H score of 1-3. Prospective studies are needed to compare the effect of ciaN in DCI with standard medical therapy.

# V157

*Slit-valve*-Mechanismus bei Arachnoidalzysten der mittleren Schädelgrube: Fallserie und Literaturübersicht *Slit-valve mechanism in middle cranial fossa arachnoid cyst: case series and literature review* 

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### Objective

Arachnoid cysts are well-demarcated, space-occupying lesions filled with cerebrospinal fluid. While many remain asymptomatic, they can cause a range of neurological symptoms when they exert pressure on surrounding brain structures. The most accepted theory for AC formation involves the slitting of the arachnoid with sequestration of CSF, though the expansion mechanism remains debated. This slit-valve mechanism is the main focus of this study.

### Methods

A retrospective analysis of adult and paediatric patients who underwent endoscopic treatment for middle cranial fossa arachnoid cysts under the guidance of the senior author between January 1993 and June 2024 was conducted. In addition, a literature review was performed.

### Results

A total of 131 patients with intracranial arachnoid cysts underwent 139 endoscopic procedures. Among them, 61 patients had arachnoid cysts located in the middle cranial fossa. Surgical videos were available for review in 44 cases. Intraoperatively, a pulsatile membrane covering the middle cerebral artery, forming a slit-valve mechanism, was observed in 31 patients (70.45%). From 61 screened literature articles, 11 met inclusion criteria, detailing 244 cases of slit-valve mechanisms in arachnoid cysts. Most cysts were located suprasellar, with endoscopic treatment being predominant.

### Conclusion

The slit-valve mechanism offers significant insights into the dynamic behaviour and expansion of arachnoid cysts. Recognizing these mechanisms is crucial for accurate diagnosis and effective surgical management, enhancing our understanding of the pathophysiology of arachnoid cysts and guiding clinical care.





# V158

Neurokognitive Effekte von Liquor-Biomarkern bei Patienten mit idiopathischem Normaldruckhydrozephalus unter VP-Shunt Therapie Neurocognitive effects of CSF biomarkers in idiopathic normal pressure hydrocephalus patients undergoing VP Shunt placement

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### Objective

Idiopathic normal pressure hydrocephalus is an increasingly prevalent neurodegenerative condition among the elderly, characterized by the Hakim triad. Accurate diagnosis and prognosis are essential since the symptoms can be reversible with appropriate treatment, such as VP-shunt surgery. This study investigates the relationship between cerebrospinal fluid biomarkers, particularly Tau, Phospho-tau, the beta-amyloid ratio (Aβ42/Aβ40), and neurocognitive outcomes post-surgery.

### Methods

Eighty patients diagnosed with iNPH who underwent shunt placement between November 2021 and July 2023 were included. A comprehensive neuropsychological test battery was administered before, one hour after, and one day after lumbar puncture, and six weeks and three months post-surgery. CSF samples were analyzed for tau, phospho-tau and the beta-amyloid ratio. Neuropsychological tests assessed various cognitive functions, including executive functions, psychomotor speed, language, and memory.

### Results

Patients with a higher beta-amyloid ratio showed significant cognitive improvement post-surgery. Neuropsychological tests, such as the DemTect and Trail Making Test A & B indicated enhanced performance over time, particularly at the three-month follow-up. Conversely, the MMSE did not show significant improvement. The data suggest that the beta-amyloid ratio is a potential prognostic marker for positive neurocognitive outcomes following VP-shunt surgery.

### Conclusion

The beta-amyloid ratio ( $A\beta 42/A\beta 40$ ) is a valuable biomarker for distinguishing iNPH from Alzheimer's disease and predicting cognitive improvement post-surgery. Patients with higher ratios exhibited better neurocognitive outcomes, emphasizing the importance of comprehensive neuropsychological assessments. These findings support the potential of personalized treatment strategies based on biomarker analysis to optimize patient selection and improve outcomes for iNPH patients undergoing VP-shunt surgery.

# V159

Ventilfehlfunktionen bei Liquorshunts: mechanische Probleme oder Anwenderfehler? Cerebrospinal fluid shunt valve malfunctions: mechanical failures or user error?

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### Objective

Advances in cerebrospinal fluid shunt valve technology have come a long way in recent years. Not only have adjustments of valve settings become easier for example, but we also see lower rates of complications like overor underdrainage. Malfunctions of shunt valves due to mechanical failures are supposed to be rare. Here we present data of explanted shunt valves from patients with shunt systems who underwent surgery because of a supposed valve dysfunction, which were sent to the manufacturer for identifying the cause for malfunction.

### Methods

Between 2014 and 2024 a total of 25 analysis reports from the manufacturer of explanted shunt valves were available for evaluation. Those were received and stored electronically. Causes of valve malfunction as supposed by the clinician were compared to those identified by the manufacturer.

### Results

Overall, 19 valves were explanted from children, 6 from adults. Valves included 11 Miethke proGAV, 12 Miethke proGAV 2.0, 1 Miethke proSA and 1 Miethke GAV 2.0. The two prevalent causes for supposed valve dysfunction in children were failure to adjust the valve setting (9/19 valves) and valve occlusion (9/19 valves). Failure to adjust the valve setting was confirmed from the manufacturer in 7/9 cases, in two cases due to deformation of the valve, and in 5 due to protein debris. Occlusion was confirmed in 5/9 cases. The prevalent cause for supposed valve dysfunction in adults was failure to adjust the valve setting (4/6 valves). Only in 2 cases a valve defect resulting in failure to adjust the valve setting was confirmed by the manufacturer, due to protein debris.

### Conclusion

The most prevalent cause for a mechanical valve malfunction in our study was protein debris resulting in failure to adjust the valve setting. Deformation of valves due to user error was only shown in two cases. Furthermore, the fact that most of the explanted valves were from children with post-hemorrhagic hydrocephalus might suggest that protein debris is still a challenge for modern shunt valve technology.

## RC057

Steigende Inzidenz des Normaldruckhydrozephalus in Deutschland: Eine Analyse der Datenbank des Statistischen Bundesamts von 2005 bis 2022 Increasing Incidence of Normal Pressure Hydrocephalus in Germany: An Analysis of the Federal Statistical Office Database from 2005 to 2022

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### Objective

Normal pressure hydrocephalus (NPH) is a reversible cause of gait disturbances and dementia in the elderly, posing diagnostic and therapeutic challenges. In Germany, the epidemiology and surgical management of NPH are not well understood. This study aimed to characterise epidemiological trends and evaluate surgical management strategies for NPH in Germany.

### Methods

A retrospective nationwide population-based study of NPH cases in Germany from 2005 to 2022 was conducted using data from the German Federal Statistical Office. Parameters assessed included incidence trends, demographic characteristics, and surgical interventions.

### Results

A total of 118,526 NPH diagnoses were recorded, with 29,662 surgical interventions. The population-adjusted incidence of NPH increased by 48%, from 5.4 to 8.0 cases per 100,000 individuals (p < 0.001), peaking in 2018. The largest increases were seen in the "80-89" age group, followed by the "70-79" and "90+" age groups. Surgical interventions increased by 8.4% (p < 0.001), with ventriculoperitoneal shunt being the predominant procedure.

### Conclusion

The study highlights a 48% rise in NPH incidence in Germany from 2005 to 2022, particularly affecting the elderly. There was also an increase in surgical interventions, underscoring the need for prioritising NPH in national healthcare research agendas.





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# V160

Kontinuierliche telemetrische Messung des intrakraniellen Drucks zur Evaluation der Auswirkungen verschiedener Körperpositionen, Aktivität und der zeitlichen Korrelatio Continuous telemetric measurement of intracranial pressure assessing the effect of different body position maneuvers, activity and time

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### Objective

Non-invasive intracranial pressure measurements using a telemetric sensor (tICP) in shunted and non-shunted patients can give new insight into patients" symptoms, help to further understand pathophysiologies and be used to optimize valve settings in shunted patients. However, so far, continuous tICP measurements (ctICP) along with body position and activity are hampered by limited technical options. Using a novel reader unit prototype for the M. Scio in this pilot study ctICP recordings assessing the effect of different body position maneuvers and activity were performed to evaluate the temporal correlation of intracranial pressure, body position and activity.

### Methods

For this prospective study, we established a standardized protocol of different body positions (lying, sitting, walking, climbing stairs). ctICP measurements were performed for up to 25min. An ICP analysis software (ICPicture, Miethke, Germany) was used for detailed evaluation of the collected data with depiction of ICP changes, amplitude (AMP) and the temporal correlation.

### Results

The patient group consisted of 5 adult patients (median age: 37.2y; range 24–52y). Among these were 4 shunted and 1 non-shunted patient (stand-alone - SA) who received a shunt after SA measurements and CSF tap test. Underlying pathologies were idiopathic intracranial hypertension (IIH, n=4) and suspected functional aqueductal stenosis. After connectivity check, ctICP showed robust continuous recordings. ctICP recordings clearly demonstrated a significant, direct ICP response in all patients changing from lying to sitting as well as lying to standing position, while no difference in the AMP was found. Further, no relevant difference in ICP or AMP between sitting or standing position was detected. The overall highest AMP values were found during activity. Position related ICP and AMP changes were more pronounced in the SA patient compared to the shunted patients.

### Conclusion

ctICP recording is warranted to further understand the pathophysiology of CSF disturbances. In our pilot study we established a protocol for ctICP and showed robust measurements and direct effects of body position and activity on ICP and AMP. ctICP provides new opportunities to obtain objective data to develop a better understanding and optimize treatment strategies. Further research with ctICP in a larger cohort comprising variable pathologies are necessary to validate and integrate this approach into clinical practice.

## RC058

Das SOPHYSA Polaris Ventil in der Hydrocephalusbehandlung: Langzeitverläufe in einer Gruppe von 325 Kindern und Erwachsenen SOPHYSA Polaris Valves in hydrocephalus treatment: long-term follow up study in a group of 325 children and

adults

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### Objective

There are still many open questions about the selection of valve systems for hydrocephalus treatment and the evaluation of treatment results. Our study deals with the SOPHYSA Polaris Valve as an example of an adjustable system as there are only scattered reports about this so far in the literature. Special focus is also put on the ongoing question of clinically relevant over- and underdrainage.

### Methods

In a retrospective long-term follow up study, we collected data from 325 consecutive patients treated in our department who received a SOPHYSA Polaris Valve. No patients were excluded. Outcome were shunt revisions, infections and shunt survival followed by the evaluation of clinical results including initial valve settings and subsequent adjustment procedures and their effect.

### Results

The whole patient group included 259 adults and 66 children (mean age 52,8 yrs and 5,3 yrs). According to the length of follow-up (< 5 yrs and >5 yrs) 4 groups were defined, maximum follow-up extended up to 15,5 yrs. Adult patient group: leading etiology pressure hydrocephalus, revision rate 37,1%, infections 10,8%, 5-years valve survival rate 79,9%, postoperative improvement after shunting 90,1%. Surgery due to overdrainage: 6,8%/6,3% (follow-up < 5yrs/>5 yrs), underdrainage 0,7%/13,5% (follow-up < 5yrs/>5yrs). Group of children: leading etiology posthemorrhagic hydrocephalus , revision rate 63,5%, infections 10,6%, 5-years valve survival rate 81,6%, postoperative improvement after shunting 84,3%. Surgery due to overdrainage 2% and underdrainage 25,5%. Both groups: 304 valve adjustments were done, 196 due to underdrainage and 108 due to overdrainage. Adjustment was followed by clinical improvement in 72,1% (adults) and 89,6% (children). No valve adjustment was done in 24/51 children and 36/111 adult patients with a follow up >5 yrs. A MIETHKE shuntassistant was used in 6 patients and a SPV 400 valve was used during a revision in 4 patients with overdrainage symptoms.

### Conclusion

According to our results an adjustable system like the SOPHYSA Polaris Valve is adequate for different etiologies of hydrocephalus in all age groups. Underdrainage is found more frequently than overdrainage, in addition to valve adjustment procedures gravitational components were needed in a small group (N=6). In a reasonable number of patients no changes of pressure settings were needed, this offers a perspective for the use of fixed-pressure systems depending on socio-economic conditions.

# V161

Rezidivraten von hormoninaktiven PitNETs/Hypophysenadenomen: Subgruppenanalyse gemäß WHO 2022 Klassifikation Recurrence rates of non-functioning PitNETs/pituitary adenomas: Subgroup analysis according to WHO 2022 classification

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### Objective

The introduction of transcription factors (T-PIT, SF-1, PIT-1), as well as estrogen receptor (ER $\alpha$ ), GATA3 and keratin (CAM5.2) stains, has led to a notable shift in the distribution of PitNETs/PAs to specific types and subtypes, reducing significantly the prevalence of null cell adenomas. Despite belonging to a specific cell line, some PitNETs/PAs show no clinical or laboratory hormone activity and are described as "silent" (non-functioning). The aim of this study is to compare the different non-functioning / silent PitNETs/PAs.

### Methods

All patients with a PitNET/PA who were operated between 2004 and 2022 in our department were included in the analysis. All tissue samples were reclassified according WHO classification 2022. A total of 455 patients could be included in the analysis: 420 gonadotrophs PitNETs/PAs, 18 silent corticotrophs, 15 silent PIT1+, and 2 null cell PitNETs/PAs.

### Results

Recurrence and progression rates based on initial resection status were as follows: gonadotroph, 8.2% and 48.6%; silent corticotroph, 25% and 87.5%; silent PIT1+, 0% and 57%; null cell adenomas showed no recurrence/progression. Silent corticotroph adenomas showed significantly more recurrences/progression compared to gonadotrophs (p=0.04), with a faster time to recurrence (30.9 months vs. 67.2 months for gonadotrophs, p=0.03). Silent corticotrophs were more invasive per Knosp classification. Moreover, only in the silent corticotroph group did one patient develop hormonal activity (confirmed Cushing's disease), two progressed to pituitary carcinoma.

### Conclusion

Silent corticotroph adenomas are more aggressive than the other nun-functioning PitNETs/PAs, with higher recurrence and progression rates in the early postoperative period. These tumors require close radiologic and laboratory surveillance, and an interdisciplinary assessment of further therapy.

## V162

Auswirkungen auf das Überleben und verschiedene radiologische Typen des Tuberculum-sellae-Meningioms: Eine internationale, multizentrische Studie Survival Implications and Distinct Radiological Types of Tuberculum Sellae Meningioma: An International, Multi-Centered Study

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### Objective

Tuberculum sellae meningioma (TSM) is one of the most frequent meningiomas of the anterior skull base. We are aimed to reveal the clinical, radiological and molecular characteristics of patients with TSM.

### Methods

Patients with tuberculum sellae meningiomas (TSMs) were retrospectively identified across three institutions (Massachusetts General Hospital, USA; University Hospital Dresden, Germany, and Fudan-Shanghai, China). Gene mutation status was determined next-generation sequencing.

### Results

We identified 125 patients with TSMs. The cohort had a median follow-up time of 41.5 months, 89.5% was female, and had an average age of 51.3 years old. Patients were diagnosed as WHO grade 1 and 2 in 119 and 6 cases, respectively. Patients were treated with postoperative adjuvant radiotherapy in 9 (8.82%) cases. Tumor recurrence and progression was identified in 16 (12.8%) patients. AKT1 and TRAF7 mutations (23, 18.4%) emerged as the predominant mutations, succeeded by PIK3CA, SMO, AKT1, POLR2A, ARID1A, PTCH1, and SUFU. Three distinct radiological phenotypes labeled A, B, and C were identified based on MRI characteristics. Type A correlated with higher WHO grade, while type B exhibited a higher prevalence of PIK3CA and SMO mutations. Notably, all type C individuals were female with grade 1 tumors, with 42.9% (3/7) had TRAF7 mutations. Kaplan-Meier analysis revealed significantly reduced progression-free survival (PFS) in patients harboring SMO mutations (HR = 6.73, 95% CI = 2.40, 18.87, p < 0.01), WHO grade 2 tumors (HR = 4.95, 95% CI = 1.28, 19.13, p = 0.02), and those undergoing gross-total resection (HR = 25.07, 95% CI = 8.01, 78.47, p < 0.01), postoperative radiotherapy (HR = 13.54, 95% CI = 4.20, 43.66, p < 0.01). Furthermore, multivariate Cox analysis determined SMO mutation status (HR = 3.95, 95% CI = 1.05, 14.90, p = 0.04) and extent of resection (EOR) (HR = 41.32, 95% CI = 6.32, 270.17, p < 0.01) as independent predictors of PFS.

### Conclusion

We identify three radiological types with distinct clinical and molecular characteristics in patients with TSMs. Of note, SMO mutation status and EOR are determined as independent predictors of PFS.

## V164

Prädiktive Faktoren für die radikale Resektion von primären, sporadischen Vestibularisschwannomen. Predictive factors for radical resection of primary, sporadic vestibular schwannomas.

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### Objective

The extent of resection (EOR) is known to impact recurrence free survival in vestibular schwannomas (VS). Identifying predictive factors for complete resection may direct treatment decisions in the future. In recent years there is increasing evidence for the involvement of inflammatory processes in the development and growth of VS. It is unclear whether inflammatory changes may also play a role in the extent of resection in VS.

### Methods

We analyzed clinical data, tumor extension, cystic characteristics and immunohistochemical markers for inflammation (CD68, CD163, CD3, CD8) and proliferation (MIB-1) as potential factors influencing the EOR in 1007 surgically treated primary sporadic VS. With CART specific cut-offs for each inflammation marker, a common inflammatory score from 0 to 2 was determined. Univariate and multivariate analyses were performed for the EOR.

### Results

Total resection was achieved in 86.5% of cases. Incomplete resection was associated with advanced age (p=0.0002), larger tumor size (p<0.0001) and cystic characteristics on preoperative imaging (p<0.0001). Increased expression of CD163, CD68 and CD3 (p<0.0001, p=0.0015 and p=0.0024 respectively) was associated with partial tumor resection (PR). CD8 was significant when its CART-specific cut-off was considered (p=0.0032). A higher inflammatory score was significantly connected to PR (p<0.0001). In the multivariate analysis, larger size (p<0.0001), older age (p=0.0051), cystic characteristics (p=0.0005) and a higher inflammatory score (p=0.0062) were independently significant factors for partial resection.

### Conclusion

Advanced age, greater tumor extension, cystic growth and higher cellular tumor tissue inflammation are independent factors for a less radical extent of resection.

# SFNC-12

### Approach related complications of the combined transpetrosal approach: the large experience of a single center

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### Objective

The combined transpetrosal approach (CTA) is a demanding and complex neurosurgical procedure with potential severe approach related complications. This study presents a large series of patients treated with CTA, with a primary focus on the complications associated with the approach and their relationship to specific radiological and clinical findings.

### Methods

We retrospectively reviewed all the CTA procedure performed in our hospital from 2013 to 2024. For each patient, medical records, operative videos, radiological images and the most recent follow-up data were reviewed.

### Results

The study included 74 patients. The ratio male:female was 1:2. The pathologies treated included petroclival meningiomas (80%), epidermoid cysts (13%), cranial nerve schwannomas (3%), and skull base bony tumors such as chordomas and chondrosarcomas (4%). Gross total resection (GTR) was achieved in 30% of cases, near total resection (NTR) in 35%, subtotal resection (STR) in 19% and partial resection (PR) in 16%. The average volume of the lesions was 34 cm3.

The most common approach-related complications were venous sinus thrombosis (24%), postoperative seizures (15%) requiring long term treatment, hearing impairments related to otitis media (9%) and pseudomeningocele (11%). Despite the relatively high incidence of venous sinus thrombosis, all patients were asymptomatic except for one case. The pseudomeningocele cases resolved with consecutives lumbar puncture, without need for further surgeries. Less common approach-related complications were CSF leak (one case, which requires surgery), meningitis (4%) and abdominal hematoma (7%) in the site used for harvesting the fat graft.

Furthermore, the present study found a correlation between certain approach-related complications and some radiological and clinical features (surgical tecnique, Labbé vein pathway, sigmoid sinus dominance, preoperative hydrocephalus, mastoid pneumatization).

### Conclusion

The CTA remains a challenging approach, even for experienced neurosurgeons. A thorough understanding of the potential complications associated with this technique is crucial when considering it for large petroclival lesions. Our patient series demonstrates that complications related to this approach are generally acceptable. A precise analysis of the preoperative workup to identify the anatomical factors and variations associated with complications is mandatory to reduce approach related complications.

# SFNC-13

### Long-Term Hearing Outcome After Radiosurgery for Vestibular Schwannoma: A Systematic Review and Meta-Analysis

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### Objective

Stereotactic radiosurgery (SRS) is one of the main treatment options in the management of small to medium size vestibular schwannomas (VSs), because of high tumor control rate and low cranial nerves morbidity. Series reporting long-term hearing outcome (>3 years) are scarce. We performed a systematic review of the literature and meta-analysis, with the aim of focusing on long-term hearing preservation after SRS.

### Methods

Using Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, we reviewed articles published between January 1990 and October 2020 and referenced in PubMed or Embase. Inclusion criteria were peer-reviewed clinical study or case series of VSs treated with SRS (single dose), reporting hearing outcome after SRS with a median or mean audiometric follow-up of at least 5 years. Hearing preservation, cranial nerves outcomes, and tumor control were evaluated.

### Results

Twenty-three studies were included. Hearing preservation was found in 59.4% of cases (median follow-up 6.7 years, 1409 patients). Main favorable prognostic factors were young age, good hearing status, early treatment after diagnosis, small tumor volume, low marginal irradiation dose, and maximal dose to the cochlea. Tumor control was achieved in 96.1%. Facial nerve deficit and trigeminal neuropathy were found in 1.3% and 3.2% of patients, respectively, both significantly higher in Linear Accelerator series than Gamma Knife series (P < .05).

### Conclusion

Long-term hearing preservation remains one of the main issues after SRS, with a major impact on health-related quality of life. Our meta-analysis suggests that hearing preservation can be achieved in almost 60% of patients after a median follow-up of 6.7 years, irrespective of the technique.

## SFNC-14

Anatomiebasierte Ziel-Devasularisationsmethode für petroklivale Meningeome: Anatomische Studie und klinische Anwendung Anatomy-Based Target Devascularization Method for Petroclival Meningiomas: Anatomical Study and Clinical Application

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### Objective

Surgery for petroclival meningiomas remains highly challenging. Effective control of bleeding improves surgical field visibility and contributes to reducing surgical risks. While the basic anatomy of dural arteries in the skull base and their role as feeding arteries for petroclival meningiomas have been reported, there is limited information on the intraoperative visualization and management of these arteries. Based on anatomical findings, we developed a rational method for feeding artery coagulation, referred to as the Target Devascularization Method.

### Methods

The dura mater along the feeding artery course was classified into three regions: Tentorial area, Petrous apex/Meckel's cave area, and Clival area. Four adult cadaveric heads were dissected and a combined transpetrosal approach was performed to examine the course of dural arteries in each region. A retrospective review of 92 petroclival meningiomas was conducted, with 52 patients undergoing preoperative angiography. The feeding arteries were analyzed through angiography and the surgical videos were reviewed.

### Results

In the cadaveric study, the medial and lateral tentorial arteries, as well as the middle meningeal artery, were identified in the tentorial area. The lateral branch of the dorsal meningeal artery (DMA) and the jugular branch of the ascending pharyngeal artery (APhA) were found in the petrous apex/Meckel's cave area. The medial clival artery, medial branch of DMA, and hypoglossal branch of APhA were identified in the clival area. We evaluated the prevalence of each artery and explored the optimal routes for accessing them. Clinically, feeding arteries identified through angiography were successfully devascularized at their optimal points. Illustrative surgical videos demonstrating techniques for each area are presented.

#### Conclusion

Even in petroclival meningioma with complex feeding artery structures, understanding the anatomical findings of dural arteries allows for the identification of optimal coagulation points. Based on preoperative angiographic findings, planning the devascularization steps should be an effective strategy.

### SFNC-15

# Management of sporadic intracanalicular vestibular schwannomas: A critical review and International Stereotactic Radiosurgery Society (ISRS) practice Guidelines.

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#### Objective

The choice of an appropriate strategy for intracanalicular vestibular schwannoma (ICVS) is still debated. We conducted a systematic review and meta-analysis with the aim to compare treatment outcomes amongst management strategies (conservative surveillance (CS), microsurgical resection (MR), or stereotactic radiosurgery (SRS)) aiming to inform guideline recommendations on behalf of the International Stereotactic Radiosurgery Society (ISRS).

### Methods

Using PRISMA guidelines, we reviewed manuscripts published between January 1990 and October 2021 referenced in PubMed or Embase. Inclusion criteria were peer-reviewed clinical studies or case series reporting a cohort of ICVS managed with CS, MR, or SRS. Primary outcome measures included tumor control, the need for additional treatment, hearing outcomes, and posttreatment neurological deficits. These were pooled using meta-analytical techniques and compared using meta-regression with random effect.

#### Results

Forty studies were included (2371 patients). The weighted pooled estimates for tumor control were 96% and 65% in SRS and CS series, respectively (P < .001). Need for further treatment was reported in 1%, 2%, and 25% for SRS, MR, and CS, respectively (P = .001). Hearing preservation was reported in 67%, 68%, and 55% for SRS, MR, and CS, respectively (P = .21). Persistent facial nerve deficit was reported in 0.1% and 10% for SRS and MR series, respectively (P = .01).

#### Conclusion

SRS is a noninvasive treatment with at least equivalent rates of tumor control and hearing preservation as compared to MR, with the caveat of better facial nerve preservation. As compared to CS, upfront SRS is an effective treatment in achieving tumor control with similar rates of hearing preservation.

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# RC060

Auswirkungen der präoperativen somatostatinrezeptor-gerichteten PET-Bildgebung auf die Resektionsplanung und die chirurgische Vorbereitung bei Meningeomen Impact of preoperative somatostatin-receptor-targeted PET imaging on resection planning and surgical decisionmaking in meningiomas

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### Objective

In meningiomas, preoperative MRI remains the primary imaging modality for resection planning, often complemented by CT imaging for skull base or intraosseous tumors. However, the advent of somatostatin-receptor (SSTR)-targeted PET promises significant advantages for delineating tumor boundaries. This study aims to investigate if inclusion of preoperative PET information to conventional MRI/CT influences resection planning in patients with meningioma.

### Methods

We retrospectively analyzed resection boundaries and parameters relevant for surgical planning including osseous resection in patients with meningioma who underwent preoperative PET imaging, based on suspicion of skull base and/or intraosseous involvement. Initially, the parameters were determined only on preoperative MRI/CT. Subsequently, resection planning was re-evaluated using the additional information provided by PET imaging. Imaging analyses were conducted using Brainlab Elements software.

### Results

47 patients met the inclusion criteria: 27 skull base, 11 convexity and 9 parafalcine meningiomas were identified. The extent of planned tumor resection was modified in the majority of cases (31/47, 66.0%) after re-evaluating surgical planning with PET imaging. In these patients, planned tumor volumes were mainly altered in meningiomas located at the skull base (19/31, 61.3%), and in tumors with intraosseous involvement (26/31, 83.9%). In detail, in 26/31 patients (83.9%) planned tumor volume increased by 4.3 cm<sup>3</sup>, while it decreased in 5/31 cases (16.1%) by 1.6 cm<sup>3</sup>. Across all patients, median tumor volumes showed an increase after reviewing PET imaging of 0.15 cm<sup>3</sup> (p = 0.001). PET imaging identified the need for further tumor resection to achieve complete resection (Simpson grade 1-3) in 9/47 patients (19,1%), who were initially considered completely resectable using MRI/CT-based planning.

### Conclusion

Our study shows that preoperative PET imaging may significantly adjust and extend resection boundaries in meningiomas, particularly in cases of skull base and intraosseous meningiomas. Our data highlights the potential limitation of MRI/CT-based planning alone, which may result in an incomplete resection plan. These findings suggest that PET imaging serves as a promising preoperative diagnostic tool that could enhance surgical precision in meningioma surgery, particularly in complex meningioma cases. Whether integrating PET into the standard preoperative evaluation improves patient outcomes should be addressed in future studies.

Abb. 1



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# SFNC-16

# *Recent advancements in multimodal temporal interference stimulation in modulating brain function and behavior.*

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Deep brain stimulation is nowadays a standard in Functional Neurosurgery. RTMS is non-invasive but limited in its efficacy and precision. Numerous studies have assessed the effect of Temporal Interference (TI) on human performance. The goal of MTi is to generate in the brain with a stereotactic precision electrical fields enabling to make discharge specific neurons a controlled way. The field must be sufficiently focal and powerful correctly oriented and with the right temporal modulation.

We analyzed studies involving preclinical, human, and computer simulations, and then discussed the mechanism and safety of TI. Finally, we identified the gaps and outlined potential future directions.

This non-invasive modality of high precision brain stimulation is having the advantage of being non-invasive and its effects are reversible. The introduction of MTI platforms in Functional Neurosurgery can be a game changer. The coupling to the individual modelisation of the patient brain (The Virtual Brain) to the non-invasive stimulation may become a universal tool for diagnosis and therapy in neurosciences.

We believe that MTI is specially a promising technology for the treatment of neurological movement disorders, due to its superior focality, steerability, and tolerability compared to traditional electrical stimulation.

# V165

### Einsatz des Multi-Target-Ansatzes bei der Tiefenhirnstimulation: Risiken und Komplikationen4o Use of multi-target approach on deep brain stimulation: risks and complications

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### Objective

The objective of this study is to evaluate the clinical outcomes and safety of multitarget stimulation (MTS) in patients with complex or atypical movement disorders (MD), pain syndromes, epilepsy, and psychiatric conditions. Specifically, this study assesses the potential benefits of MTS compared to single-target deep brain stimulation (DBS). Here, we focus on associated risks and complications.

### Methods

We reviewed a cohort of 123 patients with various conditions, including Parkinson's disease, pain syndromes, dystonia, tremor, and Tourette syndrome, who underwent MTS with separate electrodes targeting different brain structures. Patients were selected based on the presence of multiple symptoms thought to be not adequately controlled by single target DBS. Clinical outcomes, complications, and adverse effects comparable were analyzed, and the results were compared to patients with single target DBS.

### Results

Among the analyzed patients, complications related to DBS included one case of intracranial hemorrhage (0.8%), 11 instances of wound healing disorders (8.9%), and 11 cases requiring electrode reimplantation (8.9%). These rates were slightly higher, but still comparable to patients who had single target DBS.

### Conclusion

Multitarget stimulation (MTS) is a safe and effective approach for treating complex and

atypical disorders, with on acceptable rate of specific complications. Careful patient selection is crucial for minimizing risks and complications. Further research is warranted to establish standardized criteria for the use of MTS and optimal target selection.

# SFNC-17

# Wo sind effektive Elektroden bei der Stimulation des motorischen Kortex lokalisiert? Eine große multizentrische Studie

### Where are effective electrodes localized in motor cortex stimulation? A large multicenter study

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### Objective

Epidural motor cortex stimulation (MCS) has been used for over 30 years to treat refractory chronic neuropathic pain<sup>1</sup>. However, its efficacy remains controversial, its mechanisms of action unclear and the optimal electrode placement is debated. Our aim was to analyze a large series of patients to identify optimal lead localization.

### Methods

We analyzed retrospectively 73 patients treated with MCS for chronic neuropathic refractory pain across six French and German centers. Postoperative CTs were normalized in the MNI template using ANTs to calculate the coordinates of the stimulating contacts. These coordinates were mapped onto several MNI space-registered atlases<sup>2,3</sup>. The electrode-pia distance was computed. Patients were categorized in non-responders ("NR") and responders ("R" - >50% pain relief at 1 year). The latter were divided into sure-responders ("SR" - the analgesic effect ceased when the IPG was turned off) and doubtful responders ("DR"). Statistical comparisons were made for stimulation parameters, electrode coordinates and atlas values.

### Results

Statistical tests revealed a larger electrode-pia distance in NR compared to R (5.68 vs 4.78 mm, p< .005). Leads located on the right hemisphere, anteriorly and inferiorly were associated with higher response rates (p< .05). While effective electrodes were often localized on the premotor histo-functional areas in SR and R, the result was not significant. In SR, electrodes were effective regardless of motor cortex somatotopy (Fig. 1). Pain relief was associated with low electrical intensity and stimulation of 90-100 mm long streamlines.

### Conclusion

These results challenge some traditional MCS assumptions. Precise targeting of somatotopic motor regions may not be critical for pain relief. Instead, duro-pial distance could predict MCS response. The association with medium length streamlines suggests MCS modulates distant pain centers. This study highlights the need for a more nuanced approach to MCS, moving away from motor somatotopy and integrating connectivity models to refine electrode placement and optimize clinical outcomes for chronic refractory neuropathic pain.

Lefaucheur, J.-P. Cortical neurostimulation for neuropathic pain: state of the art and perspectives. Pain (2016)
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Fig. 1 Lead localization in SR





## V166

### Thalamische Zielpunkte für dystonen Kopftremor – ein systematisches Review Thalamic Targets for dystonic head tremor – a systematic review

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### Objective

Dystonic head tremor is a rare but debilitating disease, and its etiology is poorly understood. When first-line treatment with botulinum toxin injection is not sufficient, deep brain stimulation is considered. However, there is an ongoing debate about the optimal target point for dystonic head tremor. Especially thalamic targets were explored, but due to low patient numbers, randomized controlled trials are not feasible. We therefore summarized the existing literature that contains data that was collected over several decades in a systematic review.

### Methods

Literature was selected via Medline using the search term "((dystonic head tremor) OR (isolated head tremor)) AND ((deep brain stimulation) OR DBS) AND (thalamus OR thalamic OR Vim)". Abstracts were screened for interventional studies or case reports of deep brain stimulation involving patients with head tremor. For all relevant abstracts the full text was analyzed.

### Results

The search terms retrieved 22 results, of which 6 publications were selected for detailed analysis. Results of 25 patients were reported with overall good response. Tremor was reduced between 60 to 91%, with a decrease in amplitude by 77.5% and dystonia was reduced by 50 to 57%. Overall dystonia was less reduced than tremor. Different rating scales were used throughout publications. All patients with dystonic head tremor had also tremor of the upper extremities. The Vim, the Voa/VLa and Vim/VLp, Voi, inferior base of VL and PSA were targeted alone or in combination. No serious adverse events or permanent side effects were described.

### Conclusion

Thalamic DBS is an efficient therapy option for dystonic head tremor in patients with predominant tremor symptoms. The different nomenclature of the thalamic nuclei can lead to inconsistency. Therefore, exact coordinates and operative technique should be reported. Also, the terms *isolated head tremor* and *dystonic head tremor* have not been used in a consistent way. Isolated head tremor was classified as an essential tremor syndrome for some time, but has recently been acknowledged as a dystonic movement disorder. Patients" symptoms need to be described thoroughly and objectified by rating scales. Careful patient selection and genetic testing could improve the overall outcome.

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## V168

Die LITTability Studie - Analyse der Anwendbarkeit von LITT in einer Kohorte von echten GliompatientInnen The LITTability Study - Evaluation of the Applicability of LITT in a Real-World Cohort of Glioma Patients

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### Objective

Laser-interstitial thermal therapy (LITT) is a minimally invasive technique used in neurosurgery for ablation of epileptic foci and malignant lesions, especially for glioma located in regions that pose high surgical risk. Current research mainly focuses on maximizing the safety on the procedure and proofing the non-inferiority compared to open resection of glioma. However, data regarding the current applicability in real-time cohorts are lacking. The goal of this study is to evaluate the real-world applicability of LITT in glioma patients, specifically focusing on those who had undergone stereotactic biopsy, and to define limiting factors.

### Methods

For this retrospective study, we analyzed n=207 glioma patients from a monocentric stereotactic surgery database over a 5-year period (2018 – 2022). Clinical, histopathological and radiological data was assessed. To define a lesion suitable for LITT a two-step approach was used. In a first step, predefined selection criteria were applied consisting of a Karnofsky Performance Score of 70 or higher, an ASA Score of 3 or less, MRI compatibility, and glioma presenting as a single or bifocal lesion. In a second step, the LITT simulation was performed with additional criteria consisting of at least 90% possible ablation volume, a safe trajectory with avoidance of vessels, and optimal lesion accessibility without brainstem involvement.

### Results

Out of 207 patients, 137 cases met initial preselection criteria, while 36 cases (17.4%) were ultimately deemed suitable for LITT post-simulation. Common exclusion factors included multifocal lesions, irregular lesion shape, and size constraints. Among suitable cases, 94.4% had unifocal lesions, and ablation through the preexisting stereotactic burr hole was feasible in 66.7% of cases. For 44.4% of cases, only a single catheter was needed, with the number of ablation points varying from one to twelve per trajectory. The average lesion diameter for LITT-suitable cases was 26.4 mm.

### Conclusion

Even though LITT offers a promising alternative for glioma not suitable for open resection, the current application is limited. Main reasons were due to lesion morphology and size. Enhancing LITT applicability could involve addressing constraints posed by lesion geometry and volume. Prospective studies comparing LITT with conventional resection could better define the subset of glioma patients who may benefit most, advancing the potential for LITT in clinical neurosurgical practice.

# SFNC-18

Radiosurgical Corpus Callosotomy for Intractable Epilepsy: Retrospective Long-Term Safety and Efficacy Assessment in 19 Patients an Review of the Literature.

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### Objective

Some patients suffering from intractable epileptic seizures, particularly drop attacks (DAs), are nonremediable by curative techniques. Palliative procedure carries a significant rate of surgical and neurological complications. We propose to evaluate the safety and efficacy of Gamma Knife corpus callosotomy (GK-CC) as an alternative to microsurgical corpus callosotomy.

### Methods

This study included retrospective analysis of 19 patients who underwent GK-CC between 2005 and 2017.

### Results

Of the 19 patients, 13 (68%) had improvement in seizure control and 6 had no significant improvement. Of the 13/19 (68%) with improvement in seizures, 3 (16%) became completely seizure-free, 2 (11%) became free of DA and generalized tonic-clonic but with residual other seizures, 3 (16%) became free of DA only, and 5 (26%) had >50% reduction in frequency of all seizure types. In the 6 (31%) patients with no appreciable improvement, there were residual untreated commissural fibers and incomplete callosotomy rather than failure of Gamma Knife to disconnect. Seven patients showed a transient mild complication (37% of patients, 33% of the procedures). No permanent complication or neurological consequence was observed during the clinical and radiological workup with a mean of 89 (42-181) months, except 1 patient who had no improvement of epilepsy and then aggravation of the pre-existing cognitive and walking difficulties (Lennox-Gastaut). The median time of improvement after GK-CC was 3 (1-6) months.

### Conclusion

Gamma Knife callosotomy is safe and accurate with comparable efficacy to open callosotomy in this cohort of patients with intractable epilepsy suffering from severe drop attacks.

## RC061

Idiopathische intrakranielle Hypertension: Vorläufige Analyse einer nationalen Umfrage zu aktuellen diagnostischen und therapeutischen Verfahren in der klinischen Praxis in Deutschland Idiopathic intracranial hypertension – Preliminary analysis of a nationwide survey on diagnostic and therapeutic management in neurosurgical departments in Germany

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### Objective

Idiopathic intracranial hypertension (IIH) is a disorder characterized by elevated intracranial pressure with normal cerebrospinal fluid composition in the absence of hydrocephalus, mass lesions, or structural abnormalities. Recent studies have enhanced our understanding of this condition, leading to update of the diagnostic criteria. However, uncertainty persists regarding both diagnosis and optimal therapy. This study aims to investigate the diagnostic approaches, clinical management, and treatment strategies for IIH in neurosurgical clinics across Germany.

### Methods

A standardised questionnaire was sent to 124 neurosurgical clinics in Germany that regularly perform shunt surgeries. By the time of this interim analysis, 52 clinics (41.9%) had responded. The survey covered the estimated annual caseload of PTCS patients, diagnostic work-up and treatment strategies.

### Results

The proportion of idiopathic versus secondary intracranial hypertension was estimated at 77,7% and 22,3% respectively. Diagnostic lumbar puncture (LP) was performed routinely in 92% of the centers. Ventriculoperitoneal shunting was chosen as main CSF diversion procedure in a median estimate of 90% of PTCS patients. 94% of the centers always or most of the time use programmable valves. 64% of the centers use antisiphon devices always or most of the times. Initial valve opening pressure settings showed considerable variability, ranging from (5-20) cmH<sub>2</sub>O. Notably, 72% of clinics perform shunting-surgery in patients with isolated headaches and elevated CSF pressure without papilledema. Endovascular stenting and optic nerve sheath fenestration are rarely performed.

### Conclusion

The present survey provides a comprehensive overview of the current management of IIH in Germany und underlines the need for further refinements and implementation of standardized guidelines in order to clarify diagnostic uncertainties and optimize treatment outcome.

# RC062

Sicherheits- und Diagnostischer Wert der Zugangsbiopsie während der Shunt-Operation bei Hydrocephalus-Patienten: Eine retrospektive Analyse Safety and Diagnostic Value of Access-Point Biopsy During Shunt Surgery in Hydrocephalus Patients: A Retrospective Analysis

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### Objective

Hydrocephalus is often associated with neurodegenerative diseases like Alzheimer"s disease (AD), making accurate diagnosis and treatment challenging. This study aimed to evaluate the safety and diagnostic value of obtaining cortical biopsies during shunt surgery for hydrocephalus patients.

### Methods

A retrospective analysis was conducted on 67 patients who underwent cortical biopsy during shunt implantation or endoscopic third ventriculostomy (ETV) between June 2023 and October 2024. Patient demographics, clinical diagnosis, histological findings, and postoperative complications were analyzed.

### Results

No biopsy-related complications such as intracerebral hemorrhage or CSF leakage occurred. Early postoperative complications included the need for opening pressure adjustment of the shunt valve (10.5%), shunt dysfunction (6%), and infection (1.5%). Histopathological examination revealed normal findings in 61.19%, beta-amyloid deposits in 20.90%, and Alzheimer tauopathy in 7.46% of cases.

### Conclusion

Obtaining cortical biopsies during shunt surgery for hydrocephalus is a safe and feasible technique. It provides valuable diagnostic information, enabling identification of underlying neurodegenerative diseases that may impact prognosis and guide treatment strategies. This approach facilitates timely interventions and potentially improves long-term outcomes for hydrocephalus patients.



Abb. 2

Table 3.2: Postoperative early complications (< 3 months)	
Postoperative early complications (< 3 months):	
without complications	55 (82,1%)
with complications	12 (17,9%)
Diagnosis:	
Malposition/Disconnection	4 (6%)
Infection	1 (1.5%)
Slight overdrainage for valve adjustment	7 (10,5%)
Severe overdrainage, surgery indicated	0 (0%)
Biopsy-associated complication:	0 (0%)

Abb. 1

# RC063

Volumetrie des kranialen Liquorraums bei Patienten mit Verdacht auf idiopathischen Normaldruckhydrozephalus: Ein vielversprechendes präoperatives Diagnoseinstrument Volumetry of Cranial Cerebrospinal Fluid Space in Patients with Suspected Idiopathic Normal Pressure Hydrocephalus: A Promising Presurgical Diagnostic Tool

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### Objective

Idiopathic normal pressure hydrocephalus (iNPH) is characterized by ventricular enlargement with normal or slightly elevated intraventricular pressure, commonly seen in older adults. This study investigates the correlation between cerebrospinal fluid (CSF) volume, measured by MRI volumetry, and clinical outcomes in patients with suspected iNPH.

### Methods

A retrospective study of 26 patients evaluated between November 2021 and May 2024 for suspected iNPH was conducted. All patients underwent a tap test, and those with positive results received ventriculoperitoneal shunting. Clinical outcomes were assessed 3 and 6 months postoperatively. Cranial CSF volumetry was performed using MRI (Fig. 1). One-way ANOVA and post-hoc tests were used to assess differences in CSF volumes among three groups: improved after shunting, no improvement after shunting, and negative tap test.

### Results

Of the 26 patients, 5 with negative tap test results (mean age: 79 years) did not undergo shunting and had a mean CSF volume of **338.3 cm<sup>3</sup>** (range: 294.9–352.6 cm<sup>3</sup>). Among 21 patients with positive tap test results (mean age: 67 years), 18 (85.7%) showed clinical improvement (mean CSF volume: **401.1 cm<sup>3</sup>**, range: 270.1–463.9 cm<sup>3</sup>), while 3 (14.3%) showed no improvement (mean CSF volume: **329.2 cm<sup>3</sup>**, range: 270.1–359.5 cm<sup>3</sup>). ANOVA revealed significant differences in mean CSF volumes among the groups (p = 0.049, Fig.2). Post-hoc analysis confirmed a significant difference between improved and non-improved shunted patients (p = 0.033).

### Conclusion

This study reveals a significant correlation between cranial CSF volume and the potential benefit from shunting in patients with suspected iNPH. Larger preoperative CSF volumes were associated with better postoperative outcomes, suggesting that volumetry may be a valuable tool in preoperative decision-making. MRI volumetry is a non-invasive and practical diagnostic method that could aid in predicting clinical improvement and optimizing treatment strategies for iNPH. Further prospective studies are needed to confirm and expand upon these findings.









## RC064

# Sicherheit der Lumbaldrainage bei antikoagulierten Patienten: Eine retrospektive Analyse Safety of lumbar drainage in anticoagulated patients: a retrospective analysis

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### Objective

This study aimed to evaluate the incidence of spinal hematomas as a complication of lumbar drainage (LD) placement in patients on anticoagulation/antiplatelet treatment (AAT group) compared patients not on such treatment (control group). The focus was on identifying risk factors and assessing the safety of LD in this patient population.

### Methods

A retrospective review was conducted on 477 patients who underwent LD between 2012 and 2022. Patients were divided into two groups: 55 AAT patients (16 on acetylsalicylic acid [ASA], 37 on heparin infusion, and 2 on rivaroxaban [Xarelto]) versus 422 patients in the control group. Perioperative management in AAT patients included pausing heparin infusions 3 hours prior to LD placement. Data on complications, particularly spinal hematomas, were collected and analyzed.

### Results

Of the 477 patients, only one case of a spinal hematoma was observed, resulting in an incidence rate of 0.2%. This occurred in a patient on ASA, who developed an epidural hematoma leading to paraparesis. No spinal hematomas were reported in patients on heparin, rivaroxaban, or in the control group. The low complication rate underscores the effectiveness of perioperative management in minimizing the risk of spinal hematomas, even in AAT patients.

### Conclusion

LD placement in AAT patients is associated with a very low risk of spinal hematoma when appropriate perioperative measures, such as pausing anticoagulants, are implemented. These findings support the safety and feasibility of LD in this high-risk population. Nonetheless, careful patient selection, vigilant monitoring, and strict adherence to anticoagulation protocols are essential to ensure optimal outcomes.

# Vaskuläre Neurochirurgie 3 | Vascular neurosurgery 3

# V169

Inzidenz, Prädiktoren und klinische Ergebnisse von Patienten mit initial negativer DSA nach aneurysmatischer Subarachnoidalblutung

Incidence, predictors, and clinical outcome of patients with undetected aneurysms on initial DSA after aneurysmal subarachnoid hemorrhage

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### Objective

Digital subtraction angiography (DSA) is the gold standard for diagnosing ruptured intracranial aneurysms in aneurysmal subarachnoid hemorrhage (aSAH) due to its high sensitivity. However, in rare cases, ruptured aneurysms may be missed on initial DSA, delaying treatment and worsening outcomes. This study investigates the incidence, predictors, clinical features, and outcomes of aSAH cases with initially undetected aneurysms on DSA, later identified through follow-up diagnostics.

### Methods

We retrospectively analyzed consecutive aSAH cases treated between March 2006 and October 2023 focusing on delayed aneurysm detection. Variables including patient demographics, Fisher CT grade, Hunt and Hess (HH) score, aneurysm characteristics, bleeding patterns, and comorbidities were evaluated. Neurological outcomes, assessed via the Glasgow Outcome Scale (GOS) and modified Rankin Scale (mRS) at discharge and six months were compared with a matched cohort of patients with immediate aneurysm detection on initial DSA.

### Results

Among 1221 patients with aneurysmal subarachnoid hemorrhage, 14 cases (1.1%) had initially undetected aneurysms on digital subtraction angiography later identified through follow-up diagnostics. A second DSA detected the aneurysm in 57.1% of cases. Thirteen patients underwent MRI, revealing aneurysms in three cases (21.4%). A third DSA confirmed the aneurysm in 14.3% (n=2), and surgical exploration identified one case (7.1%). The mean interval between initial and repeat diagnostics was five days (range: 1–14 days), and from admission to detection 10 days (range: 1–42 days). Re-bleeding occurred in three patients (21.4%) before diagnosis. Most patients (71%) had Fisher grade III-IV hemorrhage, while 29% had perimesencephalic hemorrhage. The aneurysms were significantly smaller than those found on initial DSA (1.8 mm vs. 6.7 mm, p < 0.05).

### Conclusion

In rare aSAH cases, ruptured aneurysms may be missed on initial DSA, particularly when small. Repeat DSA, supplemented by MRI if needed, should be conducted during the same hospital stay even when the bleeding pattern resembles non-aneurysmal perimesencephalic hemorrhage. Timely and thorough diagnostics are essential to prevent potentially severe consequences from missed or delayed treatment.

# Vaskuläre Neurochirurgie 3 | Vascular neurosurgery 3

# V170

### Risikofaktoren zur Vorhersage eines schlechten Outcomes nach einer nicht-aneurysmatischen Subarachnoidalblutung Risk Factors for an Unfavorable Functional Outcome after a Non-Aneurysmal Spontaneous Subarachnoid Hemorrhage

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### Objective

Spontaneous subarachnoid hemorrhages are mostly caused by rupture of cerebral aneurysms. However, in  $\approx$ 15% the bleeding source cannot be determined in imaging. These non-aneurysmal SAH (nSAH) are known for a milder clinical course, lower complication rates and a more favorable outcome. But, cases with a complicated clinical course are still not uncommon and difficult to predict.

Aim of our study was to analyze patients" and imaging characteristics develop a prediction score for a poor outcome after nSAH.

### Methods

Retrospectively, all patients with nSAH between 2010-2021 from 6 international neurosurgical departments were analyzed.

Baseline demographics, the Hunt&Hess(HH), Fisher(FS) and Word Federation of Neurosurgical Societies score (WFNS) grades, Systemic Inflammatory Response Syndrome score (SIRS) and ASA scores were analyzed. Comorbidities, diagnostics, drugs and other risk factors, treatment methods, initial symptoms and typical complications and the blood distribution were analyzed. The outcome was assessed using the modified Rankin Scale (mRS) at 6 months defining an unfavorable outcome as mRS≥3.

### Results

474 cases (59.5% male, n=282) with a mean age of 54.5  $\pm$ 12.1 years were included. Mean ASA was 2.1 $\pm$ 0.73, mean HH, WFNS and FS were 1.6 $\pm$ 0.87,1.3 $\pm$ 0.86 and 2.7 $\pm$ 0.9. In 60.3% the blood distribution pattern was diffuse. Acute CSF diversion was necessary in 16.5% (n=78), a shunt (VP) in 20 cases (4.2%). CV was detected in 16.7% (n=79). 11 patients developed DCI (2.3%). 90.2% of patients had a favorable outcome (mRS $\leq$ 2).

In univariate analysis the risk for an unfavorable outcome was increased by multiple comorbidities, ASA (<0.0001), HH (p<0.0001), WFNS (p<0.0001), SIRS (p<0.0001), FS (p<0.0001), intraventricular blood (p<0.0001), intracerebral hemorrhage (IH) (p<0.0001) a diffuse blood distribution (p<0.0001), DCI (p=0.02) and the need for a VP (p<0.0001).
The combination of the following parameters developed the score with the highest predictive value for the outcome: WFNS (OR=6.3) and IH (OR=39.4). The AUC for the prediction score based on WFNS and IH was 0.94.

### Conclusion

The evaluation of the WFNS and analysis of the initial CT scan for intracerebral parenchyma can reliably identify patients with a high risk for an unfavorable outcome after 6 months after nSAH. The necessary data for analysis is routinely collected upon patient admission, facilitating the evaluation of the risk for poor outcomes in this challenging-to-assess patient group.

### V171

Simultanes subarachnoidales Hämatom und zerebraler Infarkt durch Rupturen eines Aneurysmas und Verschluss der Stammarterie: eine mögliche Ursache für angiografisch-negative nicht-perimesenzephale subarachnoidale Blutungen

Simultaneous subarachnoid hemorrhage and cerebral infarction due to aneurysm rupture and occlusion of the parent artery: a cause for angiogram-negative non-perimesencephalic subarachnoid hemorrhage

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### Objective

Spontaneous subarachnoid hemorrhage (SAH) is most often caused by the rupture of intracranial aneurysms. However, in approximately 15–20% of cases, no clear source of bleeding can be identified. While angiogram-negative perimesencephalic SAH is characterized by localized blood distribution and is generally associated with favorable outcome, angiogram-negative non-perimesencephalic SAH presents a more diffuse blood pattern resembling aneurysmal hemorrhage and is linked to worse outcome, with its causes and etiology remaining unclear.

#### Methods

Over a 10-year period, we reviewed the imaging studies of 524 patients with SAH admitted to our institution to identify patients with angiogram-negative non-perimesencephalic SAH. Clinical data, imaging findings, and outcomes were analyzed. Follow-up data were supplemented prospectively.

### Results

Seventy-two patients (14%) were identified with angiogram-negative SAH. Of these, 45 patients (63%) presented with benign perimesencephalic SAH, while 27 patients (37%) exhibited non-perimesencephalic patterns on CT imaging. Among the non-perimesencephalic group, 9 patients (33%) exhibited small brain infarctions correlated with parent artery occlusion. These patients (mean age 68 years) presented with severe SAH (Fisher Grade 3 or 4) and Hunt and Hess grades ranging from II to IV. Chronic arterial hypertension was present in 8 of 9 cases. All patients required cerebrospinal fluid diversion, and two developed vasospasm. At follow-up, 5 patients had a good outcome, 2 had moderate disabilities, and 2 patients were dead.

#### Conclusion

This study suggests that ruptured aneurysms of small parent arteries combined with occlusion of the artery explain some cases of angiogram-negative non-perimesencephalic SAH. The clinical outcome in these cases is similar to that observed in aneurysmal SAH, underscoring the need for diligent management.



Figure 1: Aneurysm locations and corresponding hemorrhages: A - Illustration of the vascular anatomy of the perforators of the anterior circulation. B - aneurysm located in the intracerebral segment of a perforator, with rupture typically resulting in intracerebral hemorrhage. C - Proximal aneurysm located at the interface between the brain and the subarachnoid space, with rupture associated with both intracerebral hemorrhage and subarachnoid hemorrhage. D - Proximal aneurysm in the subarachnoid segment of the perforator, with rupture predominantly leading to subarachnoid hemorrhage, while occlusion of the parent vessel can result in an infarction.

### V172

Auswirkung von Freizeitdrogenkonsum auf das Auftreten und den Schweregrad einer aneurysmatischen Subarachnoidalblutung: Ein brandgefährliches Risiko? Effect of Recreational Drug Use on Occurrence and Severity of Aneurysmal Subarachnoid Hemorrhage: Blazing Risks?

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### Objective

The recreational use of tobacco and alcohol is widespread in Western Europe. Recently, the legalization of tetrahydrocannabinol (THC) in several countries has raised questions about its impact on health. While the relationship between tobacco use and intracranial aneurysms (IA) or aneurysmal subarachnoid hemorrhage (aSAH) is well-documented, the role of THC remains unclear. This study investigates the effects of THC consumption, particularly in light of the growing number of legal users.

### Methods

We analyzed data from our prospective institutional database (06/2016–10/2023), which includes all patients treated for IA at a tertiary cerebrovascular center. Patients with complete data on alcohol, tobacco, and drug use were included. Risky alcohol consumption was defined using the WHO threshold (>2). Statistical analysis was performed using univariate and multivariate analysis (MVA). The impact of risky alcohol consumption and THC use on IA rupture and poor-grade aSAH (WFNS 4/5) was assessed, adjusting for confounding variables including age, sex, arterial hypertension, smoking, and polysubstance use.

### Results

Of 959 eligible patients, 71.9% presented with unruptured IAs. THC use was reported by 51 patients (5.3%), while 44 patients (4.6%) reported risky alcohol consumption. Both groups were predominantly male (p=0.017 and p<0.001). THC users were younger (42 vs. 57 years, p<0.001), with nearly half reporting polysubstance use (49.0%). There was no significant difference in IA sac size between THC users and non-users (p=0.459). MVA showed no association between THC use and IA rupture (p=0.171) or poor-grade aSAH (p=0.300). Conversely, risky alcohol consumption was associated with increased risk of IA rupture (p=0.042, OR=1.87) and poor-grade aSAH (p=0.008, OR=3.62).

### Conclusion

This study found no evidence that THC use negatively impacts IA-bearing patients. However, risky alcohol consumption significantly increased the risk of IA rupture and poor-grade aSAH. The high rate of polysubstance use among THC users, reflecting the pre-legalization recruitment period, may confound these results. As the THC-using population grows, further studies are needed to clarify the effects of THC, particularly regarding consumption patterns and dosages.

### V174

Die Extended Fisher Scale: Infratentorielles, peritrunkales Blutvolumen als Schlüssel zur verbesserten Outcome-Vorhersage bei der aneurysmatischen Subarachnoidalblutung - Vorläufige Ergebnisse The Extended Fisher Scale: Incorporating Infratentorial, Peritruncal Blood Volume for Enhanced Outcome Prediction in Aneurysmal Subarachnoid Hemorrhage - Preliminary Results

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### Objective

Although infratentorial, peritruncal blood volume significantly correlates with outcomes in aneurysmal subarachnoid hemorrhage (aSAH) (data under review), radiological scores like the Fisher and modified Fisher (mFisher) Scales -widely used in daily clinical practice- do not include it. This study aimed to enhance the mFisher Scale by incorporating infratentorial blood components and we propose the extended Fisher Scale (exFisher).

### Methods

This international, multicenter, retrospective study included aSAH patients from May 2012 to September 2022 (2 centers in the USA, 1 in GBR, 1 in AUT, 4 in GER). Infratentorial peritruncal blood volume was classified based on mFisher criteria and unpublished quantitative measurements into "no blood," "thin clot," and "thick clot" (ventral space-occupying hemorrhage covering the entire brainstem width in the axial plane, from the dorsum sellae to the external acoustic meatus). Patients were split into training (two-thirds) and test sets to determine parameter weights for the exFisher scale. Primary outcomes were trichotomized Modified Rankin Scale (mRS; 0–2, 3–5, 6) scores at discharge and six months. Secondary outcomes included VP shunt dependency, vasospasm, and delayed cerebral ischemia.

### Results

A total of 3,458 patients were included in this interim analysis. The exFisher scale was defined as: exFisher 1-4 = mFisher 1-4; exFisher 5 = mFisher 4 + peritruncal "thick clot."

Logistic regression for outcome and exFisher showed:

**mRS at discharge**: exFisher showed improved correlation compared to mFisher and Fisher (Pseudo R<sup>2</sup>: Fisher = 0.081, mFisher = 0.086, exFisher = 0.097). Especially specificity for predicting mortality was significantly higher with exFisher (0.799) than mFisher (0.513) or Fisher (0.439).

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**mRS at six months**: exFisher further improved correlation (Pseudo R<sup>2</sup>: Fisher = 0.032, mFisher = 0.056, exFisher = 0.069). Again, especially specificity for predicting mortality was significantly higher with exFisher (0.803) than mFisher (0.507) or Fisher (0.432), respectively.

Analysis of secondary outcomes is ongoing.

### Conclusion

We propose an extension of the mFisher Scale, the extended Fisher Scale (exFisher), incorporating infratentorial, peritruncal blood volume. Based on the present study population, the exFisher is a simple and effective tool for improving outcome prediction in aSAH patients compared to the mFisher scale, particularly in distinguishing poor and fatal outcomes. (Final results will be presented at the conference).

### RC065

Der Effekt von externen Ventrikeldrainagen bei der Behandlung von Patienten nach aneurysmatischer Subarachnoidalblutung The effect of external ventricular drains in the management of patients after aneurysmal subarachnoid

hemorrhage

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### Objective

Emerging evidence suggests that liberal use of external ventricular drain (EVD) in patients with aneurysmal subarachnoid hemorrhage (aSAH) may adversely affect outcomes. This study analyzed the effect of EVD treatment on radiological and functional outcomes in good-grade aSAH patients.

### Methods

A prospective cohort of 379 consecutive aSAH patients (January 2016 and December 2022), managed according to a standardized protocol was analyzed. Of these, 227 patients with WFNS grades 1–3 were included. Relative bicaudate indices (rBCl) from CT scans were used to identify acute hydrocephalus (rBCl > 1). DCI-related cerebral infarction and unfavorable outcomes (modified Rankin Scale 3–6) at 3 months were compared between patients treated with EVD (EVD+) and those without EVD (EVD–). Subgroup analyses evaluated the impact of EVD treatment in the presence or absence of acute hydrocephalus. Further, EVD associated complications (dysfunction, dislocation, infection, hemorrhage) were assessed.

### Results

EVD was performed in 137 patients. The mean rBCI was significantly higher in the EVD+ group compared to the EVD– group (0.93  $\pm$  0.27 vs. 0.85  $\pm$  0.22; p < 0.05). An rBCI > 1 was present in 42.5% of the EVD+ group and 25.6% in the EVD- group. The DCI-related infarction rate was higher in the EVD+ group (19.7%) compared to the EVD– group (6.7%) (OR: 3.4 [1.4–8.7]). Similarly, unfavourable outcomes were more frequent in the EVD+ group (44.1%) than in the EVD– group (11.1%) (OR: 6.3 [6.0–13.2]). Among patients with rBCI > 1, DCI-related infarction occurred in 21.1% of EVD+ patients versus 0% of EVD– patients, with unfavorable outcomes in 46.4% (EVD+) versus 13% (EVD–) (OR: 5.8 [1.5–13.20]). In patients with rBCI < 1, DCI-related infarction was observed in 19.5% (EVD+) versus 9% (EVD–) (OR: 2.5 [0.9–6.8]), with unfavourable outcomes in 42.9% (EVD+) versus 10.4% (EVD–) (OR: 6.4 [2.6–15.9]). The overall EVD associated complication rate was 34.4%.

### Conclusion

Good-grade aSAH Patients with EVD insertion have higher rates of DCI and poor outcomes than those without EVD insertion. This detrimental effect of EVD is not entirely explained by the impact of hydrocephalus, as the same effect is found in patients without hydrocephalus. However, the high complication rate associated with an EVD may partly explain these findings. Further studies are needed to assess whether refraining from CSF drainage in the absence of hydrocephalus or, where feasible, using LP/LD may improve outcomes of good grade SAH patients.

### RC066

Durchmesser der Sehnervenscheide und Outcome bei aneurysmatischer Subarachnoidalblutung Optic Nerve Sheath Diameter and Outcome of Aneurysmal Subarachnoid Hemorrhage

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### Objective

The optic nerve sheath diameter (ONSD) has been identified in several studies as a marker associated with elevated intracranial pressure (ICP) following acute brain injury. However, the utility of ONSD as an indicator of ICP elevation after aneurysmal subarachnoid hemorrhage (aSAH) remains controversial. In this retrospective study, we investigated the relationship between computed tomography (CT)-derived ONSD measurements, ICP-related complications, and functional outcomes in aSAH patients.

#### Methods

This study included all consecutive aSAH patients admitted within 48 hours of aneurysm rupture and treated at our center between January 2003 and June 2016 (n=919). Initial CT scans were analyzed for ONSD measurements. Primary endpoints included: occurrence of ICP elevation >20 mmHg at admission and during hospitalization, duration of ICP elevation, need for decompressive craniectomy (DC), development of early and delayed cerebral infarctions (ECI/DCI;  $\leq$ 72 hours post-ictus vs. later), in-hospital mortality, and functional disability at six months post-aSAH (modified Rankin Scale >2). Associations were evaluated using multivariable prediction models, adjusted for ONSD- and outcome-relevant confounders.

### Results

The median ONSD in the study cohort was 6.03 mm (interquartile range [IQR]: 5.55–6.39). Multivariable logistic regression analysis demonstrated that CT-derived ONSD (per-mm-increase) was independently associated with several adverse outcomes: ICP elevation during hospitalization (adjusted odds ratio [aOR]: 1.43; 95% confidence interval [CI]: 1.12–1.83; p=0.004), duration of ICP elevation (coefficient B: 0.22 for per-day-increase; 95% CI: 0.02–0.43; p=0.003), need for DC (aOR: 1.39; 95% CI: 1.05–1.85; p=0.023), development of ECI (aOR: 1.32; 95% CI: 1.05–1.65; p=0.018), and functional disability at six months (aOR: 1.32; 95% CI: 1.03–1.68; p=0.03). Receiver operating characteristic curve analysis identified a clinically relevant ONSD cutoff of 6.22 mm. Patients with ONSD >6.22 mm had significantly higher rates of ICP elevation (53.3% vs. 43.7%, p=0.007), DC (32.7% vs. 24.8%, p=0.013), and functional disability (57.6% vs. 46.2%, p=0.001) compared to those with ONSD  $\leq$ 6.22 mm.

### Conclusion

Our findings establish initial CT-derived ONSD as a strong predictor of ICP-related complications and poor functional outcomes in aSAH. If validated in external cohorts, CT-derived ONSD measurements could enhance treatment strategies in aSAH patients.

### V175

Aktive Blutclearance und Prävention verzögerter zerebraler Ischämie (ABCD-Therapie) reduziert den Shuntpflichtigen Hydrozephalus bei Patienten mit aneurysmatischer Subarachnoidalblutung Active Blood Clearance and Delayed cerebral ischemia prevention (ABCD) reduces shunt-dependent hydrocephalus in patients with aneurysmal subarachnoid hemorrhage

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### Objective

Chronic shunt-dependent hydrocephalus (CSH) is a common and serious complication after aneurysmal subarachnoid hemorrhage (aSAH). Active Blood Clearance and Delayed Cerebral Ischemia Prevention (ABCD) by intrathecal irrigation with urokinase and nimodipine is a technique to enhance blood clearance and prevent vasospasm. This study evaluates whether ABCD reduces the incidence of CSH in aSAH patients.

### Methods

A total of 320 aSAH patients were analyzed, including 160 receiving standard care and 160 treated with ABCD therapy. A matched 1:1 analysis was performed, pairing patients based on WFNS grade, age, cerebral herniation, intracerebral hemorrhage, and initial Hijdra score. Patients were stratified by Hijdra score to account for blood load. The incidence of CSH was compared between groups using chi-square tests, and multivariate logistic regression was performed to identify predictors of hydrocephalus.

### Results

The incidence of CSH was significantly lower in the ABCD group (19.4%) compared to the standard care group (31.3%, p = 0.015). Subgroup analysis revealed that patients with the highest blood load (Hijdra 30–42) experienced a significant reduction in hydrocephalus (45.8% vs. 22.5%, p = 0.026). In contrast, no significant effects were observed in patients with lower Hijdra scores. Multivariate analysis confirmed that the Hijdra score was a significant predictor of CSH in the standard care group (OR=1.70, p = 0.043), but not in the ABCD-treated group (p = 0.843).

### Conclusion

ABCD significantly reduces the incidence of shunt-dependent hydrocephalus in aSAH patients with a high blood load. These findings suggest that ABCD therapy may be an important preventive strategy in patients with severe subarachnoid hemorrhage.





Error bars: 95% CI

### V176

Prädiktive Faktoren und Vergleich zwischen chirurgischer und endovaskulärer Behandlung bei der spinalen duralen arteriovenösen Fistel: 22 Jahre Erfahrung eines neurovaskulären und spinalen Zentrums *Predictive factors and comparison between surgical and endovascular treatment of spinal dural arteriovenous fistula: a 22-year experience of neurovascular and spine center* 

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### Objective

Spinal dural arteriovenous fistula (SDAVF) is a rare disease with insidious clinical manifestations that are often overlooked at initial presentation. Our aim was to determine the predictive factors for a more favourable long-term outcome and to analyse the clinical outcomes between surgical and endovascular treatment.

### Methods

A retrospective chart review was performed of 81 patients treated surgically (n = 70, 86.4%) and endovascularly (n = 11, 13.6%) for SDAVF at our hospital between 2002 and 2023.

### Results

The modified Aminoff and Logue Scale (mALS) improved significantly in surgical (S) patients (45/70, 64.3%) from admission to last follow-up compared to endovascular (E) patients (3/11, 27.3%, p = 0.043). The mALS, American Spinal Injury Association Motor Score (ASIA-MS), back pain and sensory disturbances showed no differences between the two groups over the clinical course (preoperative, postoperative, first, second and third follow-up). The E group had a significantly higher rate of incomplete or failed closure than the S group (S: 3/70, 4.3% vs. E: 5/11, 45.5%, p < 0.001). Time from MRI diagnosis to treatment was an independent factor for long-term improvement of mALS in multivariate logistic regression analysis (0.978 (0.959 - 0.997), p = 0.026).

### Conclusion

Surgical treatment of SDAVF is a safe and effective procedure compared to endovascular treatment, although endovascular treatment is essential in special cases. The time between MRI diagnosis and surgical or endovascular treatment is crucial for the long-term clinical outcome of SDAVF patients.





Abb. 2



### V177

### Die räumliche Vielfalt und genetische Komplexität des Glioblastoms entschlüsseln Dissecting spatial diversity and genetic complexity of glioblastoma

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### Objective

Glioblastoma (GB) is marked by significant inter- and intratumoral heterogeneity, shaped by intricate interactions between genetic drivers and spatial transcriptional variations. This study aims to investigate how do spatial and genetic variations influence glioblastoma and its microenvironment.

### Methods

To unravel these complexities, we developed nestin-Tva C57BL/6 mouse models of de novo GB through oncogene overexpression and targeted suppression or deletion of tumor suppressors, focusing on three pivotal mutations: PDGFB, NF1, and EGFR. We employed single-cell RNA sequencing (10X Genomics) and spatial multi-omics (Nanostring GeoMx, 10X Visium HD), integrating data through mutual nearest neighborhood (horizontal) and weighted nearest neighborhood (vertical) methods, analyzed using SPATA2 software.

### Results

Leveraging advanced computational tools, including graph neural networks and single-cell deconvolution, we delineated the genetic and spatial variability within tumors and their associated microenvironments. While cellular heterogeneity was pervasive across genetic backgrounds, specific mutations drove dominant transcriptional programs: NF1 loss favored mesenchymal-like states, EGFR amplification induced astrocytic-like phenotypes, and PDGFB overexpression promoted neural progenitor-like states. These genotype-specific shifts were accompanied by distinct microenvironmental features, such as enriched neuronal signaling in PDGFB-driven tumors and pronounced immune cell infiltration in NF1- and EGFR-mutant models.

Further analysis via weighted gene co-expression network analysis (WGCNA), gene set enrichment analysis (GSEA), and spatial niche deconvolution revealed key microenvironmental trends. NF1 loss promoted mesenchymal transitions alongside immunosuppressive niches, while EGFR amplification resulted in elevated perivascular lymphocyte recruitment. These findings were validated against human spatial transcriptomic datasets, underscoring their translational relevance.

### Conclusion

Our work highlights the utility of genetically engineered mouse models in disentangling the relationships between genetic alterations, transcriptional states, and spatial heterogeneity in GB. By integrating single-cell and spatial transcriptomic approaches with sophisticated computational analysis, we provide new insights into the molecular and microenvironmental diversity of GB. These findings pave the way for more precise therapeutic strategies tailored to specific genetic and spatial tumor contexts.

### V178

# Next-Generation-TCR-Sequenzierung von peripherem Blut als diagnostisches Werkzeug zur Erkennung von Glioblastomen

Next-Generation TCR Sequencing of Peripheral Blood as a Diagnostic Tool for Glioblastoma Detection

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### Objective

Glioblastoma (GBM) is one of the most aggressive and prevalent forms of primary brain tumor and is characterized by rapid growth and poor prognosis. Non-invasive diagnostic tools have been investigated over the past decade. Recent studies have highlighted the potential of immunological profiling, particularly through next-generation sequencing of the T-cell receptor (TCR), as a novel approach for tumor identification. This study aimed to evaluate the feasibility of diagnosing GBM by analyzing TCR sequences from peripheral blood samples.

### Methods

We used blood samples from 283 patients with IDH wild-type GBM and 118 healthy donors for TCR sequencing. Next generation sequencing was performed using 2-3 ml of full blood. Bioinformatic analysis was conducted using the MiXCR platform. TCR repertoires were analyzed using clonotype reports comprising approximately five million clonotypes. The data were then used in a benchmarking model using ImmuneML.

### Results

The benchmarking analysis yielded the following accuracies for the various models used in GBM diagnosis: Random Forest (RF) achieved a performance of approximately 85%, followed by logistic regression (LR) at 80% and support vector machine (SVM) at 76%. In contrast, the k-nearest neighbor (KNN) model showed an accuracy of only 33%. These results suggest that Random Forest performs the best, whereas k-nearest neighbors are notably less effective in this application. Our machine learning model was able to predict the diagnosis of GBM using RF, with an accuracy of 85%.

### Conclusion

This study highlights the feasibility of analyzing the peripheral blood TCR repertoire for GBM diagnosis, demonstrating that immunological profiling can serve as a diagnostic tool. The strong performance of the RF model underscores its potential as a reliable tool for early diagnosis, which could ultimately contribute to improved management and outcomes in GBM patients. These findings warrant further investigation into the integration of TCR analysis in clinical practice to enhance diagnostic precision.

### V179

Glioblastom im Konnektom: Wie neuronale Phänotypen Tumorintegration und Konnektivität vorhersagen können

### Glioblastoma in the Connectome: Neural Phenotypes Predict Tumor Integrationand Connectivity

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### Objective

Glioblastoma (GB) is a particularly aggressive brain tumor which is characterized by a low overall survival due to rapid formation of neuron-tumor-networks. The neural epigenetic subtype was linked to increased tumor-neural connectivity but the mechanism remains not fully understood. Here, we aim to investigate the impact of the microenvironmental ecosystem on neuron-tumor synaptogenesis leveraging a human cortical slice model and single cell spatially resolved transcriptomic analysis.

#### Methods

A human cortical slice model was employed to visualize and assess tumor- neuronal interactions using advanced retrograde tracing techniques in human derived cell lines (n=6). This system was based on an EnvA-pseudotyped G-protein-deleted rabies virus. Spatial transcriptomics was conducted using multiplexed error-robust fluorescence in situ hybridization analysis (MERFISH). Additionally, we conducted immunohistochemical staining and confocal microscopy.

#### Results

Spatial transcriptomic evaluation of neural high and low tumors demonstrate significant unique ecosystems within the infiltrating rim of the tumors. Neural-high tumors contained increased abundance of inflammatory myeloid cells driving neuronal synaptogenesis. Retrograde tracing of neural high vs low cell lines confirmed increased synaptic density and neuronal coupling which were associated with higher invasiveness, supported by stRNA-seq, which identified genes linked to synaptogenesis and connectivity.

### Conclusion

Neural-high GB shows enhanced neuronal connectivity and invasiveness, contributing to accelerated tumor progression, which underlines the prognostic value of epigenetic tumor profiling and highlights its potential for novel therapeutic approaches.

### V180

### Inflammatorische Mikroglia fördern die Tumor-Neuronale Synaptogenese Inflammatory Microglia Activation Drives Tumor-Neural Synaptogenesis

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### Objective

Glioma-Neuronal synaptic contacts drive tumor resistance and malignancy. The mechanism of synaptogenesis remains unclear. Through integration of electrical connectivity, cellular diversity and transcriptional regulation, this study explored the impact of microenvironmental alterations which derived synaptogenesis and tumor-connectivity.

#### Methods

"ElectroGenomics" a novel spatially resolved multi-omic technology encompassing electrophysiological, transcriptional and proteomic readouts, was developed in 12 samples. To investigate tumor connectivity, we integrated a Rabis-virus based retrograde tracing model in PDOX and human neocortical slice models combined with spatial transcriptomics. Validation was performed by Microglia inhibition and KO models.

#### Results

We found that highly connected nodes in the tumor edge linked to microglia inflammatory activation driving neuronal sprouting (p<0.01) in a human and PDOX model system. Tumor cell infiltration was associated with damage response including myelin destruction resulting in microglia activation, oligodendrocyte recruitment and BDNF-driven neuronal sprouting. Inhibition of JAK/STAT signaling as well as microglia KO could significantly reduce synaptogenesis and neuronal-tumor connections (p<0.001).

#### Conclusion

This study reveals that proinflammatory microglia—activated by myelin debris—drive tumor-neuron synaptogenesis and glioma integration into neuronal circuits. Targeting microglia with depletion or JAK inhibition reduces synaptic connectivity and tumor network activity, offering a potential therapeutic strategy to disrupt glioma progression.

### V182

# Austausch von Mikroglia und Tumor-assoziierten Makrophagen in experimentellen Hirnmalignom-Modellen Replacement of microglia and tumor-associated macrophages in experimental models of brain malignancies

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#### Objective

Tumor-associated macrophages (TAM) represent a main component of the tumor microenvironment of brain malignancies and promote a pro-tumorigenic, immunosuppressive state. Modifying this myeloid cell population might hold therapeutic potential. Here we investigated methods for high-level integration of hematopoietic graft-derived myeloid cells into the developing tumor microenvironment of murine experimental models of high-grade glioma and brain metastasis.

#### Methods

C57BL/6J mice underwent bone marrow transplantations (BMT) using GFP-labeled donor cells. Replacement of endogenous microglia with donor-derived myeloid cells was achieved through additional pharmacological inhibition of the colony stimulating factor 1 receptor (CSF1R). Transplanted mice were then orthotopically inoculated with syngeneic tumor cell lines of glioma (GL261, CT2A) or breast cancer metastasis (EO771) through stereotactic intracranial injection. The extent of donor cell integration was determined with immunofluorescent analysis. The transcriptomic profile of donor-derived myeloid cells was further characterized using single cell RNA sequencing.

#### Results

We found strong integration of donor-derived myeloid cells into the tumor core in all BMT animals (median  $\pm$  standard deviation: 100.0%  $\pm$  1.6% [BMT only] vs 100.0%  $\pm$  0.0% [BMT with CSF1R inhibition] across all tumor models). Additional CSF1R inhibition led to an increase in the chimerism of donor-derived myeloid cells in peritumoral (e.g. for GL261: 49.5%  $\pm$  33.2% vs 97.2%  $\pm$  6.2%) and distant (0.0%  $\pm$  14.0% vs 93.8%  $\pm$  1.6%) brain areas. Single cell RNA sequencing demonstrated that graft-derived myeloid cells adapt transcriptional states equivalent to cells of endogenous origin including a TAM cluster, which we confirmed histologically by detecting a strong upregulation of the marker protein Galectin-3 in GFP-positive cells. We observed a small but significant survival extension in animals with high-level microglia replacement [BMT with CSF1R inhibition] compared to animals with BMT only (median survival in the GL261 model: 26 vs 22 days, p = 0.014 log-rank test).

#### Conclusion

We demonstrate that BMT was sufficient to promote a virtually complete integration of graft-derived cells into the tumor microenvironment, while augmented microglia replacement increased extratumoral engraftment. The latter might be of functional relevance, as we observed slightly improved survival with combined BMT and CSF1R inhibitor treatment preceding glioma inoculation.

### V183

Entschlüsselung der wechselseitigen neuronalen und immunologischen Interaktionen bei Glioblastomen mithilfe der räumlichen 3D-Transkriptomik von Einzelzellen Deciphering neural-immune reciprocal interactions in glioblastoma using 3D single-cell spatial transcriptomics

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### Objective

The reciprocal interaction between neural and immune components in the tumor microenvironment has emerged as a critical area of study in cancer neuroscience. Recent data has shown the increasing role of myeloid cells in enabling an immunosuppressive microenvironment in glioblastoma. However, the nature and the role of T cells and other immune components forming tumor-immune synapses remain to be fully explored. Here we aim to demonstrate how immunological stimuli and inflammatory changes affect the neural connections within and around glioblastoma cells using advanced spatial transcriptomics.

### Methods

The study employs human cortical slice models, inoculated with tumor cells carrying retrograde tracing viruses, specifically a rabies virus, to trace neuron-tumor connections. This was followed by the inoculation of reactive T cells. We used the MERSCOPE system, which allows for the 3D reconstruction of gene expression signatures in consecutive tissue slices, spanning multiple Z-depths by combining this cutting-edge technology with new segmentation approaches.

### Results

Our spatial transcriptomic analyses revealed different cellular ecosystems in the human cortical slice model. Enhanced inflammatory stimuli can increase local tumor growth and infiltration and neuronal connectivity. We found that inhibition of T cell activation using JAK-STAT inhibition can reverse the reactive hyperconnectivity. We further identified key transcription regulators defining immune cell dynamics and triggering immunological stimuli within tumor-immune synapses.

### Conclusion

The integrative multi-omic approach using imaging-based analysis and 3D single-cell spatial transcriptomics technique is a powerful tool that allows a comprehensive understanding of how immune cells influence the neural connectivity and synaptic reactivity within the peritumoral microenvironment.

### RC067

Expression of Tumor-associated Macrophages and PD-L1 in Primary Tumor and Cerebral Metastasis of Metastasized Breast Cancer Expression Tumorassoziierter Makrophagen und PD-L1 in Primärtumor und Metastase des cerebral metastasierten Mammakarzinoms

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### Objective

Tumor-associated Macrophages (TAMs) are a subset of macrophages that infiltrate tumor microenvironment exerting a variety of effects according to their different functional states, i.e. macrophage polarization in its antitumoral state, M1 and protumor state, M2. Furthermore, Programmed Death Ligand 1 (PD-L1) is a common therapeutic target in breast cancer, which in its active state suppresses cytotoxic T-cell activity, thereby promoting tumorigenesis. Both entities may contribute to tumor progression and metastasis formation. The objective of this study was to analyze distribution and impact on clinical data of aforementioned markers in tumor microenvironments in primary tumor of breast cancer and its cerebral metastasis.

### Methods

27 paired samples of primary tumor and brain metastasis and 26 further brain metastasis samples were collected. In total 53 samples were embedded in paraffin and examined by immunohistochemistry for CD68, CD 86, CD163 which represent markers for general macrophages, antitumoral, and protumoral macrophages, respectively. In addition, PD-L1 and Ki-67 status was assessed in all samples. TAM distribution was assessed using an immunoreactive scoring system, PD-L1 was analyzed by Combined Positive Score (CPS). All exhibited data was correlated to an array of clinical data, progression and survival rates.

### Results

We demonstrated a higher prevalence of TAMs in brain metastasis compared to primary tumor as well as in tumor stroma compared to tumor nest. A correlation between the presence of M2 polarized macrophages and shorter time to occurrence of brain metastasis was found, whereas higher counts of M1 polarized macrophages in brain metastasis correlated with longer survival. When investigating the presence of meningeal carcinomatosis an inverse correlation to CD86 and CD163 was observed. CD86 presented a correlation to higher grading and CD163 to hormone-receptor negative tumors. Furthermore, PD-L1 was expressed more frequently in Her2/neu+ and triple-negative tumors without effect on overall survival. PD-L1 expression in primary tumor did not predict expression in brain metastasis.

### Conclusion

Results demonstrated presence and diverse influence of TAMs in primary tumor and brain metastasis of all types of breast cancer. The observed discrepancy between PD-L1 status in primary tumor and brain metastasis warrants to consider analysis of PD-L1 in breast cancer brain metastasis as part of standard protocol.

### RC068

### Cannabinoide als epigenetische Therapeutika bei Glioblastomen Cannabinoids as epigenetic therapeutics for glioblastoma

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### Objective

Glioblastoma (GBM) is one of the most severe and aggressive brain tumors. Standard therapies such as surgery, radiotherapy, and chemotherapy are rarely effective enough and often lead to tumor recurrence. With the continuous need for novel approaches for GBM the potential use of cannabinoids has garnered significant scientific interest. Cannabinoids, particularly tetrahydrocannabinol (THC) and cannabidiol (CBD), exhibit potential anti-tumor effects through multiple mechanisms, including apoptosis, autophagy, anti-proliferative actions, and modulation of the tumor microenvironment. The role of epigenetic events in gliomagenesis is undoubtful. Epigenetics offers a connection between genetic and environmental factors that influence disease development. The best-characterized epigenetic mark is 5-methylcytosine (m5C) in DNA. It was shown that loss in total DNA methylation correlates with oxidative DNA damage, as well as a higher tumor malignancy. The most sensitive marker of oxidative stress is the presence of 8-oxo-deoxyguanosine (8-oxo-dG). Taking that into account we decided to analyze the influence of cannabinoids' administration on the total DNA methylation, as well as oxidative stress level in glioblastoma.

#### Methods

Using the nucleotide post-labeling method, we analyzed the total amount of m5C in DNA of GBM (T98G, U118, U138), and normal (HaCaT) cell lines treated with cannabinoids (cannabis paste, THC, and CBD) alone and in combination with TMZ. The amount of 8-oxo-deoxyguanosine was established with electrochemical detection.

### Results

Cell viability in GBM cell lines was stable for THC and CBD at concentrations up to 1250 ng/ml. However, for Cannabis paste, it dropped significantly after the concentration of 20 ng/ml. We observed higher DNA methylation with shorter exposure times (24h) than with longer (120h) exposure periods. With increasing cannabinoids' concentration we observed the rise of DNA methylation up to a certain point and then the decrease. The addition of TMZ caused demethylation for cannabis paste and THC, but increased methylation in the case of CBD.

#### Conclusion

Our results show the epigenetic mechanism of cannabinoid action in glioblastoma, and in the context of balancing the DNA methylation as a therapeutic target explain their observed positive effect in the clinical setting. The data also show the importance of adjusting the effective drug type and concentration. This work was supported by OPUS 19 (2020/37/B/NZ5/03249) from the National Science Center, Poland.

### RC069

# Untersuchung des Darmmikrobioms bei Gliompatienten Assessing Gut Dysbiosis in Glioma Patients

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### Objective

The gut-brain axis has gained significant attention in neurological diseases in the past years. However, its role in gliomas remains underexplored. In this study, we aimed to assess gut dysbiosis and evaluate the potential of gut microbiota as a biomarker in glioma patients.

### Methods

We collected stool samples from 32 glioma patients at admission and again 4 weeks after primary surgery. A primary control group was composed of 20 healthy individuals. To enhance differentiation, stool samples were also collected from a secondary control group consisting of inpatients with similar comorbidities but no glioma. The bacterial composition of each sample was analyzed using 16S-rRNA sequencing.

### Results

A total of 32 glioma patients, 20 healthy controls, and 21 inpatients were included in the study. In the glioma group, the bacterial family *Sutterellaceae* and the genera *Lachnospira*, *Fusicatenibacter*, and *Phocaeicola* were underrepresented compared to healthy controls (*Sutterellaceae*: p = 0.000006; *Lachnospira*: p = 0.0001; *Fusicatenibacter*: p = 0.0007; *Phocaeicola*: p = 0.01), while the family *Clostridiales incertae sedis* was overrepresented (p = 0.004). However, when comparing the gut microbiota of glioma patients to inpatients with similar comorbidities but without glioma, no significant differences were found. Interestingly, longitudinal analysis revealed that the family *Sutterellaceae*, which was underrepresented in glioma patients at admission compared to healthy controls, significantly increased after surgery (p = 0.009).

### Conclusion

Our data provide evidence of gut dysbiosis in glioma patients; however, the observed changes in gut microbiota do not appear to be specific to glioma. On the other hand, longitudinal analysis may offer potential for therapy monitoring in glioma patients. Further studies, particularly those assessing the functionality of the gut microbiota, are needed to gain a deeper understanding of the role of the gut-brain axis in glioma.

### RC070

### Die Geheimnisse des Gliosarkoms: Räumliche Einblicke in eine seltene Tumorvariante Unraveling the Mysteries of Gliosarcoma: Spatial Insights into a Rare Tumor

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#### Objective

Gliosarcoma (GS) is a rare, aggressive variant of glioblastoma (GB), comprising about 2% of GB cases. While GS and GB share genetic and epigenetic traits, GS is distinguished from GB by its biphasic histological growth pattern — glial and sarcomatous differentiation — and a greater tendency for skull invasion and distant metastases. The mechanisms driving these differences remain unclear. We propose that GS's unique architecture and clinical behavior stem from distinct interactions between tumor cells and the tumor microenvironment (TME).

#### Methods

To investigate this hypothesis, we employed sequencing-based spatial transcriptomics (ST) to analyze 15 GS samples from 13 patients, propensity matched with GB samples based on age, sex and methylation profiles. Using unsupervised clustering and non-negative matrix factorization, we identified transcriptional metaprograms in GS and GB. Cell-type deconvolution mapped tumor cell subtypes to TME components. Cell-to-cell communication analysis further elucidated the interactions between tumor phenotypes and TME cells.

#### Results

In the GS samples, we identified four spatial metaprograms that were abundant across multiple samples and characterized by shared gene expression patterns. Notably, one of these was a hypoxia-related program, with upregulated genes such as MT1X and VEGFA. Cell-type deconvolution revealed a strong spatial correlation between this program and tumor cells exhibiting a mesenchymal phenotype. The proportion of these mesenchymal-like tumor cells was significantly higher in GS tumors compared to GB tumor cells (p < 0.01).

### Conclusion

This study provides the first spatially resolved transcriptional insights into gliosarcoma, highlighting the tumor's unique architecture and interactions with the TME, and potentially offering new therapeutic targets for both GS and GB.

### V184

### Verbesserung der Reliabilität von Neglekt-Assessments für HirntumorpatientInnen Enhancing the Reliability of Neglect Assessment for Brain Tumor Patients

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### Objective

Neglect syndromes are often overlooked in everyday neuro-oncological practice although they have a major impact on quality-of life. Bedside tests such as cancellation tests do not readily distinguish between neglect and hemianopsia and are prone to bias due to attentional effects. Moreover, established tests lack parallel versions, required for repeated testing in the follow-up setting. We recently introduced the Find The Symbol Test (FST) offering five parallel versions. To elaborate on the comparability between these tests and to establish clear benchmarks for an appropriate interpretation of test results, we compare the reliability of the FST with three established neglect tests.

### Methods

We evaluated the five parallel FST versions, the line bisection as well as the apples and the bells test at a single time point in (a) 192 healthy subjects (age: 18-90y) and (b) 20 patients with right-hemispheric brain tumors. All test indices were normalized to percentile ranks to ensure comparability. Reliability analyses of (i) Number of Cancellations, (ii) Performance Time, and (iii) Asymmetry Scores were conducted between the FST versions and across all neglect tests, using R.

#### Results

In healthy subjects, the FST showed good internal consistency for cancellations ( $\alpha$ =0.71) and performance time ( $\alpha$ =0.97), while only performance time had good reliability across all tests ( $\alpha$ =0.60-0.94). The asymmetry index showed poor reliability ( $\alpha$ ≤0.45) between FST versions and across neglect tests, likely due to general attentional fluctuations rather than side-specific neglect. In patients, the FST and all tests exhibited high reliability for performance time and cancellations. Absolute asymmetry values showed strong reliability, when regarding the reliability of the non-side-related, i.e., absolute asymmetry value ( $\alpha$ =0.82).

### Conclusion

Due to its outstanding reliability, greater emphasis should be placed on performance time as a not necessarily neglect-specific marker of visuospatial attention and working speed. In contrast, the asymmetry index appears to be strongly biased, e.g. by attention, and should therefore be interpreted with caution, especially when based on a single test result. To minimize this source of misinterpretation, the use of multiple parallel FST versions per time point seems advisable.

### V185

Die Rolle von DTI-basierten Schäden subkortikaler Bahnen bei Sprachdefiziten: Einführung des Aphasia Tract Impact Score (ATIS)

The role of DTI-based white matter damage in language deficits: Introducing the Aphasia Tract Impact Score (ATIS)

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### Objective

Understanding the impact of brain tumors on language function is essential to optimize surgical outcomes. This study investigates the relationship between language deficits and white matter tract damage in patients with left hemispheric brain tumors.

#### Methods

Language function was assessed in 84 patients (IDH-wildtype glioblastoma, n=29; IDH-mutant astrocytoma, n=18; metastases, n=15; others, n=22) using the Anatomical Functional Aphasia Screening comprising 43 subtests (AFAS) and DTI-based deterministic language tractography, pre- and postoperatively. A novel Aphasia Tract Impact Score (ATIS) was introduced, considering the impact of individual language tracts (AF, 4 points; IFOF, 3 points; ILF, MdLF 2 points each; UF, FAT 1 point each) based on tract-dependent AFAS score deterioration. The relationship between ATIS and AFAS was analyzed for the different tumor types by linear regression.

### Results

Pearson correlation analysis revealed a moderate negative correlation between the ATIS and AFAS score for glioblastoma (r = -0.62), but not for astrocytoma (r = -0.13) or metastases (r = -0.37). Linear regression for glioblastoma showed a significant negative association between ATIS and AFAS score ( $\beta$  = -0.024, p < 0.05), explaining 38% of the variance (R<sup>2</sup> = 0.38, p < 0.05). Pre- and postoperative language assessments analyzed using the Wilcoxon matched pairs test indicated significant differences only for glioblastoma and astrocytoma (p < 0.05).

#### Conclusion

ATIS provides a new quantitative tool for assessing the white matter language network based on deterministic DTI tractography, especially for IDH-wildtype glioblastoma. In IDH-mutant astrocytoma and metastases, the ATIS doesn"t correlate with AFAS. Presumably, glioblastoma impairs language through tract infiltration without compensatory neuroplastic mechanisms. In contrast, astrocytoma may preserve language via neuroplasticity, while metastases affect DTI tractography edema-related with less functional impairment. Functional outcomes were preferable for metastases compared to gliomas.

### V186

Der Einfluss der Hirntumorlokalisation in klassischen und sprachunterstützenden Hirnregionen auf die sprachassoziierte fMRT-Aktivierung The influence of brain tumor localization in classical and language supporting brain areas on language processing fMRI activation

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### Objective

Brain tumors in eloquent brain areas may trigger functional reorganization of language processing even in brain areas distant from the lesion. It is unclear whether tumors in secondary but mandatory language processing supporting brain areas such as the medial temporal lobe or the precentral gyrus have an impact on language processing. This study investigates if there might be an interaction of tumor localization either in language essential or supporting brain areas and language associated activation in classical language areas of the dominant and non-dominant hemisphere.

### Methods

fMRI data of 97 patients with brain tumors in the left hemisphere and 31 healthy controls were included in this study. Patients were either assigned to a group with tumors in the inferior frontal gyrus (IF), the precentral gyrus (PC), the posterior (PT), the medial (MT) or the anterior temporal (AT) lobe. A word generation task served as a fMRI paradigm. Data analysis was done by using SPM12 comprising realignment, coregistration, normalization using segmentation information and smoothing preprocessing. Whole brain analysis was performed using the general linear model approach on individual. For ROI analysis the Marsbar toolbox and the AAL-Atlas for region of interest (ROI) definition was used. Individual analyses were only applied in ROIs not intersecting with individual tumor locations.

### Results

On whole brain level all groups except the IF group showed significant more activation in the superior parietal cortex and posterior cingulate cortex compared to healthy contols. On ROI level patients in the IF group showed significant reduced activation in the right angular and supramarginal gyrus compared to patients in the TM and the TP group as well as less activation in the right superior temporal gyrus compared to the TP group. Further the IF and the PC group exhibited reduced activation in the right inferior frontal gyrus compared to the TA and the TM group. The TA group showed increased activation compared to the TP group in the left triangular gyrus, while the TM group exposed increased activation in the bilateral parietal lobe compared to the control group. Patients in the TP group had less activation in the right supramarginal gyrus and the left inferior frontal gyrus compared to the AT and the control group.

### Conclusion

This study suggests a complex interplay of brain tumor location in classical but also language supporting brain areas and language associated brain activation.

### V187

# Unterschiedliche Paradigmen für die fMRI-basierte semantische Entscheidungsaufgabe: nonverballe Kartierung der Sprache?

### Different paradigms for semantic decision task-based fMRI: mapping language non-verbally?

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### Objective

Semantic association, which is a critical part of communication, is rather rarely part of the standard monitoring parameters for awake surgery. Here, language mapping and monitoring is typically based on overt naming paradigms and therefore restricted to patients with intact expressive language skills. In this work, we investigated the feasibility of employing different paradigms to probe semantic association, including a nonverbal paradigm, using a pyramids and palm tree test adaption (Cologne Semantic Association Task; CoSAT).

### Methods

The CoSAT is composed of 42 stimuli of three object drawings (from the Cologne Naming Test; CoNaT), arranged in triangle format. The task consisted in forced choice of the semantically associated bottom image to the top one, in three different fashions: (I) left-handed button press, (II) object naming, and (III) naming of the common sematic category or concept. We evaluated the influence of the instruction type on cortex activations by recruiting 22 volunteers (11 females, 29 +/ 10 years old) to undergo fMRI while performing all 3 forms of this task (Philips Ingenia 3T, cluster sparse acquisition). The data was analysed using SPM12.

### Results

fMRI results showed that all three paradigms predominantly activate the left-hemispheric inferior frontal gyrus (IFG). Additionally, the button press variant elicits activations of the hand knob of the motor cortex (M1), not apparent in the other two variants (p < 0.001). Interestingly, the opposite contrast (category naming > button press) seems to show an exclusive activation of the primary/secondary motor representation of tongue, face and vocalisation muscles in the inferior-anterior part of the precentral gyrus and the anteriorly adjacent gyrus (p < 0.01). Contrasting category naming > object naming, an activation in the of the parieto-temporo-occipital junction zone is observed.

### Conclusion

Our results suggest that the use of different instructions to execute a semantic association fMRI task can enable functional mapping of important language areas like the IFG, even non-verbally. While the choice of paradigm could be generally tailored to the lesion locations and the patient's skills, the button press variant of the task seems to be of particular interest to map language in patients with severe expressive language deficits.

### V188

### Tumor-induzierte Veränderungen der Reaktivität und Konnektivität des Gehirns: Eine TMS-EEG Studie Tumor-induced changes in reactivity and connectivity of brain tissue: A TMS-EEG study

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#### Objective

Effects of brain tumors may extend far beyond the structural borders of the mass, modifying activity of adjacent brain areas or even disrupting distant functional networks. Consequently, tumors that appear identical on imaging may be associated with different functional impairments and postoperative outcomes. TMS-EEG offers the unique potential to study these functional alterations by measuring the brain"s response to direct perturbations, while not relying on behavioral correlates.

### Methods

In this case series we included five patients with high- (n=2) and low-grade gliomas (n=1) or meningiomas (n=2) before and 3-6 months after surgical resection of the tumor. Prior to TMS-EEG, patients underwent a detailed neurological examination. For TMS-EEG, three cortical points were targeted with approximately 200 TMS pulses each: one tumoral, one peritumoral and one matched contralateral control point. Stimulation intensity was defined based on the amplitude of early TMS-evoked potential (TEP) components (<50ms) in the contralateral control point and kept constant for the other sites. The TMS-associated click was masked with a tailored masking noise.

### Results

In two glioma patients, stimulation of the tumoral and peritumoral spots produced a sleep-like low-complexity slow-wave suggesting dysconnectivity of the tissue. 3 months postoperatively, one of these patients showed increased slow-wave amplitudes in all spots and shortly afterwards was evaluated for a bi-hemispheric tumor recurrence. The other patient showed a normalization of TEPs alongside a general clinical improvement. The third glioma patient showed a preoperative disruption of TEPs for tumoral and peritumoral sites yet no slow-wave. Postoperatively, the patient showed an improvement in reactivity over peritumoral and tumoral areas. Finally, both meningioma patients had preserved complex TEPs for all stimulation sites and timepoints, however alongside a reduced amplitude of the oscillations compared to healthy controls.

### Conclusion

For the first time, we show that TMS-EEG can detect alterations of cortical reactivity in the perilesional tissue in brain tumor patients. A more detailed assessment of these alterations can aid the quantification of a structural and functional reserve in patients before surgery by measuring the degree of network impairment. Importantly, this is independent of the functional network at question as the method does not require a behavioral readout during stimulation.

### V191

### Instantane, schnittfreie intraoperative Histologie in der Neurochirurgie mit Multiphoton-Mikroskopie Instant slice-free intraoperative histology in neurosurgery with multiphoton microscopy

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### Objective

During neurosurgical tumor resection, rapid histological analysis is often required to guide the procedure or confirm resection radicality. The standard method, frozen sectioning, can take up to 40 minutes for results to reach the operating room (OR), depending on the clinic's logistics.

Multiphoton Microscopy (MPM) enables the histological examination of samples immediately without the need for sectioning. Instead, the intact sample is scanned after a brief staining procedure in the OR and then digitally submitted to a neuropathologist. This method can potentially greatly expedite the entire process.

### Methods

MPM is a laser-based imaging technique generating virtual sections from intact samples, using a non-linear optical effect to scan specific depths within tissue blocks. Our study aims to establish a reliable workflow and protocol for use in the OR as well as to validate the method. To date, 21 patients were included in the study and their samples imaged with the MPM scanner. All images were reviewed and diagnosed in a blinded manner by a board-certified neuropathologist in three batches, who had no prior experience with MPM images. Patient's age, sex, and lesion localization were the only supplementary information available.

### Results

The diagnosis agreed with the results of routine analysis in 19 out of 21 cases. Tissue histomorphology was further compared with snap-frozen sections and paraffin-embedded sections, demonstrating good accessibility to cell morphology and tissue texture. The average scanning time was around 2 minutes plus 3 minutes staining time and about 3 minutes for sample handling and MPM operation. There is prospect to further accelerate the scanning speed by a factor of eight and also potential to speed up the staining, sample handling and MPM operation.

### Conclusion

The new results of our study confirm that MPM could serve as a viable alternative to intraoperative frozen section analysis in neurosurgery. Remote neuropathological evaluation of intraoperative tissue is enabled through digital images, which can be generated quickly and efficiently. The high similarity between MPM images and standard H&E tissue sections minimizes the need for device-specific training for neuropathologists. Moving forward, we aim to enhance our device to streamline the workflow and maximize imaging speed. Additionally, we plan to expand the cohort size to further validate its broad applicability in neuro-oncology.





### Abb. 2



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### V192

Abgrenzung von tumoralen und nicht-tumoralen Regionen bei Gliompatienten durch quantitatives Multiparametermapping (MPM) Delineation of tumoral and non-tumoral regions in glioma patients by quantitative multi-parametric mapping (MPM)

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### Objective

Multi-parametric mapping (MPM) enables quantifiable tissue characterization through specific MRI sequences, offering scanner-independent values without the need for contrast normalization. We analyzed whether MPM contrast values can differentiate between tumoral and normal white matter (wm) to develop a quantitative approach for delineating peri-/tumoral boundaries in glioma patients.

### Methods

We analyzed 12 glioma patients (females n=6; WHO Grade 2 [n=4], WHO Grade 4 [n=7]) using four MPM sequences: MT (magnetization transfer), PD (proton density), R1 (longitudinal relaxation rate), R2s (transverse relaxation rate). We created binary lesion masks from T1c images and segmented contra-lesional wm using Atropos/ANTs. For ipsi-lesional peritumoral wm, we developed a Python3 script to sample voxel-wise MPM values at increasing Euclidean distances around the tumor mask. We applied Spearman correlation for MPM contrasts relationships and Mann-Whitney U-Test to compare tumor versus 9mm peritumoral region. Tumor type comparison used Dice scores based on discretized MPM feature space.

### Results

MPM analysis revealed strong correlations between R1-PD (r=-0.80, p<0.0001, df=2029491) and MT-R1 (r=0.93, p<0.0001, df=2029491). Region-specific analysis showed distinct mean values between tumor and 9mm peritumoral wm in MT (1.48 vs 3.64), R1 (0.55 vs 0.92), R2s (12.39 vs 23.47), confirmed by Mann-Whitney-U tests (MT: U=1,040,266, p<0.0001; R1: U=1,135,409, p<0.0001; R2s: U=1,490,712, p<0.0001). Dice scores for glioma type differentiation ranged from 0.1794 (anaplastic Astrocytoma WHO 4 vs Glioblastoma WHO 4) to 0.4161 (diffuse Astrocytoma WHO 2+3 vs Oligodendroglioma WHO 2). Low-grade gliomas showed lower gradient descent in MT/R1 values, while high-grade gliomas (WHO grades 3-4) demonstrated sharp initial gradient changes near tumor boundaries.

### Conclusion

MPM contrast patterns reveal scanner independent absolute values, which directly yield comparable tissue characteristics. These reflect tumor infiltration and edema within the surgically relevant peritumoral area. High-grade gliomas show distinct gradient changes indicating perifocal edema, while low-grade gliomas display diffuse widespread infiltration, in line with known tumor biology. These quantitative patterns may complement current standard structural MRI in characterizing tumor boundaries, though further validation studies are needed.

### V193

Konfokale Laser Endomikroskopie zeigt mikroskopische Gewebemorphologie zur intraoperativen Qualitäts-Analyse von Hirntumor-Biopsien Confocal laser endomicroscopy reveals tissue mircromorphology for intraoperative quality assessment of brain

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### Objective

tumor biopsies

Brain tumor biopsies in cases with equivocal patient history or MRI findings inherently carry a risk for inconclusive results or neurological deficits. This results in a constant need for innovation to tackle both issues. Confocal laser endomicroscopy (CLE) is an emerging technology that enables real-time assessment of tissue micro-morphology during surgery. Hence, we aimed to evaluate the utility of CLE for quality assessment of demanding brain tumor biopsies.

### Methods

The study was conducted on 19 patients undergoing brain tumor biopsies with equivocal MRI findings. Sodium fluorescein (Na-F; 5 mg per kg bodyweight) was administered as a contrast agent at the time of skin incision and CLE imaging was performed on freshly biopsied tissue ex vivo (n=1-8 per case). The CLE images were visually inspected by the neurosurgeon and the neuropathologist for signal intensity and tissue features, including cell size and density. Subsequently, the biopsies were transferred for frozen section pathology and diagnostic histopathological workup.

### Results

Imaging was performed in median 28 min (range 20-53 min) after administration of Na-F. On average, 147 images were acquired on each biopsy (range 54-331). Time series allowed to differentiate cellular patterns from contaminations with erythrocytes that were moving across the field of interest. In 13/19 cases, a strong fluorescence signal of Na-F was seen together with additional image features (e.g. increased cell density and pleomorphic cells) allowing a preliminary diagnosis. If the Na-F signal was subtle, micromorphological abnormalities could still be identified and the specimen was subsequently considered sufficient for histopathology. Typically, strong Na-F fluorescence was found in glioblastoma and lymphoma and brain metastases, while a subtle Na-F signal accounted for a broad spectrum of entities such as multiple sclerosis or low-grade glioma. It is noteworthy, that those results might be skewed considering the demanding selection of cases. Importantly, histopathological workup was not affected by CLE imaging and a definite diagnosis was possible in all cases.

### Conclusion

CLE with Na-F is a valuable tool for intraoperative quality assessment of demanding brain tumor biopsies and frequently allows for assignment of a preliminary diagnosis. Immediate histopathological evaluation enables intraoperative adaptation in biopsy location and sample amount, therefore reducing the likelihood of inconclusive biopsies and neurological deficits.

### V194

### Die Bedeutung der infratentoriellen Drucküberwachung beim Schlaganfall im Kleinhirn A benchmark approach to infratentorial pressure monitoring in cerebellar stroke

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#### Objective

Intracranial pressure (ICP) monitoring is essential for neurocritical care of patients. Current evidence surrounding infratentortial ICP measurement is very low, although several reports have been describing the insufficiency of supratentorial ICP measurement in case of infratentorial pathology. Therefore, the aim of the study was to analyze the value and feasibility of infratentorial ICP monitoring in patients with acute infratentorial pathology and develop a predictive model for outcome of those patients.

#### Methods

This multicentric prospective cohort study consisted of 35 patients admitted with hemorrhagic or ischemic cerebellar stroke in 3 different certified neurological and neurosurgical departments in Germany from 2021 to 2024. All patients underwent decompressive surgery with simultaneous supra- and infratentorial ICP measurement up to 7 days. Outcome was analyzed by modified Rankin Scale (mRS) at discharge and 6 months follow-up (FU).

### Results

The mean infratentorial ICP was significantly higher compared to the supratentorial ICP value (11.9mmHg 95% CI 10.5-13.3 versus 8.8mmHg 7.4-10.1, p<0.001). The mean ICP curves by outcome revealed that patients with unfavorable outcome had significant higher infratentorial ICP values compared to those with favorable outcome at FU (13.1 3.8 95% CI 11.1-15.1 vs 9.5 1.2 95% CI 6.8-12.1; p=0.042). The multivariate logistic regression analysis indicated that a continuous score system with age (years) plus 4x mean ICP (mmHg) as a significant predictive model for unfavorable outcome at discharge and FU (p<0.001 and p=0.001; AUC 0.88 and 0.89, respectively) with a cut-off value of 115.

### Conclusion

Infratentorial ICP monitoring allows a precise reflection of the posterior fossa region and seems to be strongly associated with functional outcome. Therefore, infratentorial ICP monitoring should be considered as standardized tool in patients with posterior fossa lesion.

### V195

Gehirnerschütterungen sind mit einer Vielzahl von Defiziten in Kognition und täglichen Aktivitäten im späteren Leben assoziiert.

History of Concussion is Associated with a Broad Range of Impairments in Cognition and Daily Activities Later in Life

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### Objective

Mild traumatic brain injury or concussion is a global health problem with around 50 million cases per year. Up to one half of individuals with a history of concussion will develop a variety of chronic symptoms, which can be diverse and non-specific. The full range of possible symptoms years to decades after a concussion is not yet fully known. In this study we aim to evaluate associations between a history of concussion and impairments in a wide range of daily activities or cognitive functions later in life within a large population.

#### Methods

This retrospective cross-sectional analysis is based on the Fox Insight study. 6,931 participants provided information on concussion history, cognitive performance and daily activities. 2,603 participants with a positive history of concussion were matched by age and sex to 2,603 participants without a history of concussion. Binary logistic regressions were used to associate a history of concussion with the presence of impairment in daily activities and cognitive performance. All analyses were controlled for the effect of demographic factors, comorbidities, medication and multiple comparisons.

#### Results

Participants (average age: 64 years; 55% female), both with and without a history of concussion, were included in the study. The average time since concussion was 43 years (SD:18; Range 0-79). A history of concussion was significantly associated with higher odds of deficits in 11 out of 15 questions on cognition and daily activities, including deficits in memory (OR=1.30, 95%CI: 1.12-1.50, p=0.002), reading (OR=1.29, 95%CI: 1.12-1.49, p=0.002), explaining (OR=1.27, 95%CI: 1.08-1.51, p=0.010), and maintaining train of thought (OR=1.36, 95%CI: 1.14-1.64, p=0.003). No significant associations were found between a history of concussion and counting money, handling financial affairs, or using a map.

### Conclusion

In this cross-sectional study of over 5,000 participants, self-reported history of concussion was associated with a broad range of subjective impairments in daily life activities years to decades later. The study findings suggest that concussion history may predispose for a broad range of impairments in daily activities later in life.

### V196

Integrative Liquor- und Gehirnproteomanalyse bei Patienten nach schwerem Schädel-Hirn-Trauma zur Evaluation potenzieller prognostische Biomarker Integrative cerebrospinal fluid and brain proteome analysis after severe traumatic brain injury to determine potential biomarkers

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### Objective

Severe traumatic brain injury (TBI) is a major cause of death and long-term disability. Prediction of prognosis is challenging due to TBI"s heterogeneity making biomarker identification crucial for predicting both severity and outcome. We conducted a multicenter prospective comprehensive quantitative proteomic analysis to explore proteomics underlying severe TBI. For the first time, cerebrospinal fluid (CSF) from different time points and brain samples were analyzed with the goal to identify brain-derived proteins in CSF after primary injury as well as proteins with prognostic value of both secondary injury and overall outcome

### Methods

Mass spectrometry (MS)-based proteome analysis was performed on 32 consecutive patients with severe TBI including CSF from three time points (days 0, 3, and 6; n=79) and brain samples (day 0, n=19) after TBI from patients requiring evacuation of brain haematoma, along with CSF from 17 healthy controls. Standard neuromonitoring data such as intracranial pressure (ICP), somatosensory evoked potential (SSEP), intensive care daily monitoring parameters were evaluated together with proteomic data. Data-independent acquisition (DIA) was used for protein quantification, quantitative MS data were analyzed using bioinformatical methods (principal component analysis) and unsupervised hierarchical clustering. Surviving patients were followed-up at least 6 months using standard scales

### Results

A total of 3209 brain- and 2076 CSF proteins were identified. 591 brain-derived proteins were exclusively present in severe TBI patients" CSF, indicating primary injury. Significant protein regulation with corrected p< 0.01 was observed in TBI -CSF compared to controls on days 0 (265 proteins), 3 (184 proteins), and 6 (236 proteins). Using hierarchical clustering analysis proteins with similar temporal abundance patterns were identified. This included known TBI-associated proteins (GFAP and UCHL1) which peaked at day 0 and decreased over following days. Moreover, we could identify seven proteins in CSF significantly associated (p< 0.01) with Glasgow outcome scale GOS (CFHR1, GM2A, CLSTN1, NPTX1) and ICP monitoring (UCH-L1, YWHAG, NPTXR)

### Conclusion

This study provides an integrative analysis of human CSF- and brain proteome profiling after severe TBI revealing a differentiated protein profile in CSF after primary injury. Additionally, our analysis strongly suggests the prognostic value of six new identified proteins

### V197

### Identifikation einer perilesionalen Regenerationszone nach traumatischer Rückenmarksschädigung Defining a perilesional regeneration zone following experimental Spinal Cord Injury

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#### Objective

Traumatic Spinal Cord Injury (SCI) is followed by a secondary injury cascade, spreading tissue damage along to formerly unharmed spinal cord (SC) regions. Endogenous regenerative potential is thought to be highest in SC regions adjoining the injury. Defining the secondary injury's extent is essential to develop locally targeted therapies. Here, we characterize the temporospatial aspects of vascular injury and recovery, inflammation and glial scarring to define a peritraumatic regeneration zone following experimental SCI.

#### Methods

Adult C57BL/6J mice (n=24) underwent thoracic SCI (Th6/7, clip-compression 5g, 60s) or sham-injury (laminectomy). At days(d) 1, 3, 7, 14 and 28 after surgery, animals (n=4/group) were sacrificed via FITC-Lectin perfusion. Immunohistochemistry (CD31, Ki-67, GFAP, Iba1, CSPG) assessed vascular injury and recovery, inflammation, and glial scarring in the trauma epicenter (R0) and in two adjoining SC regions (R1: 1-3mm, R2: 3-5mm cranially/caudally). Animal experimental permission was granted (G0314/17).

#### Results

While significant vessel injury occurred at all time points in R0 (p<0.05), significant loss of functional vasculature (CD31+/FITC-Lectin+) was primarily observed at d3 in R1 and R2 (p<0.05). Endogenous revascularization (CD31+/Ki67+) was significantly detectable at d3 in all regions (p<0.001), leading to full restoration of functional vasculature by 28d only in R2 (3-5mm, p<0.05). Inflammatory responses (GFAP+, Iba1+) were observable between d3-7 in all regions (R0-2, 3d: p<0.05, 7d: p<0.001), while glial scarring (co-localization of GFAP+/CSPG+) was significantly measurable between d14-28 in R0 and R1 (p<0.001), not extending into R2 (p>0.05).

#### Conclusion

These findings unveil the occurrence and timeframe of spreading tissue damage following SCI and highlight a regionally increased regenerative potential in SC regions directly adjoining the injury epicenter. Endogenous regenerative processes start within the first week after SCI with the potential to substantially restitute functional vasculature. Further studies are needed to examine related cell-cell-interactions to develop targeted therapies aimed at this peritraumatic regeneration zone.
### V198

Das Potential der navigierten transkraniellen Magnetstimulation in der Vorhersage des motorischen Outcomes bei Patienten mit akuten traumatischen Rückenmarksverletzungen The potential of navigated transcranial magnetic stimulation to predict motor outcome in patients with acute traumatic spinal cord injury

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#### Objective

Traumatic spinal cord injuries (tSCI) often result in lifelong disabilities and pose a high socioeconomic burden. Given the heterogeneity of tSCI is a critical need for objective, quantifiable methods to evaluate the current status and predict neurological outcomes. The aim of this study was to evaluate the potential of navigated transcranial magnetic stimulation (nTMS) to predict motor outcomes in patients with acute tSCI.

#### Methods

A total of 20 patients suffering from tSCI were included. nTMS motor mapping was performed and compared to intraoperative neuromonitoring data, as well as patient outcomes, including detailed motor function and American Spinal Injury Association Impairment Scale (AIS) scores.

#### Results

Mean age was 68.9 ± 15.6 years (28-94 years). Preoperatively, 7 patients (35.0%) were classified as AIS A or B. 13 patients (65.0%) were classified as AIS C or D. At follow-up, 5 patients (25.0%) had improved.

In all patients motor evoked potentials (MEPs) were elicited. Recordings of nTMS and intraoperative neuromonitoring (IONM) were available for 17 patients and a total of 88 muscles (62 UE muscles, 26 LE muscles). In IONM, MEPs were observed for 38 (61.3%) of 62 UE muscles and 5 (19.2%) of 26 LE muscles, while in nTMS, MEPs were observed in 41 (66.1%) and 7 (26.9%) of these muscles. Combining the results of IONM and nTMS, a sensitivity of 85.2% and a specificity of 88.9% for motor function of the tested muscle at follow-up was achieved for upper extremity muscles. For lower extremity muscles, a sensitivity of 57.1% and a specificity of 100% was achieved.

#### Conclusion

nTMS allows for an objective assessment of motor system integrity in patients with acute SCI. Despite a relatively low sensitivity, potentially due to decreased excitability, this technique provides excellent specificity in predicting short-term and long-term motor outcomes.

### V199

Analyse des anatomischen Verteilungsmusters inflammatorischer und neuroregenerativer Prozesse in der chronischen Phase nach experimentellem Schädel-Hirn-Trauma im Mausmodell Analysis of the spatial profile of inflammatory and neuroregenerative processes in the chronic phase after experimental traumatic brain injury in mice

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#### Objective

Many preclinical traumatic brain injury (TBI) studies choose local inflammatory markers as primary outcome parameters. However, many of these studies focus their pathoanatomical outcome analysis on the assessment of the traumatic penumbra and neglect changes in distant brain areas, that might be just as relevant for neurological function. Therefore, in order to evaluate if such limited approaches to preclinical outcome assessment are sufficient, we assessed the effect of one of the most utilized preclinical TBI models, the controlled cortical impact (CCI) model, on inflammatory as well as regenerative processes in the ipsi- as well as the contralateral hemisphere in the chronic phase after trauma induction.

#### Methods

A total of 20 C57Bl/6 wildtype mice were randomly assigned to receive either a controlled cortical impact (bolt diameter 2mm, impact depth 1mm, velocity 8m/s) or a sham surgery. On day 28 post CCI the animals were sacrificed and the brains were removed. The inflammatory response as well as regenerative processes in five distinct regions of interest (ROIs: penumbra, ipsi- and contralateral cortex, ipsi- and contralateral hippocampus) were assessed utilizing immunofluorescent staining of coronal frozen sections of the brains with the following staining targets: Iba1, CD86, CD206, GFAP, MBP, NeuN and Olig2. The five ROIs within the CCI group as well as the ROIs of CCI and sham operated animals were statistically compared; p<0.05 was considered significant.

#### Results

While pro- and anti-inflammatory processes were significantly promoted in ipsilateral ROIs in CCI animals (e.g., mean Iba1+ cells/sROI in the penumbra:  $0.57 \pm 0.10\%$  vs.  $4.91 \pm 1.12\%$ , p<0.001 for sham and CCI), they seemed to be downregulated in contralateral ROIs (e.g., GFAP intensity in the contralateral cortex:  $164.41 \pm 3.16$  U vs.  $148.60 \pm 4.26$  U, p=0.027 for sham and CCI). Besides the penumbra the ipsilateral hippocampus seemed to be an inflammatory hotspot. Regenerative processes were bilaterally inhibited by CCI (e.g., Olig2+ cells/sROI in the contralateral cortex:  $223.40 \pm 35.37$  vs.  $131.07 \pm 19.00$ , p=0.021 for control and CCI).

#### Conclusion

CCI significantly affects inflammatory and regenerative processes not only in the ipsilateral, but also in the contralateral brain hemisphere. Therefore, careful assessment of both hemispheres is mandatory in preclinical TBI trials utilizing the CCI model.

## V200

Vergleich der chirurgischen Ergebnisse von Bohrloch- und Twist-Drill-Trepanation bei chronischem subduralem Hämatom: Eine bizentrische Studie

Comparison of surgical outcomes of burr hole craniostomy (BHC) vs. twist drill craniostomy (TDC) for treating chronic subdural hematoma: a bicentric study

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#### Objective

Surgical treatment remains the cornerstone of managing chronic subdural hematoma (cSDH) and is recommended for all symptomatic patients. Given the availability of different surgical approaches, this study aimed to compare burr hole craniostomy (BHC) with twist drill craniostomy (TDC) in terms of revision rates and recurrence to guide optimal patient selection for each method.

#### Methods

We retrospectively analyzed cohorts from two neurosurgical centers, each exclusively utilizing one of the approaches as the primary treatment (hospital 1: TDC in local anesthesia; hospital 2: BHC in general anesthesia). Demographic, clinical, imaging, and outcome data were extracted from hospital records. The primary outcome was defined as the improvement in the Markwalder Grading Score (MWS) at discharge compared to admission. Secondary outcomes included revision surgeries during hospitalization and readmissions for reoperation due to recurrence within 90 days.

#### Results

A total of 638 patients were included (TDC: n=297, BHC: n=341; mean age 74±12 years; 74% male). Antithrombotic medication was present in 53% of patients, comorbidities were common (64%), and 51% presented with neurological deficits. The median MWS at admission was 1 (IQR 1–3), and patient characteristics were comparable between the groups. Revision surgery during the hospital stay was required in 14% of TDC patients (OR 2.199, 95% CI 1.232–3.924), compared to 8% in the BHC group (p=0.008). However, recurrence requiring surgery within 90 days after discharge did not occur significantly more frequently in TDC patients (16% vs. 13%; p=0.876). Moreover, TDC was associated with better odds of MWS improvement at discharge compared to BHC (OR 2.839, 95% CI 1.96–4.112, p<0.001). Subgroup analysis revealed that patients with comorbidities (OR 2.899, 95% CI 1.34–6.273, p=0.007) and those on antithrombotic therapy (OR 2.113, 95% CI 1.027–4.347, p=0.042) had significantly higher odds of MWS improvement with TDC.

#### Conclusion

For patients with comorbidities or on antithrombotic therapy, TDC may offer better early postoperative outcomes. However, BHC is associated with a lower revision rate during the hospital stay. Optimal patient selection remains crucial for improving overall surgical outcomes in cSDH.

### V201

Vergleich der Effekte einer einwöchigen und einer einmaligen Interleukin-4 Applikation auf die Entzündungsreaktion und das Kontusionsvolumen in der subakuten und chronischen Phase nach experimentellem Schädel-Hirn-Trauma im Mausmodell Comparison of the effects of a one-week and a single-dose Interleukin-4 treatment regimen on the inflammatory response and contusion volume in the subacute and chronic phase after experimental traumatic brain injury in mice

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#### Objective

Recently, we showed that the single-dose administration of the anti-inflammatory cytokine Interleukine-4 (IL-4) affects the local inflammatory response as well as the contusion volume in the acute as well as the subacute phase after experimental traumatic brain injury (TBI). However, it remains unclear, whether an extended treatment regimen can prolong these beneficial effects. Therefore, we assessed inflammatory changes as well as contusion volumes in the subacute and chronic phase after experimental TBI and initiation of a one-week IL-4 treatment regimen in mice.

#### Methods

A total of 100 C57BI/6 wildtype mice were randomly assigned to receive IL-4 at a dose of 5mg/kg (IL-4) or phosphate buffered saline (Control) subcutaneously either once 15 minutes after controlled cortical impact (CCI) or once daily for seven days starting 15 minutes after CCI. On days seven and 28 post CCI (7dpi and 28dpi, respectively), the animals were sacrificed and the brains were removed. The inflammatory response in five distinct regions of interest (ROI) and contusion volumes were assessed utilizing immunofluorescent and Nissl staining of coronal frozen sections of the brains. Groups were statistically compared and p<0.05 was considered significant.

#### Results

In contrast to a single dose administration of IL-4 (i.e.,  $10.85 \pm 1.19 \text{ mm}^3 \text{ vs.} 6.82 \pm 0.65 \text{ mm}^3$ , p=0.02 for control and IL-4 7 dpi), the repetitive administration of IL-4 did not reduce contusion volumes (i.e.,  $11.68 \pm 1.67 \text{ mm}^3 \text{ vs.} 13.01 \pm 1.58 \text{ mm}^3$  for Control and IL-4 7 dpi). Furthermore, the early anti-inflammatory effect of the single-dose administration of IL-4 could not be extended by utilizing a one-week treatment regimen (i.e., GFAP intensity in the ipsilateral cortex:  $176.23 \pm 11.17$  U vs.  $162.26 \pm 8.87$  U for Control and IL4 7dpi; Iba1/CD86 colocalized cells/sROI in the ipsilateral hippocampus:  $0.43 \pm 0.09\%$  vs.  $0.29 \pm 0.04\%$  for Control and IL4 28dpi).

#### Conclusion

In contrast to a single dose administration of IL-4, a one-week treatment regimen does neither ameliorate the inflammatory response nor reduce contusion volumes in the subacute and chronic phase after CCI; however, additional studies need to assess potential early systemic anti-inflammatory effects within the first week after trauma induction.

## V202

Minibohrlochtrepanation und druckkontrollierte fibrinolytische Spültherapie reduzieren Rezidive chronischer Subduralhämatome: Erste Erfahrungen mit 30 Fällen *Twist-drill craniostomy and pressure-controlled fibrinolytic irrigation therapy reduces recurrence of chronic subdural hematomas: initial experience in 30 cases* 

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#### Objective

Recurrence of chronic subdural hematoma (cSDH) is a highly prevalent complication. We introduced twist-drill craniostomy with pressure-controlled fibrinolytic irrigation therapy (TDC-FIT) to enhanced clearance of blood and membranes - the most likely drivers of recurrence - from the subdural space. Here, we compare outcomes of TDC-FIT to a twist-drill and drainage approach.

#### Methods

A retrospective study included 376 patients treated with TDC and 30 patients at high risk for recurrence (membranous or recurrent cSDH) were selected for TDC-FIT between January 1, 2021, and December 31, 2024. The primary endpoint was the reoperation rate due to symptomatic recurrence or persistence of cSDH at 6 months. Secondary endpoints included hematoma resolution, perioperative complications, and the impact of antithrombotic therapy.

#### Results

Reoperation was required in 128 (34.1%) TDC patients and in one (3.3%) TDC-FIT patient (P = .007). Hematoma membranes (OR 2.6, 95% CI 1.6-4.3, P < .001) and double antithrombotic therapy (OR 10.3, 95% CI 1.1-93.3, P = .04) were significantly associated with reoperation in the TDC cohort. TDC-FIT showed superior hematoma resolution with a similar complication profile (Table 1). TDC-FIT patients had a significantly lower reoperation rate despite a higher presence of hematoma membranes (75% vs. 34.7%, P = .002).

#### Conclusion

We observed a very low recurrence rate in the high-risk patients selected for TDC-FIT. The intervention is safe and a resource saving alternative to embolization of the middle meningeal artery.

	TDC	TDC-FIT		
	cohort	cohort	OR (95% CI)	<i>P</i> -value
Patients, No.	376	30		
Age, median, y	80	75.5		.08
Female (%)	31.2	25	1.4 (0.4–3.9)	.78
Bilateral hematoma surgery (%)	12.1	6.3	0.7 (0.1–3.8)	.70
Antithrombotic therapy (%)	51	43.8	0.8 (0.3–1.9)	.61
Double antithrombotic therapy (%)	1.9	6.3	4.3 (0.3–30)	.26
Hematoma membrane (%)	34.7	75	5.5 (1.7–16)	.002
Reoperations (%)	34.1	6.3	0.2 (0.0–1.0)	.026
Complications (%)	5.4	6.3	1.6 (0.3–9.4)	.60
Adjunctive therapy (%)	8	12.5	1.7 (0.6–1.7)	.63
mRS 0–3 (%)	85	87.5	0.8 (0.2–3.2)	> .99
Deaths, No.	11	0		> .99

Table 1. Comparison between the TDC and TDC-FIT com	Table 1.	ole 1. Comparison	between	the TDC a	and TDC-FIT	cohorts
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Adjunctive therapy refers to the treatment for a CSF fistula or a CSF leak and/or the embolization of the middle meningeal artery. Abbreviations: twist-drill craniostomy (TDC); twist-drill craniostomy and pressure-controlled fibrinolytic irrigation therapy (TDC-FIT); odds ratio (OR); confidence interval (CI).

## V203

#### Multidimensional Comparison of Microsurgical Clipping and Endovascular Techniques for Anterior Communicating Artery Aneurysms: Balancing Occlusion Rates and Periprocedural Risks Multidimensional Comparison of Microsurgical Clipping and Endovascular Techniques for Anterior Communicating Artery Aneurysms: Balancing Occlusion Rates and Periprocedural Risks

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#### Objective

The anterior communicating artery is a common location for intracranial aneurysms. Anterior communicating artery aneurysms (AcomA) pose a significant risk of rupture. Treatment options include microsurgical clipping and endovascular techniques, but the optimal approach remains controversial. This study aims to compare the outcomes of these two treatment modalities in a single-center patient cohort using a comprehensive matching process based on clinical and morphological parameters.

#### Methods

A retrospective analysis was conducted on 1,026 patients with 1,496 intracranial aneurysms treated between 2000 and 2018. After excluding cases lacking 3D-angiography or aneurysms with other localization or no treatment, 140 AcomA were selected. The study matched 24 surgically treated AcomA cases with 116 endovascularly treated cases based on 21 morphological (Figure 1) and four clinical criteria, including age, sex, Hunt and Hess score and Fisher grade.

#### Results

The microsurgical clipping group demonstrated a significantly higher rate of complete aneurysm occlusion compared to the endovascular group (p = 0.007). However, this was associated with a higher incidence of postoperative ischemic complications in the surgical group (13 out of 24 cases) compared to the endovascular group (2 out of 116 cases) (Figure 2). Despite this observation, no significant differences were found in clinical outcomes at discharge or follow-up, as measured by the modified Rankin Scale (p > 0.999). Both groups had comparable rates of hydrocephalus, vasospasm, and delayed cerebral ischemia.

#### Conclusion

In our matched cohort analysis, microsurgical clipping resulted in higher aneurysm occlusion rates but carried an increased risk of ischemic complications compared to endovascular treatment. Clinical outcomes were comparable between the two modalities, suggesting that treatment decisions should be individualized based on aneurysm characteristics and patient factors. Further prospective studies are warranted to optimize treatment strategies for AcomA.



Figure 1. Demonstration of successful matching process, showing similar aneurysm morphologies in both treatment groups: surgically treated AcomA (blue, top row) and endovascularly treated cases (red, bottom row).



**Figure 2.** Illustration of comparison between surgical and endovascular treated AcomA regarding (A) occlusion rate and B) occurrence of ischemic complications.

Abb. 2

## V205

Angiographische und MR-morphologische Aspekte der de-novo kontralateralen Krankheitsprogression in europäischen Moyamoya-Patienten

Angiographic and MRI features of de-novo contralateral disease progression in European moyamoya patients

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#### Objective

Some Moyamoya patients may develop contralateral disease progression (CDP) over time. The aim of this study was to identify incidence, as well as clinical, angiographic and MR-morphologic features during the initial phase of CDP in these patients.

#### Methods

We retrospectively reviewed all MMD patients treated at our center unilaterally for possible secondary disease progression on the contralateral side. We analyzed subsets of patients with initially unilateral disease only (group 1), unilateral disease with very weak signs of initiation of MMD on the contralateral side (group 2) and patients with bilateral affection but only unilateral hemodynamic impairment (group 3) initially. We then evaluated symptoms and treatment of CDP, as well as the performed diagnostics including MRI with vessel-wall imaging, angiography and time to contralateral treatment.

#### Results

We analyzed a total of 216 patients, 27 patients had unilateral, 9 patients had bilateral disease but were initially only in need of unilateral revascularization. CDP was diagnosed in 11 (5%) of all cases, of these in 7 (64%) of initially unilateral MMD patients (groups 1 and 2), as well as in 4 (36%) of the unilaterally treated bilateral MMD patients during a median follow-up period of 29 months. The surgical treatment on the initially affected hemisphere was a direct STA-MCA bypass in 97,3%. CDP led to treatment on the contralateral hemisphere after a median of 23 months. At this time, the second surgical treatment was a direct contralateral STA-MCA bypass in all of the cases. All disease progressions were diagnosed on DSA showing a progredient stenosis of the terminal portion of the ICA and/or proximal MCA. Analysis of vessel wall imaging revealed strong (n=5) and moderate (n=2) contrast enhancement in all affected vessel segments of patients with CDP (group 1 and 2). In group 3 we saw more heterogenous results with VW-CE with n=2 cases of moderate, n=1 with no contrast enhancement. VW-CE Imaging was not available in one patient.

#### Conclusion

CDP can be seen in a relevant number of patients with initially only unilateral affection, resulting in the need for contralateral revascularization. These numbers underline the need for long-term follow-up of MMD patients including vessel-wall imaging as this might be a relevant early indicator for disease progression.

## V206

Längsschnittanalyse neurologischer Ergebnisse nach wiederholten Blutungen durch Hirnstammkavernome: Erkenntnisse aus einer internationalen Multizenterstudie Longitudinal Analysis of Neurological Outcomes Following Recurrent Brainstem Cavernous Malformation Hemorrhages: Insights from an International Multicenter Study

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#### Objective

This study aimed to evaluate the natural course of brainstem cavernous malformations (BSCM) and identify predictors of functional neurological outcomes following single and multiple symptomatic intracerebral hemorrhages (ICH).

#### Methods

This international multicenter study included 383 patients from three tertiary referral centers followed between 2003 and 2023. Inclusion criteria encompassed patients with confirmed BSCM, complete baseline characteristics, MRI data, at least one symptomatic ICH, and follow-up assessments. Patients who underwent surgical removal or were lost to follow-up were excluded. Functional outcomes were assessed using the modified Rankin Scale (mRS) at diagnosis, before and after each ICH, and at the last follow-up. Statistical analyses were performed using the Wilcoxon signed-rank test to compare mRS scores across different time points.

#### Results

The cohort had a mean age of  $41.47 \pm 15.51$  years, with 57.4% being female. The average follow-up was  $63.16 \pm 85.75$  months. Neurological deterioration was observed in 47.2% after the second ICH and 46.5% after the third ICH. Compared to the initial diagnosis, 22.3% exhibited worsened functional outcomes at the last follow-up. Progressive functional decline was noted with successive ICH events.

#### Conclusion

While functional recovery is possible after an ICH, the likelihood of complete recovery diminishes with each subsequent event. Successive hemorrhages were significantly associated with worsening neurological function, underscoring the critical need for tailored management strategies in BSCM patients.

## V207

Die Machbarkeit der Fusion von TOF MRA und 2D DSA Bildern zur prä- und intraoperativen Darstellung von intrakraniellen arteriovenösen Malformationen und duralen arteriovenösen Fisteln Fusion of TOF MR angiography and 2D DSA imaging to support pre- and intraoperative visualization of brain arteriovenous malformations and dural arteriovenous fistulas

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#### Objective

Brain arteriovenous malformations (bAVM) and dural arteriovenous fistulas (dAVF) are complex cerebral vascular disorders that require precise spatial and angioarchitectural understanding for effective surgical intervention. Historically, digital subtraction angiography (DSA) and magnetic resonance angiography (MRA) have been analyzed separately. While workflows for fusing these imaging modalities have been developed primarily for radiosurgical treatment of bAVMs, their application to dAVFs or open surgery remains unexplored. This retrospective study aimed to assess the feasibility, time requirements and perceived benefit of DSA and MRA fusion for surgical management of bAVM and dAVF cases. Ultimately, fused images may be used intraoperatively to navigate arteries vs. veins or the fistulous point, respectively.

#### Methods

3D time-of-flight (TOF) MRA and 2D DSA images were semi-automatically co-registered using commercially available software. Lesion-relevant vessels and, for dAVFs, the fistulous point were manually segmented on the fused images. Quality of the fusion was rated on a 3-point Likert scale and linear regression was used to evaluate the influence of experience on the mean time required per fusion. An online survey was distributed to Swiss and German neurosurgical departments to assess perceived benefit of fusion images.

#### Results

In this analysis, 83 patients with bAVM (n=42, 51%) or dAVF (n=41, 49%) were included. 145 pairs of TOF MRA and 2D-DSA images (bAVM n=53, 36%; dAVF n=92, 64%) were co-registered. Fusion was possible in n=51 (96%) and n=91 (99%) of cases with bAVM or dAVF, respectively. The median time for the fusion process was 2.8min [IQR 2.0min – 4.0min], while manual segmentation of vessels or fistulous point took 11.6min [IQR 7.9min – 18.5min]. Linear regression showed a reduction of 1.2s per fusion with increasing experience (p<0.001), although only 11.2% (r2=0.1118) of the variance in fusion time could be explained by this factor.

#### Conclusion

Navigating fused MRA and DSA images may be an additional tool to differentiate vessel angioarchitecture intraoperatively in selected cases of bAVM and dAVF. Our data show a reliable workflow with reasonable time expenditure and a good quality of the fused images. Survey results will be available in Q2 2025. A prospective study will be required to test the benefit of the additional tool versus time expenditure and cost.

## RC071

Eignung einer Lumbalpunktion oder Lumbaldrainage bei akutem Hydrozephalus nach aneurysmatischer Subarachnoidalblutung Eligibility of lumbar puncture or lumbar drain for acute hydrocephalus after aneurysmal subarachnoid hemorrhage

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#### Objective

Acute hydrocephalus is a common complication following aneurysmal subarachnoid haemorrhage (aSAH), affecting up to 40% of patients. Standard treatment involves external ventricular drain (EVD) insertion, which carries risks of complications, and recent evidence suggests it may negatively impact patient outcomes. Lumbar puncture (LP) or lumbar drain (LD) are increasingly proposed as a potential alternative. This study aimed to evaluate the proportion of patients eligible for LP/LD as initial treatment for acute hydrocephalus and assess interobserver reliability in determining eligibility.

#### Methods

We reviewed CT scans and clinical data from 92 consecutive aSAH patients (January 2023 and October 2024), drawn from a prospectively maintained database. Ten patients were randomly selected and evaluated independently by three reviewers. Eligibility and necessity for LP/LD as initial treatment were assessed using baseline CT scans and reevaluated with the addition of clinical information at admission. In cases of neurological deterioration prior to aneurysm occlusion, eligibility was reassessed using follow-up CT scans and updated clinical data. The proportion of patients deemed eligible for LP/LD was determined for each reviewer, and interrater reliability was assessed using Fleiss" kappa coefficient.

#### Results

Based on initial CT scans, LP/LD was considered feasible in 60%, 40%, and 50% of cases across the 3 reviewers, with moderate interrater agreement ( $\kappa$  = 0.50). After incorporating clinical information, eligibility dropped to 20%, 0%, and 40% of cases, with fair agreement ( $\kappa$  = 0.32). Some patients were deemed ineligible for LP/LD despite meeting imaging criteria due to clinical considerations. Among three patients with neurological deterioration prior to aneurysm treatment, LP/LD was considered feasible in 100%, 67%, and 100% of cases, though interrater agreement was poor ( $\kappa$  = -0.13). Overall, LP/LD was deemed ineligible as an initial treatment in 10%, 30%, and 30% of cases by the reviewers.

#### Conclusion

These preliminary results suggest that LP/LD is considered feasible in more than half of the patients with hydrocephalus after aSAH based on imaging criteria, with moderate interobserver agreement. Adding clinical criteria reduces eligibility and increases variability among reviewers. Expanding the cohort and including more observers is needed to better understand the main determinants influencing decision-making and to standardize assessment and management of acute hydrocephalus.

### V208

# Lebensqualität nach operativem Verschluss spinaler duraler arteriovenöser Fisteln: eine retrospektive Studie Quality of life after surgical occlusion of spinal dural arterio-venous fistulas: a retrospective single-center study

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#### Objective

Spinal dural arteriovenous fistulas (dAVFs) represent a rare vascular disorder, often causing progressive myelopathy due to venous congestion. This study aimed to evaluate surgical outcomes and health-related quality of life (HRQoL) in patients undergoing surgical treatment for dAVFs.

#### Methods

We conducted a retrospective, single-center analysis of patients who underwent surgical treatment for dAVFs at our institution between 2012 and 2023. Demographic, clinical, and imaging data were collected. Treatment success was defined by fistula occlusion confirmed via digital subtraction angiography (DSA), while clinical improvement was assessed using the modified Aminoff and Logue Disability Scale (mALS). HRQoL was evaluated prospectively with patient-reported EQ-5D-5L questionnaires, with EQ-5D index values calculated using the German value set.

#### Results

A total of 38 patients were included, with a mean age of  $65.3 \pm 1.6$  years and a male-to-female ratio of 3.1:1. Most patients (35/38, 92.1%) presented with gradually progressing symptoms, with a median symptom duration of 10.5 months (IR: 2.8-24.0 months). Preoperative symptoms were most often sensory deficits (36/38, 94.7%) and lower extremity hemiparesis (20/38, 52.6%). The median preoperative mALS score was 3 (IR: 1-6). DAVFs were commonly located at the thoracic spine (30/38, 79.0%) and predominantly supplied by single arterial feeders (36/38, 94.7%). Successful fistula occlusion rate was high (34/38, 89.5%), although postoperative DSA identified partial occlusions due to newly formed feeders in 4 patients, requiring secondary surgery. At outpatient follow-up, the mALS score showed significant improvement (3 [IR: 1-6.25] *vs.* 1 [IR: 0.25-3], *p* = 0.020). MRI findings demonstrated a significant reduction in myelon edema and dilated perimedullary veins (92.1% *vs* 45.5%, *p* = 0.001; 79.2% *vs.* 20.8%, *p* = 0.001, respectively). EQ-5D index values were significantly higher at follow-up compared to preoperative assessments (0.41 *vs.* 0.79 *p* = 0.003), with overall self-rated health status also improving substantially (37.5 [IR: 27.5-66.3] *vs.* 65.0 [IR: 47.5-80.0] *p* = 0.002).

#### Conclusion

Surgical management of spinal dAVFs achieves high rates of fistula occlusion and significant neurological recovery, accompanied by substantially improved HRQoL. Incorporating standardized patient-reported outcomes highlights the broader impact of surgical interventions, supporting informed discussions with patients and caregivers.

## V204

Management Europäischer Erwachsener Moyamyoa Patienten mit standardisiertem Bildgebungsprotokoll und multiterritorialer Revaskularisation

# Management of European adult Moyamoya patients with standardized imaging protocols and multiterritorial tailored revascularization procedures

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#### Objective

Moyamoya Angiopathy (MMA) was initially described in East Asian population and is increasingly recognized worldwide, including among Caucasians. To date, knowledge of disease characteristics, imaging findings, and treatment outcomes in non-Asian populations remain limited. This study aims to extend the understanding of MMA in adult Caucasian patients, with a focus on tailored revascularization strategies, surgical outcome and long-term follow-up.

#### Methods

Epidemiologic, clinical, as well as standardized multimodal diagnostic, treatment and follow-up data of 216 adult patients treated for MMA since 2013 at one center were analyzed retrospectively. All imaging data were graded in a standardized fashion.

#### Results

Our cohort consisted of 204 Caucasian and 12 Asian patients, with a female-to-male ratio of 2.7:1 and a median age of 37 years at symptom onset. Median follow-up time was 24 months (range 4-120 months). Moyamoya syndrome was seen in 8 (3.7%) patients. Ischemic events were the most common initial presentation (75.5%), while hemorrhagic strokes were less frequent (7.7%). Angiography revealed unilateral disease in 34.8% of cases and posterior circulation was involved in 9.8%. The most common Suzuki grade was III (33.9%). Surgery was performed in 71.3% of patients by placing a total of 354 extracranial-intracranial (EC-IC) bypasses, including 231 MCA, 112 ACA and 11 PCA revascularizations, of which 233 were direct, 121 indirect ones. Perioperative ischemic strokes occurred in 1.7% per bypass, long-term follow-up demonstrated a high bypass patency rate of 96.7% for all bypasses and a low stroke recurrence rate of 1.3%. Wound healing problems were the most common postoperative complication (17 patients, 4.8% per bypass), of which 7 (2.0%) needed surgical revision

#### Conclusion

This study is the largest published cohort of Caucasian Moyamoya patients to date. Due to high expertise and rigorous adherence to diagnostic standards, tailored treatment plans may lead to high treatment success rates with bypass patency, complication and long-term stroke rates which appear to be better than described in the literature.

## V210

Intraoperatives MRT vs. 5-ALA für die resektion von Glioblastomen: Update der Überlebensdaten und Korrelation von Bildgebungs-basierter supramaximaler Resektion gemäß der RANO Resect Klassifikation Intraoperative MRI versus 5-ALA for the resection of Glioblastoma: Update of survival data and correlation of imaging-based supramaximal resections according to the RANO resect classification system

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#### Objective

In a prospective controlled multicenter study for newly diagnosed glioblastoma a comparable rate of total resections was shown for iMRI (81%) and 5-ALA (78%), which was accompanied by comparable median overall survival (OS) in both cohorts. Meanwhile, survival data were updated and imaging results were analyzed according to the RANO resect classification system.

#### Methods

OS data were updated with the participating centers. For identification of supramaximal resections, blinded visual and volumetric quantification of peritumoral FLAIR hyperintensity was performed with distinction between non contrast-enhancing tumor (nCE) and edema. Tumor volumes and resection status were classified as described by the RANO resect group.

#### Results

In contrast to the published findings, patients operated with iMRI (20.0 months) showed a statistically significant (p=0.012) longer OS compared to 5-ALA (17.7 months) after updating the OS data. Aiming to identify causes for this unexpected new finding, several analyses have been performed but did not identify possible confounders. Analysis of both cohorts for completely and incompletely resected tumors revealed a significant (p=0.011) OS benefit for completely resected tumors in the iMRI (median OS 22.6m) compared to the 5-ALA (median OS 18.8m) cohort. However, no significant OS differences between both cohorts were seen for incompletely resected tumors (18.4m vs. 16.3m, respectively, p=0.632), making an adjuvant treatment effect unlikely. Further analysis of MR data revealed significantly more supramaximal resections (2 blinded rater visual analysis: 29 patients in the iMRI vs. 11 patients in the 5-ALA cohort, p <.001).Volumetric analysis of the FLAIR signal showed a significantly greater redeuction of nCE in the iMRI group (78% vs 65%, p<.01), as well as edema. Analysis

according to the RANO-resect classification also revealed significant (p=0.016) differences between both treatment arms (table 1).

#### Conclusion

The update of OS data revealed an unexpected survival benefit for patients after iMRI-guided resections compared to 5-ALA. Broad analyses revealed no conclusive confounder, but a higher rate of supramaximal resections in the iMRI cohort, compared to 5-ALA. The herewith seen longer OS times match stringently to findings of the RANO resect group. Reasons for more supramaximal resections in the iMRI cohort might be caused by more "anatomical" resections due to the use of white-light compared to 5-ALA.

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		Treatme		
21		5-Ala	iMRI	Total
RANO	Class 1	68	82	150
Resect	Class 2a	20	8	28
Class	Class 2b	25	40	65
	Class 3	9	5	14
	Class 3b	0	2	2
Total		122	137	259

Table 1: RANO classification for both treatment arms;  $p = 0.016^{-1}$ 

## V212

# The HiResGlio Trial: Sicherheit und Effektivität pathologisch-kontrollierter, supramaximaler Resektion in der Gliom-Chirurgie– vorläufige Ergebnisse

# The HiResGlio Trial: Safety and effectiveness of cellular-guided supramaximal resection in glioma surgery – preliminary results

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#### Objective

Supramaximal safe resection is the primary goal in glioma surgery. However, RO resection is generally considered unfeasible due to the diffuse growth pattern of gliomas and the risk of neurological deficits. The *HiResGlio* trial aims to evaluate the feasibility and safety of histologically-guided resection using real-time intraoperative assessment by a neuropathologist.

#### Methods

Resection is conducted while an attending neuropathologist examines up to five native tissue samples from each direction of the resection margin. If smear preparations show increased cell density indicative of tumor tissue, up to four follow-up resections in each direction of the resection margin are performed to approach possible RO resection. RO resection is defined as a decrease in pleomorphic neoplastic cell density across sequential probes until reaching levels consistent with normal parenchyma. The primary outcome is the Karnofsky Performance Scale (KPS) at 30 days postoperatively. Secondary outcomes include the number of re-resections required to achieve RO, the comparison of RO resection rates with radiological gross total resection (GTR), postoperative immunohistochemical (IHC) and DNA methylome (EPIC array) analyses, and any surgery terminations due to safety concerns.

#### Results

Fourteen patients have been enrolled in the *HiResGlio* trial. Median KPS at 30 days postoperatively was 90%. In 10/14 patients (71%), resection had to be extended beyond the assumed neuronavigation-based GTR due to the identification of increased cell density. The mean number of re-resections into the peritumoral niche was 2 (range: 1–7). GTR was achieved in 11/14 (79%) patients, which correlated with R0 resections (11/14; 79%). Postoperative IHC analysis revealed either a regular or reduced cell density in the final ("R0") sample in comparison to the "pre R0" samples from the same direction in 8/9 cases (89%). R0 samples, which presented with regular cell density during intraoperative assessment, showed lower mitotic and proliferative activity in 6/8 (75%) and 7/9 (78%) cases, respectively. Methylome analysis was performed on samples that were tumor-negative both intraoperatively and in IHC assessment. No surgeries were terminated due to safety concerns.

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#### Conclusion

Preliminary results of the *HiResGlio* trial suggest that histologically-guided supramaximal resection is both effective and safe for glioma surgery. In most cases, resection can be extended to achieve tissue properties comparable to normal brain tissue.

## V213

Hi-SMILE: Prospektive Studie zur stereotaktischen Laser Interstitial Thermal Therapy (LITT) und präklinischem Tumororganoid-basiertem Medikamentenscreening bei rezidivierenden high-grade Gliomen. Ergebnisse nach 20 Patient:innen

Hi-SMILE: Prospecitve study on stereotactic Laser Interstitial Thermal Therapy (LITT) and preclinical tumororganoid-based drug screening in recurrent high-grade glioma. Results from 20 patients

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#### Objective

Recurrent high-grade glioma (glioblastoma & astrocytoma WHO 4°) require innovative locoregional and systemic treatment options. Laser Interstitital thermal therapy (LITT) is a stereotactic, minimally invasive surgical approach to target small and difficult to resect tumors under MR-thermometric guidance. Tumororganoids are representative tumor avatars that enable ex-vivo drug testing even from small tissue samples provided by stereotactic biopsies. The Hi-SMILE study is an ongoing trial to evaluate safety and efficacy of LITT and feasibility of preclinical tumororganoid-based drug screening in n=30 patients with recurrent high-grade glioma.

#### Methods

Patients are prospectively enrolled in a registry. Fot LITT tumor volume and ablation coverage, as well as accuracy of laser catheter placement are assessed. OR time, length of hospital stay and surgical complications are documented. Stereotactic frame-based biospsy and laser catheter placement are performed before laser ablation is carried out in an intraoperative MRI setting.biopsy samples taken during LITT surgery are used for tumororganoid formation. After tumororganoid formation, ex-vivo high-throughput drug testing of up to 9 selected drugs is performed. Responses are classified as "sensitive" "intermediate" or "resistant".

#### Results

So far, n=20 patients (12 females, 8 males; mean age 58.3 years (+/- 11.1 years) have been enrolled. Final histological diagnoses was glioblastoma (n=14), astrocytoma WHO 4° (n=4) and radiation necrosis (n=2). N=9 patients required 2 laser catheters to cover the desired mean tumor volume of 4.0 (+/- 3.5) ml. Mean operative time was 166 minutes (+/- 45) of which a mean 90 minutes (+/- 25) were spent in the intraoperative MRI scanner. Ablation coverage was on average 228% and took on average 12min 55s per catheter. Laser catheters could be placed with a Euclidian distance of 1.1 mm (+/- 1.2) and a mean radial error of 0.7 mm (+/- 0.6). Treatment-related complications were two epileptic seizures and one deterioration of a preexisting neurological deficit. It was always possible to test at least 4 drugs. Most tumors revealed a high level of drug resistance with only 2 cases revealing drug sensivitivy more than 1 drug.

#### Conclusion

Surgical accuracy and ablation coverage are high in LITT for recurrent glioma. The procedure is safe and well tolerated by patients. Progression-free and overall survial will be evaluated at the end of the trial.

## V214

#### Intraoperative MRT-gesteuerte Resektion von Tumorresten verbessert das Patienten-Outcome bei Primärresektion von IDH-1 Wildtyp Glioblastomen: Eine unizentrische, retrospektive Beobachtungsstudie Intraoperative MRI-Guided Resection of Tumor Remnants improves Patient Outcome in the Primary Resection of IDH-1 Wildtype Glioblastomas: A Monocentric, Retrospective Observational Study

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#### Objective

Glioblastoma (GBM) is an aggressive brain tumor with an unfavorable prognosis. Achieving gross total resection (GTR) is crucial for improved outcome. Despite advances like fluorescence-guided surgery (FGS), residual tumors often remain undetected, negatively affecting prognosis. This study evaluates how intraoperative MRI (iMRI) complements FGS by detecting and facilitating the removal of tumor remnants to optimize GTR rates and improve survival.

#### Methods

In this single-center, retrospective study, 118 patients with IDH-wild-type GBMs underwent surgery using 3-Tesla iMRI and FGS. Patients were divided into 4 groups based on iMRI and postoperative MRI data: AR-: No additional resection, as iMRI confirmed GTR. AR+/GTR: Additional resection after iMRI achieving GTR. AR+/STR: Additional resection after iMRI achieving subtotal resection (STR). AR-/TR+: No additional resection after iMRI, despite tumor residue due to contraindications (e.g. eloquent localization, motor-evoked potential deterioration and tumor vascular invasion). Outcomes included residual tumor detection (FGS vs. iMRI), overall survival (OS), and progression-free survival (PFS).

#### Results

iMRI detected residual tumor in 32% of cases that were not identified through surgeons' microscopic assessment despite FGS (p<0.001), allowing for subsequent resection converting patients with STR (n=37) to GTR in 35.1%. Mean OS was longest in the AR+/GTR group (n=13, 32.8 months) followed by AR- (n=71, 21.5 months) and AR+/STR (n=24, 19.6 months) while AR-/TR+ was significantly shorter (n=10, 8.2 months, p<0.001), including significant differences between AR+/STR and AR-/TR+ (p=0.016). PFS showed corresponding differences (mean 13.2, 11.3, 8.3 and 5.5 months) but non-significant (p=0.11).

#### Conclusion

iMRI enhances resection quality by identifying and facilitating the removal of tumor remnants undetected by methods like FGS, achieving additional GTR in 11% of total cases. Even without achieving GTR, iMRI-guided additional resections can provide survival benefits by reducing tumor burden, underscoring its pivotal role in GBM surgery. Future research will include volumetric analyses and AI-based predictions to refine surgical strategies.

**Fig.1:** Sankey diagram illustrating the flow from the surgeon's intraoperative tumor residue assessment to iMRI findings and postoperative MRI outcomes.

Fig.2: Kaplan-Meier estimates with risk tables for OS (A) and PFS (B) in GBM patients, comparing study arms.

Abb. 1





#### Abb. 2



## V215

# Vergleich von MRT- und PET-RANO-Kriterien zur Quantifizierung der r*esidual disease* nach Resektion eines Glioblastoms

A head-to-head comparison between MR- and FET PET-based delineation of residual tumor tissue in glioblastoma

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#### Objective

More extensive resection is favorably associated with survival in patients with newly diagnosed glioblastoma, and residual tumor volume represents a powerful prognostic marker for patient stratification. A classification system to stratify patients based on the post-operative tumor volume on MRI has been proposed. As [<sup>18</sup>F]FET-PET is increasingly used for the delineation of glioma extent, we aimed to compare MR-based tumor volumetrics on post-operative imaging to PET-based volumes.

#### Methods

We retrospectively searched our institutional database for individuals with newly diagnosed *IDH*-wildtype glioblastoma who underwent both [<sup>18</sup>F]FET-PET and MRI following open surgical resection. Remaining tumor volumes were evaluated independently by two investigators using PET RANO 1.0 and MRI-based RANO *resect* criteria. PET volumes of patients assigned to respective RANO *resect* classes were compared and spatially correlated with MRI volumes.

#### Results

We identified 46 patients in which both MRI and [<sup>18</sup>F]FET-PET was available for review. With final data analysis being ongoing, we have yet analyzed 19 patients in which postoperative MRI revealed measurable contrastenhancing (CE+) and non-contrast-enhancing (CE-) disease in 15 patients (79%). Most cases were classified as RANO resect classes 2 and 3, with 21% (4/19) assigned to class 1. PET RANO criteria identified measurable disease in all patients, with PET-defined tumor volumes consistently encompassing and often exceeding MRIdefined volumes. Within RANO resect classes, higher PET volumes correlated with higher classes, ranging from 14.9 cm<sup>3</sup> in class 1 to 21.8 cm<sup>3</sup> in class 3.

#### Conclusion

Our study shows that PET may identify more patients with remaining measurable disease after surgery than MRI, with PET volumes frequently exceeding MRI volumes. This may point towards an increased sensitivity of PET in detecting residual tumor. While our findings await confirmation in the final study cohort which will be presented at the meeting, our preliminary observation therefore suggest that [<sup>18</sup>F]FET-PET may present a valuable tool to complement MRI for the stratification of patients based on the residual tumor volume and potentially also to guide local therapies.

## V216

Der neuronale Reservekapazität bestimmt das postoperative Ergebnis bei Patienten mit Rolandischen Gliomen. The neuronal reserve capacity defines the postoperative outcome in Rolandic glioma patients.

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#### Objective

Rolandic glioma patients face a high perioperative risk of developing a new postoperative motor deficits, which can adversely impact patient outcomes. Advancements in technology, such as preoperative motor mapping, functional diffusion imaging, and intraoperative monitoring, have enhanced surgical safety. Nevertheless, these patients continue to exhibit variable postoperative outcomes. The objective of this study is to evaluate the neuronal reserve as a novel concept for stratifying perioperative risk by means of both established and emerging nTMS variables.

#### Methods

We analysed data of 194 glioma patients who underwent pre-operative nTMS examination prior to surgical resection between 2015 and 2022. Muscle strength was assessed using the BMRC scale at three time points: pre-operatively, post-operatively and at three-month follow-up. Specifically, we investigated the nTMS variables: Tumour-to-Tract Distance (TTD), Resting Motor Threshold (RMT), Motor Area and Volume (MA and MV), Cortical Silent Period (CSP) and Recruitment Curve (RC).

#### Results

Motor impairment at both short-term and long-term follow-up was associated with shorter TTD (IQR = 0.48–11.0 mm, p < 0.001) and tumour recurrence (primary: 135, recurrence: 59, p = 0.043). CSP was significantly prolonged in the tumour-affected hemisphere compared to the unaffected hemisphere (114.06 ms  $\pm$  43.37 vs. 108.37 ms  $\pm$  36.99, p = 0.011), and higher CSP ratios were linked to an increased risk of impairment pre-operatively and post-operatively at discharge (IQR = 1.0597–1.4489, p = 0.005). A larger MV in the tumour-affected hemisphere was associated with better motor status at admission (IQR = 15 101–75 668 mm<sup>2</sup>·µV, p =0.024).

#### Conclusion

The findings of this study demonstrate that the notion of neuronal reserve capacity, as determined by nTMS, serves as a valuable instrument in the preoperative risk stratification of glioma patients. TTD is a strong predictor of postoperative outcomes at both short-term and long-term follow up. Increased MV appears to indicate compensatory mechanisms that help preserve motor function and raised cortical inhibition of the diseased hemisphere is associated with poorer motor outcomes.

## V218

Real-World Überlebensanalyse von Patient:innen mit Isocitratdehydrogenase-mutiertem WHO-Grad 4 Astrozytom, die mit Tumor Treating Fields (TTFields)-Therapie behandelt wurden Real-world survival analysis of patients with isocitrate dehydrogenase-mutant WHO grade 4 astrocytoma treated with Tumor Treating Fields (TTFields) therapy

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#### Objective

Tumor Treating Fields (TTFields) therapy received a CE-mark for the treatment of patients with newly diagnosed WHO grade 4 glioma, based on improved progression free survival and overall survival (OS) in the EF-14 study. Besides patients with isocitrate dehydrogenase (IDH) wildtype glioblastoma, the EF-14 study included patients with IDH-mutated (IDHmut) tumors, which have been reclassified as astrocytoma IDHmut, WHO grade 4 (Astrocytoma IDHmut/G4) and are associated with a better prognosis than IDH wildtype. However, large real-world datasets of this cohort are lacking. Here, we report real-world outcomes of patients with Astrocytoma IDHmut/G4 treated with TTFields in the US.

#### Methods

By analyzing electronic health records from the xCures real-world data platform, patients in the US with newly diagnosed Astrocytoma IDHmut/G4 and treated with TTFields between January 1 and December 31, 2019, were examined, and their IDHmut status was confirmed. Survival was analyzed based on IDH-mut status and TTFields usage for two different usage categories (minimum 30 days treatment): low (<50%) and high ( $\geq$ 50%) usage.

#### Results

82 out of 1285 patients with known IDH status had an IDH-mut and were included. The median (range) age of patients was 40.6 (21–75) years, 71% were men (n=58) and 59% had also a methylguanine-DNA-methyltransferase promoter methylation (n=48). TTFields therapy was used in median for 9.4 months with a median usage of 76.8%. OS at two and four years was 66% (95% CI: 56–77%) and 44% (34–57%), respectively. The group with high TTFields usage had improved OS in comparison with low usage (HR: 0.53 [0.28–1.02], P=0.057, n=80). As of the data cutoff, 5 out of 22 patients with at least 4 years of survival were still on therapy.

#### Conclusion

This study highlights the utility of the xCures platform datasets in systematically evaluating real-world outcomes for a rare glioma subtype. Our findings suggest that patients with Astrocytoma IDHmut/G4 may benefit from TTFields therapy. Additional patient follow-up and correlative data will be presented.

## V219

# Aufdeckung der Gewebeinfiltration von Glioblastomen im Gehirn durch kontrollierte transiente Hypoxie während der BOLD-MRT

Revealing Glioblastoma Brain Tissue Infiltration with Controlled Transient Hypoxia during BOLD-MRI

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#### Objective

Hypoxia is considered an important diagnostic and therapeutic target in glioblastoma, yet no clinical imaging is currently available to inform about tumor hypoxia, whereas magnetic resonance imaging (MRI) only plays a limited role in the assessment of glioblastoma infiltration and imaging surveillance of treatment response. We introduce a hypoxia-targeted BOLD-MRI with potential to discriminate non-contrast enhancing (CE) glioblastoma infiltration and as a surrogate for tissue hypoxia.

#### Methods

Twenty-six adult patients with newly diagnosed untreated glioblastoma were longitudinally included in the present investigation to undergo a BOLD-MRI during a standardized isocapnic double hypoxic protocol. %BOLD signal change, contrast-to-noise ratio (CNR), Rsquared and Lag were calculated voxel-wise in volumes-of-interest (VOIs) using in-house written Matlab scripts after SPM-preprocessing. Statistical analysis included comparison of calculated variables in tumor VOIs against contralateral flipped masks and of tumor VOIs among each other and with healthy tissue. Color-coded overlay maps were produced in each patient for qualitative analysis.

#### Results

Controlled transient hypoxia induces strong negative BOLD signal changes with high CNR and Rsquared in CE tumor tissue and marked difference from healthy brain, necrosis and edema. (Figure 1) Pathological hypoxia-BOLD response extends to non-CE peritumoral tissue with potential to characterize tumor-infiltrated FLAIR-hyperintensities before blood-brain barrier disruption. (Figure 2)

#### Conclusion

Hypoxia-targeted BOLD-MRI has potential to better depict glioblastoma infiltration and abnormal neovasculature beyond the contrast-enhancing tumor core as well as to identify "hypoxic hotspots" for more informed surgical and radiotherapy planning, as well as better surveillance of therapy response from chemo- and immunotherapies.





Abb. 2



## V220

# Rolle von Hyperkonnektivität zwischen Tumor und gesundem Gehirn bei Glioblastompatientinnen und - patienten

#### Role of hyperconnectivity between tumor and healthy brain in glioblastoma patients

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#### Objective

Glioblastoma is a systemic brain disease. In recent years, it could be shown that glioblastoma cells integrate into normal neural circuits, even forming synapses with neurons. Furthermore, experimental data showed that increased connectivity between glioblastomas and healthy brain was associated with decreased survival. Here, we used resting-state fMRI (rsfMRI) to reproduce these experimental results with an advanced imaging technique *in vivo*.

#### Methods

30 patients with glioblastoma were prospectively enrolled. All patients underwent rsfMRI and patient data was compared to a reference cohort of 1000 healthy controls to determine abnormality of functional connectivity on an individual level. Next, we used this data to quantify whether the whole tumor region showed more or less connectivity to the rest of the brain when compared to the corresponding brain region in healthy controls. The results were then correlated with survival data. Furthermore, rsfMRI data analysis - capable navigation software was used in a subset of patients (n = 4) to determine whether there were region – specific connectivity differences within the tumor.

#### Results

24 patients had tumor progression (median PFS 8.2 months) and 19 patients died (median OS 13.4 months) during the observation period. Univariate cox regression models showed that higher functional connectivity between the tumor and the rest of the brain was associated with lower PFS (p<0.001) and lower OS (p<0.0001). This held true in multivariate models which included potential confounders (age, KPS, tumor volume, resection status, MGMT promoter methylation). Furthermore, connectivity analysis of the tumor showed that there were regions within the tumor which were hyperconnected to the rest of the brain while other areas within the tumor showed no connectivity to the healthy brain.

#### Conclusion

We found that increased connectivity between the tumor and the rest of the brain was associated with decreased PFS and OS. We therefore speculate that rsfMRI might be a useful tool to determine how extensively glioblastomas have integrated into the neuronal circuitry of the brain. RsfMRI could therefore serve as an imaging correlate for the biological relationships described by the emerging field of cancer neuroscience. Additionally, our results suggest that hyperconnectivity between tumor and healthy brain detected in our cohort could be due to specific hyperconnected regions within the tumor, an observation which could open up new avenues of treatment.

## V221

Verbesserung der präoperativen Beurteilung des motorischen Systems durch den Einsatz von nTMS-basierter Kartierung der Supplementärmotorik in Patienten mit frontalen Hirntumoren Advancing preoperative assessment of the motor system through nTMS-based mapping of the supplementary motor area in patients with frontal brain tumors

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#### Objective

Low-grade gliomas frequently occur in the frontal lobe, making an accurate assessment of the risk for postoperative motor deficits, including supplementary motor area (SMA) impairments, critical for surgical planning. This study evaluates the feasibility and accuracy of navigated transcranial magnetic stimulation (nTMS) in mapping the SMA.

#### Methods

Continuous theta-burst stimulation was applied to six target sites anterior to the nTMS-identified primary motor area in the superior frontal gyrus. Patients performed the nine-hole peg test during stimulation, with task performance and duration recorded.

#### Results

The study included 22 patients (mean age 47.7  $\pm$  17.3 years; range 25.3–79.4), equally split between low-grade and high-grade gliomas. Twelve patients (54.5%) had left-sided lesions. nTMS-positive sites were similarly distributed across hemispheres (right: median 3 [range 2–4] vs. left: 3 [1–4]; p = 0.694).

Six patients (27.3%) experienced a prolonged postoperative SMA syndrome, which persisted at the 3-month follow-up. One patient (4.5%) developed permanent motor deficits due to a primary motor area lesion. We observed a significantly higher median number of resected nTMS-positive SMA sites (2 [2–3]) in patients with prolonged SMA syndrome compared to those without SMA syndrome (0 [0–2]; p = 0.004). Resection of nTMS-positive SMA points demonstrated 100% sensitivity and 78.6% specificity for predicting prolonged SMA syndrome. Subcortical analysis of the nTMS-based frontostriatal and frontal aslant tracts showed 100% sensitivity and 68.8% specificity.

#### Conclusion

This small cohort study demonstrates that nTMS-based SMA mapping is feasible and accurate. The resection of nTMS-positive cortical SMA sites and associated subcortical fiber tracts provides excellent sensitivity for prolonged SMA syndromes. It should complement nTMS motor mapping in motor-eloquent brain lesions to identify at-risk patients and enhance surgical outcomes and preoperative consultation.

## V222

#### Double Vision: Das Vier-Augen-Prinzip in der Glioblastom-Chirurgie Double Vision: Four-Eyes Principle in Glioblastoma Surgery

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#### Objective

Glioblastomas are aggressive brain tumors where achieving gross-total resection (GTR) of contrast-enhancing tissue significantly improves patient survival. Techniques such as neuronavigation, 5-aminolevulinic acid (5-ALA) fluorescence guidance, and intraoperative MRI have been developed to enhance resection precision. While studies demonstrate that both intraoperative MRI and 5-ALA are highly effective in achieving GTR—particularly in specialized centers with experienced surgeons—randomized trials and broader clinical application reveal significantly lower GTR rates in routine practice.

This discrepancy underscores the challenges of achieving consistently high resection rates. Inspired by highreliability practices in other fields, such as the "four-eyes principle" in aviation safety and dual control systems in nuclear power operations, we developed the DoubleVision (DV) protocol for glioblastoma surgery. This innovative approach integrates a second experienced neurosurgeon to provide intraoperative resection control when functional measurements permit total resection, aiming to bridge the gap between ideal outcomes and real-world practice.

#### Methods

In a pilot study, 53 adult patients with suspected glioblastomas were recruited. The DoubleVision method involved intraoperative collaboration between two neurosurgeons using 5-ALA fluorescence guidance. Postoperative tumour volumes were evaluated via contrast-enhanced MRI using BraTumIA software (Brain Tumour Image Analysis, University of Bern, Switzerland) and confirmed by a neuroradiologist. Neurological outcomes were assessed and compared with historical data.

#### Results

DoubleVision achieved 100% total resection rates, with all 45 patients in this group achieving complete resection (residual volume  $\leq 0.175$  cm<sup>3</sup>) and an average residual volume of 0.0153 cm<sup>3</sup>. Of the 53 patients, 45 were operated on using DoubleVision, while 8 underwent surgery without it. Among these 8, only 4 achieved total resection, with an average residual volume of 0.6846 cm<sup>3</sup>. Neurological outcomes were assessed within the study cohort, showing 22% improvement, 68% stability, and 10% worsened deficits.

#### Conclusion

The DoubleVision approach enhances resection rates. Future studies should evaluate its widespread applicability and its impact on patient outcomes and survival.

## V223

Intrakavitäre Ozon-Therapie in der Behandlung von Glioblastomrezidiven- Ergebnisse einer Matched-Pair Analyse

Intracavitary ozone therapy for the treatment of recurrent glioblastoma – results from a matched-paired analysis

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#### Objective

As Glioblastoma (GBM) cells prefer hypoxemia to maintain their tumour-forming capacity, Ozone ( $O_3$ ) has been shown to inhibit tumour proliferation and induce apoptosis due to reactive oxygen species. Clinical evidence suggests potential benefits, with one small case series of five patients. This study represents the largest series and aims to analyze the effectiveness of intracavitary  $O_3$ -application in recurrent glioblastoma (rGBM).

#### Methods

We conducted a matched-paired analysis of patients with rGBM treated at our center. One group underwent surgery for rGBM followed by the implantation of an intracavitary catheter being connected to a subcutaneous reservoir in reasonable distance to the skin incision. In an outpatient setting, 10 ml of  $O_2/O_3$  with a concentration of  $40\mu g/ml O_3$  was applied into the resection cavity following CSF aspiration. Therapy was repeated every two weeks. The control group were patients with rGBM receiving standard therapy with surgery and either temozolomide rechallenge, lomustine or regorafenib as per tumor board consensus. Primary outcome was overall survival. Secondary outcomes were  $O_3$ -related complications.

#### Results

A total of 28 patients were included in the analysis. Of these, 14 received  $O_3$  and were matched to 14 patients with rGBM based on initial therapy received, extent of resection at recurrence surgery, MGMT promotor status, and preoperative Karnofsky performance score. Overall, 243  $O_3$ -applications were performed with a median of 8 applications in each patient. Patients receiving  $O_3$  had a mean overall survival of 72 months compared with 16 months in the standard group (p=.002). The mean survival after surgery for rGBM was 22 months in the  $O_3$ -group compared with 6 months in the control group (p=.01). Two patients developed a postoperative CSF leakage which was successfully treated with a lumbar drainage.  $O_3$  application was well tolerated by patients: three (21%) reported transient headaches and/or nausea after application, but no serious adverse events, such as infection and/or  $O_3$ -related deaths were seen.

#### Conclusion

Intracavitary  $O_3$  appears to be a safe and effective treatment as an adjunct for patients with rGBM and may allow to extend their overall survival. Prospective studies are needed to validate these observations.

## V224

Re-Operationen bei Patienten mit hirneigenen infiltrierenden Tumoren - Indikationen und Einfluss aufs Outcome Second Look Surgery in Patients with Diffuse Infiltrating Brain Tumors – Indications, Implications and Outcome

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#### Objective

The evidence for complete resection of contrast-enhancing areas, as well as non-contrast-enhancing marginal zones of intrinsic brain tumours, has been substantiated by significant studies in recent years. This applies to low-grade gliomas (LGG) and high-grade gliomas (HGG). However, achieving this through a single surgery is not always feasible in patients with tumours in highly eloquent areas — the present analysis aimed to conduct a structured evaluation of surgical re-intervention from various perspectives.

#### Methods

A retrospective data analysis of a cohort of patients who underwent surgery between 01/2013 and 12/23 was obtained concerning  $2^{nd}$  look surgery for various reasons, defined by surgical re-intervention between 4-6 weeks after the first attempt. The following aspects were analysed: the reason for planned  $2^{nd}$ , localization, changes in the extent of resection tumour volume, and neurological outcome (NHISS).

#### Results

Of 1146 patients, 443 underwent multiple surgeries of whom 57 underwent 2<sup>nd</sup> look surgery (13%), mean age at first surgery was 55 years [ $\pm$ SD 14.5]. Planned 2<sup>nd</sup> look surgery was performed in 31.5 % (n=18) for various reasons, mostly in eloquent localisations requiring bilateral approaches or cases with primary debulking and neurological improvement for awake surgery approaches. Unplanned 2<sup>nd</sup> look surgery was conducted in 68.5 % of patients mostly due to significant residual tumours in post-OP MRI. Histopathological diagnoses were 96.5% HGG (n=55), and 3.5 % LGG (=2). Tumour localization did not differ between hemispheres (left n=26, right n=26, multi n=4 %, motor or speech eloquent 54%, n=31). The mean time between the first and second look was 11.5 days. 2<sup>nd</sup> look surgery led to functional deterioration in 23% of patients (n=13). Resection results were improved in 81 % of patients by 2<sup>nd</sup> look.

#### Conclusion

2nd look surgery mostly was performed unplanned due to residual tumour volume or planned as a surgical strategy in eloquent surgery to achieve maximum save resection. In most cases, it was proven as a safe possibility to extend resection results with the aim of a significant increase in OS. However, analysis of PFS and OS compared to a matched cohort by diagnosis, localization, residual tumour volume and without 2nd surgery is the subject of ongoing analysis and needs to be statistically proven.

## V225

Einfluss des Alters auf molekulare Veränderungen und die Therapie-Stratifizierung in der multimodalen Glioblastomtherapie

Influence of age on molecular changes and treatment stratification in multimodal glioblastoma therapy

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#### Objective

The increasing life expectancy has led to a rise in high-grade gliomas, particularly in patients of older age. The impact of chronological age, associated molecular changes and contributing factors on therapy response, progression-free survival (PFS) and overall survival (OS) remain uncertain.

#### Methods

Between January 1st, 2016, and December 31th, 2021, patients with glioblastoma IDH-wt (CNS WHO grade 4) were included. RNA- and T-cell receptor sequencing was performed in a subset of patients. Primary outcome parameters were extent of resection (EOR), progression free- and overall survival. Multivariate analysis was performed to identify independent predictors of survival.

#### Results

A total of 286 patients were included. The mean age was 66.4 years. Chronological age did not correlate with overall survival (r=0.12). With age, tumor immune composition changed towards macrophages with M2 phenotype and decreased numbers of CD8 + and neutrophiles. Aging related genes were not enriched. Beyond 69.5 years of age, despite similar PFS (p=0.0783), OS (p<0.0001) was significantly shorter, compared to younger patients. Extent of resection and adjuvant radiochemotherapy were significant predictors of OS (p<0.0001). No difference in PFS and OS was found between younger and older patients treated with maximal safe resection, followed by concomitant RT and chemotherapy and adjuvant chemotherapy.

#### Conclusion

This study suggests that age alone should not be the sole determinant in therapeutic decision-making for glioblastoma patients. Gross total resection and adjuvant therapy, tailored to individual clinical status, significantly impact survival outcomes. Patient- specific treatment strategies are important to minimize undertreatment and optimize therapeutic outcomes in older patients.





Figure 1: Chronological age and survival in glioblastoma. Chronological age per se does not correlate with overall survival ( $r^2=0.12$ , 95%CI -0.42 to -0.19). (A) Mean PFS was similar in older and younger patients with cut-off values of 65 years and 70 years (p=0.0783) (B) Mean OS differed between both age groups. (p<0.0001) (C)

Abb. 2



**Figure 3. Extent of resection and adjuvant therapy:** GTR was achieved in 145 (50.7%) patients (young: 89/60.1%; elderly: 56 /40.6%), STR in 76 (26.6%) patients (young: 39/26.4%; elderly: 36/28.3%), and 66 (23.1%) underwent a biopsy only (young: 20/13.5%; elderly: 46 /33.3%). No differences in procedure-related complications were observed. The extent of resection was a significant predictor of PFS and OS in both younger and older patients (p<0.0001). (A) PFS (p=0.3883) and OS (p=0.8389) were similar between concomitant treatment according to Stupp or Perry protocol in older patients. (B) Concomitant treatment was associated with prolonged OS (Stupp: p=0.0044; Perry: p=0.0101) compared to monotherapy. (C)

## RC072

Auswahl des optimalen intraoperativen Tests für Wachoperationen auf Grundlage der Testdurchführbarkeit und eignung während präoperativen nicht-invasiven Kartierungen Determining optimal intraoperative task for awake surgery based on task feasibility and suitability during preoperative non-invasive mapping

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#### Objective

During awake surgeries, classic naming tasks remain the standard, while some consider lesion location. Still, the complex language network and associated deficits demonstrate a high inter-individual variability. Hence, we propose that non-invasive preoperative mapping may allow for a more individualized and, thus, optimized task selection.

#### Methods

Pre- and subsequently intraoperative language mapping was conducted in 9 patients with left hemispheric frontal (n=2), parietal (n=1), temporal (n=3), or insular (n=3) glioma ( $35.4 \pm 11.5$  years, 77.8% male). The selection of tasks for awake language mapping was based on the feasibility of a task during navigated transcranial magnetic stimulation (nTMS) mapping and task-specific cortical and subcortical sites within (peri-)tumoral areas identified with nTMS-based mapping and respective tractography.

#### Results

According to standard aphasia diagnostics, classic naming and verbal semantic association tasks were applied in 77.8% of cases without language deficits. One case with slight naming deficits could still reliably perform the object naming mapping but not the semantic association task. However, according to standard testing, an auditory single-word comprehension task was used instead in a single case with slight naming deficits but severe expressive difficulties during nTMS. All tasks selected were feasible during intraoperative mapping, and cortical and subcortical language-relevant sites were identified with reliable detection concordance.

#### Conclusion

Based on task feasibility and suitability during preoperative non-invasive mapping, a more individualized task selection for awake intraoperative mapping can be achieved considering the individual language network and profile.

## RC073

Identifikation ausgedehnter bihemisphärischer Sprachnetzwerke durch präoperative nTMS-basierte Kartierung eines verbalen semantischen Assoziationstests Identification of extensive bihemispheric language networks by preoperative nTMS-based mapping using a verbal semantic association task

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#### Objective

Accurately mapping higher cognitive functions remains a challenge both intraoperatively and preoperatively. Navigated transcranial magnetic stimulation (nTMS) offers a noninvasive method for preoperative identification of eloquent brain areas, which can then be applied for function-based fiber tracking (FT). This study evaluated the cortical and subcortical networks identified by preoperative nTMS-based mapping using a verbal semantic association task based on the Pyramid and Palm Tree Test (PPTT).

#### Methods

The PPTT task was incorporated into standard preoperative nTMS-based language mapping. FT was performed according to clinical protocols, using a fractional anisotropy (FA) threshold set at 50% of the maximum FA and a minimum fiber length (FL) of 100mm.

#### Results

The study included 20 right-handed patients (mean age:  $44 \pm 11$  years) with right-sided gliomas. Overall error rates in the lesional (right) hemisphere were  $0.108 \pm 0.053$ , compared to  $0.098 \pm 0.047$  in the contralateral (left) hemisphere (p = 0.215). However, semantic error rates were significantly higher in the right hemisphere (0.0275  $\pm 0.015$ ) than in the left (0.016  $\pm 0.015$ , p = 0.01).

Network analysis demonstrated comparable fiber volumes between hemispheres (left:  $61.0 \pm 49.0$ , right:  $63.0 \pm 41.3$ ; p = 0.640) and fiber lengths (left:  $121 \pm 8.7$  mm, right:  $118 \pm 7.9$  mm; p = 0.353). [IS1] [MO2] However, FA values were significantly higher in the left hemisphere (left:  $0.369 \pm 0.038$ , right:  $0.349 \pm 0.037$ ; p = 0.003).

#### Conclusion

The PPTT enables function-based identification of the bihemispheric networks underlying semantic association and complex language processing. nTMS-based FT of the PPTT task revealed an extensive network in the right hemisphere, comparable in volume and fiber length to the left hemisphere. These findings suggest that bihemispheric networks are crucial in higher cognitive functions, including semantic processing during language tasks.

### RC074

Die Rolle des intraoperativen Neuromonitorings bei der Gliomresektion in der Nähe der motorischen Areale Role of Intraoperative Neuromonitoring in Resection of Gliomas associated to Motor Function

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#### Objective

Tumor resection in eloquent brain regions without monitoring functional cortical areas and tracts is associated with the risk of causing irreparable damage that can significantly reduce the patient's quality of life. Intraoperative electrophysiological examinations can be used to identify motor-relevant areas and to monitore their function during tumor resection.

#### Methods

Between Sep 2016 and Oct2021, 60 operations were performed under IONM on intracranial supratentorial gliomas with eloquent locations close to he motor area.

The patients were divided into 2 groups depending on the last intensity of current used when resection was stopped while maintaining a motor response:

• Group I (36 pat): Resection was stopped at a positive response at 5 to 10 mA, sometimes despite tumorremnants still being visible with the operating microscope.

• Group II (24 pat): Resection was stopped at a positive response at 15 to 20 mA, with no tumor remnants identified with the operating microscope.

The clinical status was documented preoperatively, on the 1st postoperative day, on the 5th postoperative day, and 3-6 months after the operation.

#### Results

In 35% of pat (N= 21), the tumor was completely removed (GTR); in 25% of pat (N= 15), more than 90% of the tumor was removed; in 40% of pat (N= 24), less than 90% of the tumor was removed.

In Group I (36 pati), 44% of pat (N= 16) showed a deterioration in their Motricity Index on the first day after the operation compared to preoperative levels. This number decreased to 36% (N= 13) on the fifth postoperative day and to 17% (N= 6) after three months. The Karnofsky Index showed that 17% (N= 6) of these patients remained in a worse clinical condition three months after the operation compared to preoperative levels.

In Group II (24 pat), 38% (N= 9) showed a deterioration in the Motricity Index on the first postoperative day compared to preoperative levels. This number remained the same on the fifth postoperative day and decreased to 18% (N= 4) after three months, with 27% (N= 6) of these patients remaining in a worse condition compared to preoperative levels after three months, with no statistical difference between the 2 groups (Chi-square test)
#### Conclusion

The study showed, that cortical and subcortical resection of gliomas up to the 5 to 10 mA limit appears to be as safe as resection up to the 15 to 20 mA limit. There was no statistically significant difference in the patient's overall ability and motor function before and after the operation.

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## RC075

## Molekular-gesteuerte Neurochirurgie: Bestimmung des Neural-Scores durch intraoperative epigenetische Profilerstellung

Molecular-guided Neurosurgery: Detection of Neural-Score through intraoperative epigenetic profiling

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#### Objective

The extent of integration of glioblastoma cells into the brains neural circuit has an important role in the tumour progression. The more integrated glioblastoma requires a larger extent of resection. Intraoperative molecular profiling of this "neural" subtype remains challenging. Here, we demonstrate a novel algorithm to accurately detect the epigenetic neural phenotype intraoperatively within less than an hour.

#### Methods

In this study, 23 patients were enrolled and 1-3 biopsies were multiplexed and barcoded for intraoperative sequencing. DNA extraction and library preparation was performed using the rapid-UKER protocol. Sequencing was performed by MinION system on the R10.4 Flow cells. Prediction of the neural phenotype was performed by a contrastive-based deep-learning model using cross-attention for accurate prediction.

#### Results

Mean DNA extraction and library preparation (tissue2sequencing) time was 48.76 minutes using the rapid-UKER protocol containing transposase adapters technology. Mean fragment length of the DNA was 5428 +/- 1432 bp. Sequencing speed was between 953-2132 CpG sites per minute resulting in accurate predictions after 10 minutes (two sequencing fasa5 batches) in reality. Computational simulation demonstrate that the mean prediction time was 7.23 +/- 2.13 minutes.

#### Conclusion

Intraoperative epigenetic profiling is an accurate tool to predict the neural phenotype and may be used to molecular-guided resection in the future.

## V226

Assoziation zwischen der Einfuhr von Omega-3-Fettsäuren und der Präsenz von intrakraniellen Aneurysmen in der UK Biobank Kohorte

Association of intake of omega-3-fatty acids with presence of intracranial aneurysms in the UK Biobank cohort

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#### Objective

Unruptured intracranial aneurysms (IAs) have a prevalence of 3%, in high-risk groups up to 12%. Preventive repair of IA patients comes with a risk for stroke/death up to 4%/0.3%, but the risk of rupture in most incidental diagnosed IAs is less than the risk of preventive repair. Conservative treatment options for high-risk persons or for IA patients, that accompany observation with follow-up imaging, are urgently needed. Recent studies showed that a high intake of omega-3-fatty acids (n3-FAs) lead to a reduction of stroke incidence. On a molecular level, n3-FAs exert different ways of anti-inflammatory effects, i.e. recruitment of anti-inflammatory macrophages, reduction in pro-inflammatory MCP-1. Since inflammatory processes play a major role in IA pathogenesis, the study aims to show a protective role of the intake of n3-FAs on the pathogenesis of IAs.

#### Methods

This study included patients with IAs and controls from the prospective UK Biobank cohort, who fulfilled the diet questionnaires DietWebQ. The daily intake of n3-FAs was calculated from the diet questionnaires. Non-parametric analyses, logistic regression analyses were performed.

#### Results

A total of 210,842 participants (538 IA patients, 210,304 controls) were included. In controls 55.1% were female, in patients 68.2%. Median age in controls was 60 (52-65) years, in patients 61 (54-65) years. Median n3-FAs were in patients with IAs 1.698 (1.199-2.335) g, in controls 1.800 (1.302-2.459) g (P=0.017) (Figure 1). The odds of harbouring an IA increased by 10% per 1 g decrease in daily intake of n3-FAs (OR 1.10 [95% CI 1.003-1.20] per 1 g decrease). For participants with a low intake of n3-FAs the OR for having an IA was 1.34 (95% CI 1.06-1.71) compared to participants with a high intake (Table 1).

#### Conclusion

Our data indicate that a low intake of n3-FAs is associated with IA presence. Anti-inflammatory effects of n3-FAs might play a protective role on intracranial vessels or IAs. Future studies should assess whether a high intake of n3-FAs is beneficial for persons at high risk of developing an IA or for those with an IA to reduce the risk of rupture.

This research has been conducted using the UK Biobank Resource under application number 411099.

Figure 1: Distribution of omega-3-fatty acids

Table 1: Association of omega-3-fatty acids with IA presence according to quartiles





Abb. 2

Omega-3-fatty acids [g]	No. of cases (%)	OR (95% CI)	<i>P</i> value
>2.458	117 (21.7)	Reference	
1.799-2.458	125 (23.2)	1.07 (0.83-1.38)	0.607
1.302-1.799	139 (25.8)	1.19 (0.93-1.52)	0.169
<1.302	157 (29.1)	1.34 (1.06-1.71)	0.016

## V227

Ein Transkriptionsfaktor-Atlas zerebraler arteriovenöser Malformationen enthült Schlüsselfaktoren der vaskulären Instabilität und Ruptur

A Transcription Factor Atlas of Brain Arteriovenous Malformations Reveals Key Drivers of Vascular Instability and Rupture

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#### Objective

Brain arteriovenous malformations (AVMs) pose a significant risk of hemorrhagic stroke, primarily in younger individuals. This study aims to establish a transcription factor atlas in AVM endothelial cells to enhance our pathophysiological understanding and reveal targets for therapeutic intervention.

#### Methods

We utilized single-cell RNA sequencing to construct a comprehensive atlas of transcription factors in AVM endothelial cells. Data were derived from two public datasets, involving 76,125 and 4,601 AVM endothelial cells respectively. Our workflow included differential gene expression analysis to identify TFs uniquely expressed in AVM endothelial cells, and subcluster analysis to investigate expression levels of these TFs along the arteriovenous axis. Gene ontology and functional pathway analyses were performed, studying the functional relevance of novel TFs. Finally, we utilized imaging mass cytometry (IMC) to validate the spatial distribution of identified TFs and assess their interactions with the immune microenvironment and angiogenic processes within the nidus.

#### Results

Our analysis revealed a distinctive transcription factor profile in AVM endothelial cells, with several novel transcription factors implicated in vascular remodeling and instability. These factors predominantly influenced angiogenic and inflammatory pathways, with a pronounced expression in venous endothelium. Gene Ontology analysis and functional pathway analysis highlighted their significant involvement in pathogenic vascular processes. Validation in two independent datasets as well as utilizing IMC provided spatial confirmation of these interactions, demonstrating the crucial roles of these TFs in promoting vascular instability.

#### Conclusion

The transcription factor atlas provides a detailed molecular insight into the dynamics of AVM progression. By pinpointing specific transcription factors associated with AVM instability, this atlas lays the groundwork for developing targeted therapies that could stabilize these lesions and prevent catastrophic complications. This study not only advances our understanding of the cellular drivers of AVM rupture but also opens new avenues for precision medicine in neurovascular care.

## V229

Frischer Wind im Altbekanntem. Vorhersage von Rezidiven bei chronischen Subduralhämatomen durch maschinelles Lernen

Adding a new twist to an old plot: machine prediction of chronic subdural hematoma recurrence

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#### Objective

Chronic subdural Hematoma (cSDH) is a common neurosurgical condition with rising prevalence in the aging population. Despite the efficacy of the surgical treatment, 4-20% of the cSDH are recurring, with significant associated morbidity. We sought to delineate, using radiomics and supervised machine learning, preoperative intrinsic imaging characters of the cSDH associated with recurrence and re-treatment.

#### Methods

We analyzed (so far) retrospectively the preoperative CT Scan in 50 (out of 154) patients with cSDH that underwent surgical evacuation of the hematoma. After extracting 108 independent radiomics features from the imaging using the pyradiomics Python library, we modeled the probability of recurrence using different supervised machine learning algorithms. To avoid overfitting all models where 5-fold cross validated and the performance evaluated using standard metrics (receiver operating characteristic area under the curve (ROC AUC), precision, recall, F1 score as well as Matthews correlation coefficient (MCC) for the quality of the binary classification).

#### Results

The median age of the patients at presentation was 78 (range: 67-88), of which 69% where male and 31% female. 44% of the patients had a midline shift. The rate of recurrence in this group was 41%, the median time interval before recurrence was 4 weeks postoperatively. The random forest model optimized with recursive feature elimination trained on the extracted radiomics features achieved a ROC AUC of 0.786 with precision of 0.85, F1 score of 0.633, Recall of 0.88 and an MCC on 0.419. The logistic regression outperformed it with an excellent ROC AUC of 0.84 and MCC of 0.61. The most important predictors were the volume of the hematoma as well as the local and global entropy.

#### Conclusion

The volume and pattern of the cSDH as extracted using radiomics can accurately predict the recurrence of the haematoma, independent of clinical and operative factors. These results need to be validated on the larger patient cohort.

### V230

Endoskopisch assistierte Mirkovaskuläre Dekompression bei Trigeminusneuralgie: Langzeit-Ergebnisse Endoscopic assisted microvascular decompression in Trigeminal Neuralgia: Long term Outcome

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#### Objective

Microvascular decompression (MVD) represents the gold standard of surgical treatment for classic trigeminal neuralgia. The endoscopic assisted approach (EA-MVD) is used less frequently. We therefore present our long-term results and experience from the last 20 years.

#### Methods

We analysed our prospectively maintained database of 182 patients who underwent EA-MVD surgery for trigeminal neuralgia between 2000 and 2020 in our hospital. Details on the adjunct use of the endoscope, type and number of compressing vessels were noted in surgical reports. Follow-up including pain status, medication intake and complications was carried out by our outpatient clinic or via telephone interview.

#### Results

Mean follow up was 62 months ranging from 3 to 240 months. At the time of the last survey, 143 (78,6%) of patients still had a very good outcome (BNI I-II). Fourteen patients (7,7%) initially reported persistent pain right after operation. Twenty-Five patients (13,7%) had a recurrence (BNI III or higher) within the observation period. In twenty-nine (16%) patients, the endoscopic inspection was particularly useful due to anatomical features that obstructed the straight-line view of the microscope. The most frequently involved vessel was the SCA (70%). Either additional or pure venous involvement was found in 67 cases (36,8%). In 29 patients (16,9%), multiple compressing vessels were identified. We found no significant influence on outcome with regard to gender, disease duration or type of compressing vessel. Transient complications including CSF leakage, minor haemorrhage, diplopia or meningitis occurred in 17 (9%) of patients. Permanent sensory disturbances, regardless of type and severity, were present in 43 (23,6%) of the cases. Persistent hypacusis occurred in 10 (5.5%) of patients.

#### Conclusion

EA-MVD is a safe method that facilitates bimanual surgery while still being able to visualize the entirety of the nerve and its surroundings. Our study demonstrates very good long-term results in approximately 80 % (BNI I or II) of our patients and at least overall improved pain status in 178 (97,8%) cases. In the future, more studies are needed that directly compare endoscopically assisted MVD with established procedures and which can demonstrate both higher case numbers and long-term follow-up.

## V231

Quantitative Pupillometrie bei chronischem Hydrozephalus nach aneurysmatischer Subarachnoidalblutung: Eine Pilotstudie

Quantitative Pupillometry for Chronic Hydrocephalus After Aneurysmal Subarachnoid Hemorrhage: A Pilot Study

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#### Objective

To evaluate the utility of quantitative pupillometry (QP) for detecting and monitoring pathological pupillary changes in patients with chronic hydrocephalus (HCP) following aneurysmal subarachnoid hemorrhage (aSAH) and to assess the impact of ventriculoperitoneal shunt (VPS) placement on pupillary parameters and symptoms.

#### Methods

This ongoing prospective study enrolled patients who survived severe aSAH and developed clinically and radiologically confirmed chronic HCP. All patients presented with headache, nausea, or other suggestive symptoms. Pupillary assessments were performed pre- and postoperatively using the automated NPi 200<sup>®</sup> pupillometer. The neurological pupillometry index (NPi) ranges from 0 to 4.9, with values >4.0 considered physiologic. Each patient underwent VPS insertion based on clinical and imaging criteria.

#### Results

Eight patients (mean age 58.0 years, SD 11.2) met the inclusion criteria. Prior to surgery, the NPi was <4.0 in at least one pupil for all patients (mean bilateral NPi 3.4, SD 0.3), suggesting altered pupillary reactivity likely associated with increased ICP. Following VPS insertion, a significant improvement in mean bilateral NPi was observed (from 3.4 to 4.2, SD 0.4; p<0.05). This correlated with clinical amelioration of symptoms—particularly headache and nausea—in all cases. While the Evans index decreased from 3.7 SD 0.3 to 2.9 SD 0.1 postoperatively, this change did not reach statistical significance. Nevertheless, normalization of pupillary reactivity was evident and consistently aligned with symptomatic relief.

#### Conclusion

These preliminary findings underscore the merit of quantitative pupillometry in detecting and monitoring chronic HCP after aSAH. QP provided objective evidence of pathological pupillary responses in patients with elevated ICP and confirmed their improvement following VPS placement. Although larger, multi-institutional studies are required to validate these observations, our pilot data suggest that QP may serve as a valuable adjunct for guiding clinical decision-making. Specifically, routine QP assessments could facilitate earlier interventions, enable more precise monitoring of shunt function, and potentially enhance patient outcomes in the management of chronic post-aSAH hydrocephalus.

## RC076

#### Negative Auswirkungen von systemischen Entzündungen auf den Verlauf einer aneurysmatischen Subarachnoidalblutung Detrimental effect of systemic inflammation on the course of aneurysmal subarachnoid hemorrhage

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#### Objective

Intracranial aneurysm rupture leading to aneurysmal subarachnoid hemorrhage (aSAH) is a life-threatening condition associated with primary brain injury and subsequent complications, such as cerebral vasospasm, delayed cerebral ischemia, and infections. Infections contribute significantly to morbidity, yet differentiating infectious fever from central fever poses challenges. This study evaluates the impact of C-reactive protein (CRP), leukocyte counts, and body temperature on neurological outcomes, in-hospital mortality, and sepsis occurrence in patients with aSAH.

#### Methods

We retrospectively analyzed 727 patients treated for aSAH between December 2004 and June 2016 at a tertiary care center. CRP levels, leukocyte counts, and daily temperature readings during the initial three weeks of intensive care were collected. Outcome measures included neurological outcomes assessed by the modified Rankin Scale (mRS) six months post-discharge, in-hospital mortality, and sepsis occurrence. Binary logistic regression models evaluated the predictive value of these parameters, adjusted for confounders such as age, bleeding severity, and treatment modality.

#### Results

Unfavorable outcomes (mRS  $\geq$ 4) were observed in 36.9% of patients, with a significant association with mean CRP (adjusted OR 1.08; confidence interval (Cl) 1.03-1.14; p=0.001) but not leukocytes (aOR 1.05; 95% Cl 0.99-1.11; p=0.087). In-hospital mortality correlated with both CRP (aOR 1.07; 95% Cl 1.02-1.13; p=0.005) and leukocyte count (aOR 1.08; 95% Cl 1.01-1.14; p=0.018). Subfebrile temperatures showed a weak protective effect (aOR 0.89; 95% Cl 0.83-0.96; p=0.001), while febrile temperatures were not predictive of outcomes. Sepsis risk was associated with elevated CRP (OR 1.23; 95% Cl 1.12-1.34; p<0.001) and febrile days (OR 1.12; 95% Cl 1.00-1.26; p=0.050).

#### Conclusion

CRP is a valuable biomarker for predicting neurological outcomes and mortality in aSAH patients, outperforming leukocyte counts and febrile temperatures. The findings emphasize the need for routine CRP monitoring to identify infections and guide early intervention. Effective differentiation between central and infectious fever remains crucial for optimizing care and reducing complications in this patient population.

## V232

Rolle der Embolisation der Arteria Meningea Media bei einer Untergruppe von Patienten mit einseitigem subduralem Hämatom, die einer chirurgischen Evakuierung unterzogen werden: Eine systematische Übersicht und Meta-Analyse randomisierter kontrollierter Studien

Adjunctive role of middle meningeal artery embolization in subgroup of patients with unilateral subdural hematoma patients undergoing surgical evacuation: A systematic review and meta-analysis of randomized controlled trials

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#### Objective

Chronic subdural hematoma (cSDH) is a common neurological condition, with high recurrence rates after surgical evacuation, posing significant challenges for patient outcomes. Middle meningeal artery embolization (MMAE) has emerged as a potential adjunctive therapy to reduce recurrence and reoperation rates. This metaanalysis evaluates the impact of MMAE on recurrence and reoperation rates in surgically treated unilateral subdural hematoma patients.

#### Methods

A systematic review and meta-analysis were conducted, adhering to PRISMA guidelines. Randomized controlled trials comparing surgical evacuation with and without adjunctive MMAE were included. The primary outcomes were recurrence and reoperation rates within 90 days. Pooled odds ratios (ORs) were calculated using a random-effects model. Statistical heterogeneity was assessed using the I<sup>2</sup> statistic.

#### Results

Two trials involving 965 patients met inclusion criteria. 478 patients underwent surgery with MMAE, and 487 patients underwent only surgery. MMAE reduced reoperation rates from 6.0% in controls to 2.5% in the MMAE group (OR: 0.41, 95% CI: 0.20–0.82; p = 0.01), with no significant heterogeneity ( $I^2 = 0$ %). Recurrence rates were lower in the MMAE group (5.2% vs. 9.2%, OR: 0.52, 95% CI: 0.17–1.59; p = 0.25), but the difference was not statistically significant.

#### Conclusion

MMAE significantly reduces the risk of reoperation in surgically treated unilateral subdural hematoma patients and may also reduce recurrence rates. These findings support the integration of MMAE as an adjunct to surgery in selected patients.

## V233

Der Einfluss der tiefen Hirnstimulation auf die mit Morbus Parkinson assoziierten Rückenschmerzen und adulten spinalen Deformitäten

The impact of deep brain stimulation on back pain and adult spinal deformities associated with Parkinson's disease.

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#### Objective

Parkinson's disease is the second most common neurodegenerative disorder worldwide. Back pain and spinal deformities are common comorbidities in patients with Parkinson's disease.

Deep brain stimulation is an established component of Parkinson's disease therapy, particularly for addressing the neurological cardinal symptoms. However, the role of deep brain stimulation as a therapeutic option for chronic back pain and spinal deformities in Parkinson's disease remains largely unclear.

The aim of the present study is to investigate the effect of deep brain stimulation on back pain and spinal deformities associated with Parkinson's disease.

#### Methods

As part of a prospective observational study, the Oswestry Disability Index (ODI) was collected to quantify back pain in 49 Parkinson's patients treated with deep brain stimulation. The data were obtained one week preoperatively as well as three, twelve, and 24 months postoperatively. Additionally, biplanar full-body X-rays were performed to assess sagittal balance. Approval from the responsible ethics committee and the Federal Office for Radiation Protection has been obtained.

#### Results

Of the patients studied, 69% reported a preoperative Oswestry Disability Index (ODI) > 20%, indicating at least a moderate impairment in quality of life due to back pain. Three months after the intervention, the median ODI in this group had decreased by approximately 9%, representing a clinically significant improvement (p = 0.0004).

A deviation of the sagittal vertical axis (SVA) of >40 mm was diagnosed preoperatively in 68% of the patients suffering from back pain. At the 24-month follow-up, a significant improvement in the median SVA was observed, decreasing from an initial 55 mm to 39 mm (p = 0.045).

#### Conclusion

This study is the first to structurally investigate the effect of deep brain stimulation on Parkinson"s diseaseassociated chronic back pain and adult spinal deformities in a large cohort of patients with Parkinson"s disease. Deep brain stimulation appears to be a promising therapeutic approach for managing these comorbidities of Parkinson"s disease. However, the pathophysiology of Parkinson"s disease-associated back pain remains unclear and should be explored in future studies.





Abb. 2



## V234

Nachhaltigkeit der semi-implantierbaren Nervus peronaeus Stimulation bei Patienten mit zentraler Fußheberschwäche - technische und klinische Aspekte Durability of semi-implantable closed loop peroneal nerve stimulation in patients with central foot drop technical aspects and clinical effects

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#### Objective

Semi-implantable functional electrical stimulation (siFES) of the peroneal nerve for central drop foot via a 4channel cuff electrode has positive effects on gait velocity [1], gait balance [2], quality of life [1], and brain plasticity [3]. This long-term follow-up report focuses on longevity of the implant (Actigait<sup>m</sup>) and sustained therapeutic effects.

#### Methods

We evaluated 34 of 45 patients with a mean time of 8.5 years of siFES implantation. 136 implant channels were examined for conductivity. Clinical assessment included a 10-meter gait velocity test at maximal (Vmax) and comfortable (Vcomf) walking speeds in On- and Off-modes. We also rated patient satisfaction.

#### Results

We present preliminary findings from a patient subgroup (n = 34) whose devices remained in active use. Of 136 channels tested, only one showed an increased impedance, without clinical sequelae. Mean Vmax was 0.89 m/s with stimulation "on" vs. 0.83 m/s "off", and mean Vcomf was 0.68 m/s with stimulation "on" vs. 0.63 m/s "off", which represents meaningful improvement. Accordingly, most patients (30/34) reported substantial benefit for everyday life.

#### Conclusion

This retrospective analysis reports meaningful effects of siFES in central drop foot patients for gait speed after 8.5 years. For most patients, FES is a lifelong therapy, which places demands on device longevity.

#### Referenzen:

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## RC077

Interdisziplinäre Behandlung chronischer Beckenschmerzen bei Endometriose durch Elektrodenimplantation zur Neuromodulation (ILIAS) - eine prospektive Analyse. Interdisciplinary Laparoscopic Implantation of Neuromodulation Electrodes at the Sacral Plexus (ILIAS) for Treatment of Chronic Pelvic Pain Due to Endometriosis - A Prospective Analysis

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#### Objective

In a previous, retrospective study we could show that the interdisciplinary laparoscopic implantation of a neuromodulation electrode at the sacral plexus (ILIAS) allows pain relief following surgery for the endometriosis treatment. The aim of the current study is to investigate the effectiveness of this interdisciplinary approach regarding pain relief, improvement of quality of life, and patient satisfaction in a prospective analysis.

#### Methods

Prospective analysis of 6 women suffering from chronic pelvic pain, who underwent laparoscopic exploration of the sacral plexus, implantation of electrodes for neuromodulation, with the support of neuromonitoring between 2023-2024. One patient was excluded because of missing follow-up data. Pain medication, pain intensity (Numeric Rating Scale [NRS]), overall quality of life (EQ-5D-5L), Beck's Depression Inventory (BDI-V), Pain Catastrophizing Scale (PCS), and a Patient Satisfaction Questionnaire (CSQ-8) were evaluated prospectively, 3 months before, 3 and 6 months after surgery. Statistical analysis was performed using the Mann-Whitney U test and Wilcoxon rank-sum test.

#### Results

Mean age 34.6  $\pm$  0 years. NRS significantly decreased from a median of 8.5 (IQR 7.3–9.8) before surgery to 1.3 (IQR 1.0–3.0) at the six-months follow-up (p < 0.001). Similarly, the EQ-5D-5L index, which initially reflected a poor quality of life with a median value of 0.31 (IQR 0.18–0.48), rose substantially to 0.91 (IQR 0.91–0.98) over the same period (p < 0.004). BDI-V scores showed a clear reduction in depressive symptoms, improving from a median of 43.0 (IQR 18.3–51.3) preoperatively to 13.0 (IQR 3.0–15.5) after six months (p < 0.017). PCS, which was elevated preoperatively with a median of 30.5 (IQR 23.5–36.8), decreased significantly to 4.5 (IQR 0.8–9.0) (p < 0.001). Finally, CSQ-8 scores demonstrated strong patient satisfaction, with 97.8% of the maximum possible score achieved.

#### Conclusion

This prospective analysis showed that ILIAS is an effective treatment option for chronic pelvic pain. Significant pain reduction, improvement in quality of life and depressive mood, as well as strong patient satisfaction were achieved. This interdisciplinary method is a good option for the treatment of chronic pelvic pain.

## RC078

Periphere Nervenstimulation zur Behandlung des chronischen, therapierefraktären Iliosakralgelenk-Syndroms – Eine prospektive, randomisierte Multicenterstudie Peripheral nerve stimulation for chronic intractable sacroiliac joint pain – A prospective randomized multicenter study

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#### Objective

Patients with chronic low back pain often suffer from sacroiliac joint pain (SIJP) with reported prevalence between 10% and 30%. Conservative treatment consist of pain medication, physical therapy and interventional procedures such as infiltrations and radiofrequency ablations with high recurrency rates. Patients undergoing sacroiliac joint (SIJ) fusion report moderate pain reduction. Treating SIJP with spinal cord stimulation is challenging and the results are not satisfying. Therefore, peripheral nerve stimulation (PNS) for chronic SIJP was implemented in small experimental trials with promising results. The purpose of this study was to determine the effect of PNS in patients with severe therapy-refractory SIJP compared to best medical treatment.

#### Methods

Ethical approval was obtained from the local ethics committee (EA4/189/20). In this multicenter prospective randomized controlled trial patients with SIJP were randomized either to best medical treatment (BMT) or best medical treatment with PNS between April 2022 and June 2024. Lead placement was performed via fluoroscopically guided peripheral nerve stimulation of the S1 to S3 lateral branches. Patients underwent a trial period of 3 to 14 days followed by a permanent implantation if patients experienced at least 50% pain relief. All implantations were performed with the same PNS system and implantable impulse generator. Outcome scores (NRS, ODI, SF36, ADS-K, PSQI), pain medication, complications and doctor visits were documented during outpatient visits scheduled 3, 6, and 12 months after permanent implantation. The reduction in NRS after six months was defined as the primary outcome. Here, we report the preliminary results of ODI and NRS changes in both groups after 6 months.

#### Results

90 patients could be included and randomized within the period of 2 years. Preliminary data evaluation of the 6 months results illustrate a NRS reduction of 5 NRS points in the PNS group and a NRS reduction of 1 NRS point in the BMT group. ODI reduction of 13 points could be depicted in the PNS group compared to 1 in the BMT group. Perioperative complications consisted of 1 wound infection and 1 lead dislocation (2%).

#### Conclusion

Peripheral nerve stimulation is a simple, selective and safe treatment option for patients with chronic refractory SIJP. Reported complication rates were low. The preliminary patient reported outcomes regarding pain relief and disability and after 6 months are very promising.

Abb. 1



## SFNC-19

#### Neurosurgical Ablative techniques for Cancer Pain: 50 years later, is this still relevant?

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#### Objective

Most patients suffering from cancer will face pain. In some cases, that pain will remain intractable, and its management suboptimal, especially in case of opioid toxicity. Neurosurgical lesioning methods (DREZotomy, cordotomy, mesencephalotomy, cingulotomy...) were largely developed worldwide in the 1970-80s and have proven to be effective for cancer pain. Not only do these techniques offer high therapeutic benefits to end stage cancer patients when they are proposed in the right setting, but also, they do not require implanted hardware, are minimally invasive and many can be performed without general anaesthesia.

#### Methods

Due to the improvement in cancer management and the development of opioids, the use of such ablative techniques has decreased in many countries, with the next generation of neurosurgeons lacking the knowledge and training for these techniques. In the recent decade there has been a renewed interest in these techniques, with a growing body of evidence supporting their use. The different techniques will be presented by 2 experienced neurosurgical teams on the bases of state-of-the-art knowledge and through interactive case discussions, demonstrating how interdisciplinary team work can help in "tailoring" the best personalized treatment for each patient.

#### Results

After a complete review of the literature on these techniques, the first French experience of a masterclass on percutaneous cordotomy using on a 3D printing model will be presented. Due to the positive feedbacks of this first experience a masterclass associating young neurosurgeons and pain physicians will be held in 2024. The goal of this masterclass is to familiarize participants with modern approach of neurosurgical ablative techniques for the treatment of intractable cancer pain and define their current role in the palliative management of patients with advanced cancer

#### Conclusion

Ablative methods are not being adequately passed onto the next generation of surgeons – leaving future cancer patients without these alternatives. Passing on the knowledge and training younger neurosurgeon is a major issue.

### RC079

Rückenmarkstimulation zur Behandlung des primär progressiven Freezing of Gait: Langzeitnachbeobachtung Spinal cord stimulation for the treatment of primary progressive freezing of gait: long term follow-up

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#### Objective

This study aims to evaluate the effectiveness of spinal cord stimulation (SCS) in treating two patients with atypical Parkinson's disease characterized by primary progressive freezing of gait (PPFoG), a rare and challenging motor symptom that is resistant to conventional treatments. Both patients exhibited severe mobility limitations due to PPFoG and were considered for SCS as an alternative therapeutic approach.

#### Methods

Two patients with diagnosed PPFoG, unresponsive to pharmacological and other conventional interventions, underwent SCS therapy. Patient 1 presented with a 6-year history of progressive gait freezing and poor response to dopaminergic medication. Patient 2 had a 5-year history of freezing of gait associated with atypical features. SCS electrodes were implanted at the thoracic level targeting gait control pathways. Clinical outcomes were assessed using gait analysis, the Unified Parkinson's Disease Rating Scale, Timed "Up and Go" test, Berg Balance Scale, and patient-reported outcomes on freezing episodes. Both patients were followed up for 12 months to assess long-term outcomes.

#### Results

Both patients experienced initial improvements in freezing following SCS implantation. Patient 1 showed a marked reduction in freezing episodes and better gait stability, while patient 2 reported improved mobility, particularly in initiating movement, within the first 3 months after implantation. However, the positive effects of SCS were not sustained. Over time, both patients experienced a gradual return of freezing episodes and worsening mobility. By the 12-month follow-up, the stimulation no longer provided meaningful benefits, and both patients reported a decline in quality of life compared to baseline. As a result, the SCS devices were explanted.

#### Conclusion

SCS may offer short-term benefits for patients with PPFoG, particularly in improving freezing and mobility during the early post-implantation period. However, the long-term efficacy of SCS in such cases is limited, without sustained benefits. Larger studies are necessary to explore the underlying mechanisms of the transient improvements and to identify strategies for achieving more durable outcomes with SCS.

## RC080

#### Gesichtshautdurchblutung als nicht-invasiver Biomarker zur Bestätigung der Elektrodenpositionierung während der Thermokoagulation des Ganglion Gasseri Facial skin perfusion as a non-invasive biomarker for confirmation of electrode positioning during thermocoagulation of the Gasserian ganglion

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#### Objective

Accurate electrode positioning during thermocoagulation of the trigeminal ganglion is crucial to maximize pain relief. Previously, we demonstrated the safety and feasibility of laser speckle imaging (LSI) for facial perfusion imaging during stimulation of the Gasserian ganglion (GG) in humans. This study investigated the clinical relevance of LSI during GG thermocoagulation and its association to outcome.

#### Methods

In this prospective observational study, 21 patients underwent 25 unilateral procedures for refractory trigeminal neuralgia. Under general anesthesia, an LSI device was positioned perpendicular to the face and skin perfusion was continuously recorded at 25 Hz. Continuous LSI measurements were performed at baseline, fluoroscopic needle placement, electrical stimulation (motor test), and thermocoagulation. Real-time facial perfusion was visualized and quantitatively analyzed within ipsilateral and contralateral V1/2/3 regions of interest, and perfusion changes were correlated with clinical outcomes.

#### Results

LSI was successfully performed in all procedures without adverse events. Compared to baseline, skin perfusion significantly increased across all dermatomes during the procedure (needle placement:  $50.2\pm9.3\%$ , motor test: 48.7 $\pm$ 8.3%, thermocoagulation: 48.8 $\pm$ 8.6%; p<0.03 vs. baseline). Longitudinal comparisons of these three measurements revealed no differences in perfusion changes (p>0.06). The observed perfusion increase patterns were similar on the treated and untreated sides (p>0.32) and the perfusion increase did not differ based on whether the motor test induced a contraction of the masseter muscle or not (p>0.19). At 4-week follow-up, quality of life was significantly improved compared to preoperatively (SF-36, p<0.001), especially in the subdomain bodily pain (p<0.0001), but no correlation was found between perfusion changes and outcome (Spearman's rho -0.05 to 0.1).

#### Conclusion

During thermocoagulation of the trigeminal ganglion, facial skin perfusion determined by LSI increased significantly after needle placement, which may serve as a non-invasive biomarker for confirmation of correct electrode positioning. The predictive value of perfusion changes regarding outcome needs to be determined in randomized efficacy trials.

### RC081

Diagnostische Zuverlässigkeit und Komplikationen Rahmen Basierter Stereotaktischer Biopsien - Eine Analyse von 622 PatientInnen Diagnostic Yield and Complications in Frame-based Stereotactic Biopsies – Analysis of 622 consecutive patients

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#### Objective

Frame-based stereotactic brain biopsy is a reliable technique for obtaining tissue samples from intracranial lesions, essential for integrated molecular and histopathological diagnoses, particularly in cases unsuitable for resection. Despite advances in imaging, significant discrepancies between radiological and histopathological diagnoses persist. Although generally safe, rare but serious complications may occur. This study evaluates the safety, diagnostic accuracy, and complications of frame-based stereotactic brain biopsy, focusing on lesion location and radiological features.

#### Methods

A retrospective analysis of our stereotactic database was conducted for the period 2015–2023. N= 622 patients who underwent stereotactic biopsy for unclear brain lesions were included. Neuropathological, surgical, radiological, and clinical follow-up data was analyzed regarding diagnostic yield and complications.

#### Results

The overall diagnostic yield was 88.9%, with glioblastoma (48.6%) and lymphoma (19.6%) being the most common diagnoses. A concordance rate of 75.1% was found between the suspected diagnoses and the final molecular and histological diagnoses. Diagnostic yield was positively associated with the suspected diagnoses of "lymphoma", "glioma,", the presence of necrosis and contrast enhancement in presurgical imaging. Negative associations were observed for the suspected entities "inflammatory processes", "unclear lesion", non-enhancing lesions and lesions located in the occipital lobe. Complications were identified in 61 cases (9.8%), predominantly presenting as neurological deterioration (48 cases, 7.7%), which was temporary in 25 cases (4.0%) and permanent in 23 cases (3.7%). New Neurological deterioration was associated with post-surgical hemorrhage in 50% of the cases (n=24, 32.0 % temporary deterioration, 69.9% permanent deterioration). Other complications were surgical site infections (n=4), wound healing disorders (n=8), and seizures (n=6). 30-day mortality rate was 3.4%, a direct relation with surgery-was found in 3 cases (0.5%).

#### Conclusion

Frame-based stereotactic brain biopsy for unclear CNS lesions is a reliable neurosurgical procedure with a high diagnostic yield. The diagnostic outcome is influenced by the suspected diagnosis and radiological features, underscoring the importance of precise clinical questions. Although complications are rare, neurological deterioration is the most common adverse event, warranting careful risk-benefit evaluation in clinical decision-making.

## RC082

#### KI-assistierte Volumetrie von Hirnarealen und Liquorräumen bei spontaner intrakranieller Hypotension Brain and CSF Volume Changes in Al-assisted MRI Volumetry in Spontaneous Intracranial Hypotension

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#### Objective

Spontaneous intracranial hypotension (SIH) is associated with a myriad of symptoms, the most common being orthostatic headache and magnetic resonance imaging (MRI) findings, such as brain sagging and cortical vein distension, caused by a spinal CSF leak or a CSF venous fistula. Treatment usually involves surgical closure of the CSF leak or fistulas, often leading to significant symptomatic improvement. However, the follow-up in SIH patients is complicated by the currently limited ability to predict symptomatic responses from or detect subtle postoperative changes in perioperative imaging. This study investigated whether AI segmentation tools can detect quantifiable changes in MRI imaging in SIH patients and whether these changes correlate with clinical outcome parameters.

#### Methods

We performed a retrospective analysis in 56 patients with spontaneous intracranial hypotension who underwent surgical closure of a spinal CSF leak. We used AI-assisted volumetry of pre- and postoperative MRI imaging using the established AssemblyNet segmentation model to quantify CSF and brain volumes. We correlated the results with pre- and post-operative clinical patient-reported outcome measures based on the HIT-6, EQ-VAS and EQ-5D-5L scores.

#### Results

Patients demonstrated a significant increase in total ventricle CSF volume after SIH surgery (mean +13.7% after surgery, p < 0.001). Volumetric analysis of brain lobes revealed region-specific responses to restoration of CSF dynamics, with a significant decrease of occipital lobe volume (-0.110%, p = 0.002) and nonsignificant increases in frontal lobe (+0.055%), temporal lobe (+0.072%), and cerebellar volume (+0.026%). All clinical scores improved significantly postoperatively. There was only a weak correlation between some clinical scores and total ventricle CSF volume.

#### Conclusion

Surgical closure of Spinal CSF fistulas in SIH patients is associated with quantifiable changes in MRI, such as increased intraventricular CSF volume, which appears to be independent of the clinical outcome. Al-assisted volumetry may offer valuable prognostic information in clinical practice, potentially aiding in the prediction of patient outcomes following surgery.

### RC083

Wirksamkeit und Sicherheit der Lumbaldrainage bei verschiedenen Indikationen: Eine retrospektive Studie mit 477 Fällen Efficacy and safety of lumbar drainage across various indications: a retrospective study of 477 cases

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#### Objective

To assess the efficacy and safety of lumbar drainage (LD) across different clinical indications, with a focus on complications.

#### Methods

We retrospectively analyzed 477 patients who underwent LD placement between 2012 and 2022. Indications for LD included perioperative management during aortic surgery (159 cases, 33.3%), postoperative cerebrospinal fluid (CSF) leaks (139 cases, 29.1%), therapeutic CSF drainage (95 cases, 19.9%), postoperative or perioperative relief (76 cases, 15.9%), diagnostic lumbar drainage for normal pressure hydrocephalus (NPH) (3 cases, 0.6%), and other rare indications (5 cases, 1.0%). Complications and patient outcomes were evaluated.

#### Results

Of the 477 cases, 433 (90.8%) had no complications. However, 24 cases required re-insertion due to insufficient CSF flow. Two patients (0.4%) developed infections, and one patient (0.2%) on acetylsalicylic acid (ASA) suffered an epidural hematoma resulting in paraparesis. Overdrainage occurred in 17 patients (3.6%), manifesting as headaches in 13 cases, headaches with nausea in 4 cases, and subdural hygroma in one case.

#### Conclusion

Lumbar drainage is a highly effective and safe procedure for various clinical indications. Despite a low overall complication rate, careful monitoring and prompt management of complications, particularly in anticoagulated patients, are essential to optimize outcomes. These findings support the continued use of LD in neurosurgical and perioperative care, while highlighting the need for standardized protocols to mitigate risks.

### V235

#### Management chronischer subduraler Hämatome bei spontaner intrakranieller Hypotension Management of Chronic Subdural Hematoma in Spontaneous Intracranial Hypotension

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#### Objective

For the management of chronic subdural hematoma (cSDH) caused by spinal CSF leaks in spontenous intracranial hypotension (SIH), there is no accepted algorithm. The question of treatment priorization (cSDH vs CSF leak) and whether invasive CSF leak diagnostics (dynamic myelography) poses a risk for progression or aggravation of cSDH is unanswered. This study describes characteristics and proposes a management algorithm for cSDH in a large cohort of SIH patients.

#### Methods

This retrospective cohort study included all patients who underwent surgical or interventional closure of a spontaneous spinal CSF leak between April 2018 and April 2024. Demographics, characteristics of the cSDH (maximum width in coronal sections, uni- vs. bilateral, symptomatic +/-) leak type, and treatment were analyzed. Risk factors for cSDH were identified using logistic regression analysis, and differences in cSDH prevalence across leak types by ANOVA.

#### Results

Among 272 SIH patients, 85 (31%) presented with developed cSDH, predominantly bilateral (88%). Hematoma width ranged from 2 to 30 mm. cSDH prevalence was highest in CSF-venous fistula (43%), followed by ventral (31%), and lateral leaks (22%). Male sex (OR=4; p<0.001) and age >70 years (OR=6; p=0.008) were significant risk factors for development of cSDH. Surgical intervention was performed in 23 (27%) patients, mostly bilaterally (14/23, 61%). No patient required emergency evacuation, however, 17/23 (74%) had symptoms clearly attributable to cSDH. The biggest conservatively treated cSDH was 20mm. Of the surgically treated cSDHs, all but one (with a width of 7mm) were larger than 12mm. No neurological deterioration occurred during invasive diagnostics and conservative management. After closure of the spinal CSF leak, none of the patients, regardless of initial hematoma size, required additional cSDH treatment.

#### Conclusion

: In patients with spinal CSF leaks and cSDH, we recommend immediate surgical evacuation of the cSDH if neurological deficits or a significant mass effect are present. However, in completely vigilant patients without neurological deficit and a hematoma width of 10mm or smaller, it seems safe to address the spinal CSF leak first and adopt a conservative "wait-and-see" approach for the cSDH. A prospective validation of this management paradigm is needed.

### RC084

Intraluminale Endoskopisch-geführte Shuntkatheterplatzierung bei Schlitzventrikeln und komplexem Hydrocephalus Intra-Catheter Endoscopic Ventricular Catheter Placement in Slit Ventricles:and Complex Hydrocephalus

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#### Objective

The position of the ventricular catheter is essential for a proper function of cerebrospinal fluid diversion system. The incidence of proximal catheter misplacement reaches up to 45%. A semi-rigid- intra-catheter endoscope-guided method might be helpful in reducing complications and misplacement in complex hydrocephalus cases.

#### Methods

A retrospective study based on a prospectively acquired database of patients who underwent VC placement between 2012 and 2022. Accuracy of catheter placement was graded on postoperative imaging using three-point Hayhurst grading system. Complication and revision rates were documented and compared between both groups with an average follow up period of 24 months.

#### Results

A total of 189 patients with intra-catheter endoscope-guided VC-placement were identified. 63 patients with Slit ventricles , 31 patients with BIH, 45 patients with revision surgery with enlarged ventricle size, 44 patients with difficult anatomy in complex hydrocpehalus. 74 % of VC were Grade 1. There were no Grade 3 placements in the intra-catheter-endocsope group. Early shunt failure occurred in 2 patients due to proximal obstruction.

#### Conclusion

VC placement using the intra-catheter endoscope-guided VC-placement technique is a safe and effective procedure, which can help achieving significantly higher success rate and lower revision and complication rate in VC-Placement in slit ventricle Patients and complex hydrocephalus cases. Accordingly, we recommend using this technique, especially in patients with difficult anatomy.

Abb. 1



### Abb. 2



## RC085

Ein neues Lumbo-Peritoneal-Shunt-System mit einer Gravitationseinheit: Erste Erfahrungen und klinische Perspektiven A new Lumbo-Peritoneal Shunt System including a gravitational unit: First Experiences and Clinical Perspectives

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#### Objective

In Europe and North America, communicating hydrocephalus (HC) is commonly treated with ventriculoperitoneal shunts (VPS) or ventriculoatrial shunt (VAS), while in Japan and other Asian countries, lumboperitoneal shunts (LPS) are preferred. Despite the risk of overdrainage and the associated complications, so far, no adaptable differential valve along with a gravitational unit was available for LPS until recently. Here we report on our first cohort treated with a novel modular valve system designed for LPS.

#### Methods

We retrospectively analyzed 30 patients who underwent LPS implantation due to different HC pathologies between March 2023 and November 2024. LPS shunt implantation was performed in a single-position approach, implementing lateral positioning suitable for the lumbar approach as well as the lateral laparotomy. Valve settings were adapted from VPS routine at our neurosurgical department.

#### Results

The median age was 61+/-15 years, with various HC etiologies including: idiopathic normal pressure HC (n= 13, 43.3%), posthemorrhagic HC (n=12, 40%), idiopathic intracranial hypertension (n=3, 10%) and HC after tumor surgery (n=2, 6.7%). Surgical time was 70+/-16.4min. Relevant complications requiring reoperation occurred in 4 patients (13.3%), with peritoneal catheter dislocation accounting for 75% of these cases. Only one serious event necessitated LPS removal due to infection. Clinical overdrainage was observed in 13.3% of patients, but resolved in all cases after valve adjustment. Follow-up imaging did not show relevant hygroma or subdural hematoma requiring evacuation. Finally we found the LPS system as a valuable rescue option for patients with complex cranial wound conditions.

#### Conclusion

This study is the first to use the novel LPS system including a differential valve and gravitational unit, showing promising outcomes across various hydrocephalus etiologies. Most complications were of minor nature only requiring outpatient visits. More over the LPS system is a valuable option for patients with complex cranial wound conditions. Further investigations involving larger cohorts and prospective designs are imperative to validate these outcomes and optimize treatment strategies.

## BO-07

#### Characterization of the Neurophysiological Profile of Raynaud"s Phenomenon using ECAP Dose-Controlled Closed-Loop Spinal Cord Stimulation

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#### Objective

Raynaud's phenomenon (RP) is an episodically occurring vasospasm of the peripheral arteries that causes cyanosis, erythema, pain, paresthesia, and sometimes ulceration of the fingers and/or toes1. There are some case-reports on the utility of spinal cord stimulation (SCS) to treat RP2-9. However, there is a lack of objective evidence on differences in neurophysiology between RP and non-RP patients. Limited evidence exists on the impact of these neurophysiological differences on cervical SCS neural dosing levels. While experienced SCS implanters intuitively anticipate differences in cervical spinal cord (SC) sensitivity, this is empirical due to lack of neurophysiologic data in implanted SCS patients.

In this retrospective analysis, we evaluate differences in neurophysiology in RP and non-RP patients with cervical lead placements using ECAP dose-controlled closed-loop (CL) SCS.

#### Methods

Global study and real-world ECAP CL subjects (N=80) with cervical lead placements were included in this retrospective analysis. To identify differences between RP (n=10 patients) and non-RP (n=70 patients) cervical neurophysiology, activation plots were utilized.

#### Results

Median ECAP threshold was similar between cervical RP (0.55μC) vs. non-RP (0.63μC) patients. Median cervical RP stimulation range (0.97mA) was 28% lower vs. non-RP cervical patients (1.35mA), but not significantly different. Median cervical RP spinal sensitivity (0.35μV/μC) was not significantly different vs. non-RP cervical patients ( 0.30μV/μC).

#### Conclusion

Cervical SCS requires significantly lower amplitudes for neural activation compared to thoracic stimulation indicating spinal-level CSF differences10. Cervical spinal cord sensitivity is significantly higher compared to thoracic stimulation because of spinal-level CSF differences and heterogeneous dorsal column fiber population10. RP patients with cervical SCS have similar ECAP thresholds and SC sensitivity compared to non-RP cervical patients. RP stimulation range is lower than non-RP cervical patients but not significantly different. This highlights the need for precise and consistent activation in cervical SCS.

### V236

Crossmodale Plastizität in der Grenzregion zwischen auditorischem und visuellem Kortex und Auswirkungen auf die Verarbeitung auditorischer Informationen bei adult-ertaubten Ratten Cross-modal plasticity in the cortical auditory-visual transition zone and effects for processing of auditory information in adult-deafened rats

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#### Objective

The ability of the brain to adapt to adult-onset deafness has implications for hearing restoration with cochlear implants (CI). Compensatory cross-modal plasticity between visual and auditory cortex, as well as intra-modal plasticity, may influence the outcome of CI. Moreover, hearing loss may affect neural processing of auditory information in the medial prefrontal cortex (mPFC) as a representative for cognitive function. Here, we investigate the neural processing of CI stimulation in the transition zone between auditory and visual cortices and in the mPFC six months after deafness-onset in adult rats.

#### Methods

Male Sprague-Dawley rats were deafened by intracochlear neomycin injection (n=8), and normal hearing rats served as controls (n=8). After recovery, rats were trained for six months to respond to brief visual stimuli in the Five Choice Serial Reaction Time Task (5CSRTT). After that, anaesthetized deaf rats and hearing controls (acutely deafened) were implanted with CIs and neural activity was recorded via 32-channel silicon probes across the transition zone between auditory and visual cortices and in the mPFC during CI and visual stimulation.

#### Results

Chronic adult-onset deafness caused a shift in the auditory-visual border, with activity during visual stimulation expanding into the auditory cortex, but without expanding into the core auditory region (p<0.05). The power of the cochlear implant-evoked responses within the auditory cortex was weaker in deafened rats (p<0.05). Combined auditory and visual stimulation did not substantially affect auditory activation. In the mPFC, neural activity was moderately increased during visual stimulation in deafened rats, but not during CI stimulation.

#### Conclusion

Our findings show that "cross-modal plasticity" between visual and auditory cortices in adult-onset deafness is primarily a local effect, without affecting core auditory regions. In addition, although intramodal changes are present in the auditory cortex, they remain comparable between chronically deafened adult rats and normal hearing controls. These plastic changes after adult-onset deafness may be addressed by appropriate CI stimulation.

### V237

Therapie neurometabolischer Erkrankungen durch den Ersatz von Mikroglia mittels intrakranieller Zelltransplantation *Replacement of microglia through intracranial cell transplantation as a novel therapy for neurometabolic disorders* 

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#### Objective

Migration of transplanted myeloid cells into the brain following systemic hematopoietic stem and progenitor cells transplantation (HCT) holds great promise as a therapeutic modality to correct genetic deficiencies in the brain such as lysosomal storage diseases. However, the toxic myeloablation required for allogeneic HCT can cause serious, life-threatening side effects limiting its applicability. Here we explored a brain-restricted, high-efficiency microglia replacement approach without myeloablative preconditioning.

#### Methods

We used a transgenic mouse model of Sandhoff disease, in which homozygous knockout of the *Hexb* gene leads to deficiency of the  $\beta$ -hexosaminidase isoenzymes with consecutive accumulation of glycolipids in the brain. Affected animals present with progredient neurological deficits and a reduced life expectancy. Microglia replacement was performed through the intracerebroventricular injection of hematopoietic cells consecutive to preconditioning with radiotherapy and colony stimulating factor 1 receptor inhibition at 6 weeks of age. Donor cells were carrying the wild type alleles for *Hexb*. After transplantation, recipient animals underwent additional immunomodulatory therapy to prevent allograft rejection. Transplantation efficiency and extend of genetic restoration were assessed through histological analysis. Functional effects of the cell therapy were evaluated through behavioral and survival analysis.

#### Results

In the allogeneic transplantation setting, a median area of 55.6% (SD ±37.2%, n=14) of the brain was occupied with donor-derived myeloid cells 12 weeks after transplantation. We detected restoration of  $\beta$ -hexosaminidase activity as well as a reduction in glycolipid accumulation compared to *Hexb* knockout animals (PAS stain, p = 0.001 MWU). Treated animals demonstrated significantly improved neurological function (e.g. median time on rotarod at 17 weeks of age: 166s ±97s vs 14s ±10s, p <0.0001 MWU) and extended survival (p = 0.0006, Cox proportional hazards regression model).

#### Conclusion

Our results overcome current limitations of conventional HCT and may pave the way for the development of allogeneic microglial cell therapies for the brain through the intracranial injection of donor cells – a potential new domain for the field of neurosurgery.

### V238

Die Auswahl des Anästhetikums beeinflusst die hämodynamische Kopplung von Spreading Depolarization in einem gyrencephalen Modell zur reversiblen zerebralen Hypoperfusion Hemodynamic coupling of Spreading Depolarization is affected by the choice of anesthetic in a gyrencephalic model of reversible cerebral hypoperfusion

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#### Objective

Spreading Depolarizations (SD) serve as a key pathophysiological factor in delayed cerebral ischemia. The hemodynamic responses associated with SD are influenced by the metabolic state of the tissue. We hypothesized that the frequency and type of these responses may differ depending on the anesthetic agent. Therefore, we investigated the effect of two commonly used surgical anesthetics on the characteristics of hemodynamic response patterns to SD in a gyrencephalic model of spontaneous SD occurrence.

#### Methods

This prospective, randomized study included 12 female landrace swine (30–40 kg) that received either propofol (Prop; n=6) or isoflurane (Iso; n=6) anesthesia. Mean arterial blood pressure (MAP) and partial pressure of CO2 (pCO<sub>2</sub>) were maintained within target ranges of 60–80mmHg and 40mmHg, respectively. For spontaneous SD induction, endovascular balloon catheter occlusion and reperfusion of the feeding trunks of the porcine rete mirabilis were performed. Cortical perfusion was continuously monitored using intraoperative laser speckle imaging (LSI) and SD-coupled hemodynamic response patterns were analyzed within the SD propagation areas identified by LSI.

#### Results

Physiological parameters did not differ between groups (Prop / Iso for MAP 82±5 / 65±6mmHg; pO<sub>2</sub> 194±30 / 229±110mmHg; pCO<sub>2</sub> 43±7 / 43±6mmHg; p>0.05 for all parameters). In 7 out of 12 animals (58%), a total number of 50 SD-associated hemodynamic responses were observed, mainly during global vessel occlusion (27/50; 54%) and subsequent reperfusion (15/50; 30%). Anesthetic-specific differences were noted, with 27/50 (54%) SDs recorded in 5/6 (83%) propofol animals and 23/50 (46%) SDs in 2/6 (33%) isoflurane animals (\*p=0.039 vs. propofol). Analysis of 223 regions of interest (ROIs) associated with 50 SDs identified seven distinct perfusion patterns, which were categorized into hyperemic (110/223; 49%) and hypoemic (113/223; 51%) SD coupling. In Prop animals, hypoemic coupling was associated with a significantly lower resting perfusion (\*\*\*p=0.001).

#### Conclusion

The choice of anesthetic influences the occurrence and hemodynamic response associated with SD, which offers new insights into differential hemodynamic coupling and highlights the complex interaction between brain parenchyma and the cerebral vasculature during SD.

### V239

Hydrogenperoxid in der Neurochirurgie: Wert und pathophysiologische Auswirkungen auf das Gehirngewebe von Menschen und Tieren

The value of hydrogen peroxid in neurosurgery and pathophysiological effect of hydrogen peroxid in human and animal brain tissue

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#### Objective

Hydrogen peroxide (H2O2) is a well-known hemostatic and antiseptic agent in neurosurgical practice. While there are concerns regarding the use of H2O2 due to its potential for neuronal damage, the pathophysiological effect on neuronal cells is not clearly understood.

#### Methods

An online survey concerning the use of H2O2 was conducted among 242 neurosurgeons in board-certified platform and an experimental study was designed to investigate the effect of H2O2 on neuronal and tumor cells. Brain tissue of mice and brain/tumor tissue of humans were irrigated with H2O2 3%, H2O2 1.5%, NaCl 0.9% and processed by bipolar coagulation. Tissue sections were obtained and stained with H&E and analyzed by the depth and degree of neuronal damage measured from the cortical surface (m).

#### Results

The survey showed that 81% of neurosurgeons use of H2O2 in neurosurgical practice, however only 5% of the participants had a literature-based knowledge of the pathophysiological mechanism of H2O2. The experimental study found that H2O2 cause vacuolization of neuronal tissue in mice brain tissues, with a mean depth of damage of 343.7+/-39.7um after 2 minutes and 460.1+/-36.4 um after 10 minutes exposure to H2O2 3% (p<0.001). In human brain tissues, vacuolization was detected in sections exposed to H2O2 1.5% and 3%, with a mean depth of damage of 543.8+/-304.5 um and 859.0+/-379 um (p=0.003). In the bipolar coagulation group, the mean depth of neuronal damage with 2504+/-1490 um was nearly three times greater than H2O2 group (p<0.001). Similar results were observed in human tumor tissues as well.

#### Conclusion

H2O2 seems to damage neuronal and tumor cells less than the conventional bipolar cauterization suggesting as a good alternative to be used for hemostasis and marginal tumor cell treatment. However, due to its potential risk for embolism, H2O2 should be used with caution.

### V240

## Neue Erkentnisse zur Mikrothrombose-vermittelten Blut-Hirn-Schranken Störungen bei Schädel-Hirn-Trauma Novel Insights of Microthrombi-Mediated Blood-Brain-Barrier Dysfunction after Traumatic Brain Injury

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#### Objective

Traumatic brain injury (TBI) is characterized by reduced cerebral blood flow and increased blood-brain barrier (BBB) permeability, yet the mechanisms driving these disturbances remain insufficiently understood. Emerging evidence suggests that microthrombi (MTi) in the traumatic penumbra may play a critical role in contributing to BBB dysfunction. This study aims to characterize the formation and composition of post-TBI MTi, their impact on BBB permeability in an experimental as well as clinical setting.

#### Methods

MTi and BBB leakage were visualized following controlled cortical impact (CCI) in C57BL/6 mice by systemic administration of super-bright 30 nm lipid nanodroplets (LnDs). Brains were stained for immune cells, platelets, erythrocytes, fibrine and investigated by fluorescent confocal imaging. Additionally, caveolin (Cav1) knockout mice (Cav1tm1Mls/J) and wildtype controls (WT) were used to investigate the mechanisms of BBB opening after TBI. To validate the relevance of microthrombi-mediated BBB dysfunction in humans, we performed an analysis of an open-access snRNAseq dataset by Garza et. al. (Cell reports, 2023) of human TBI samples and controls.

#### Results

Our findings demonstrate that 50% of MTi were associated with extravasation of albumin, fibrinogen, IgG, and LnDs within the traumatic penumbra. Immunohistochemical analysis revealed variable MTi composition, which consisted of erythrocytes, platelets, fibrin, and leukocytes in different proportions. The extravasation of blood-derived molecules positively correlated with the cellular presence within MTi (n=426 clots; R=0.31, p=0.02) and inversely with fibrin content (R=-0.64, p<0.001). Genetic deletion of Cav1 significantly reduced LnD extravasation compared to WT controls (n=5 animals per group, p=0.002), consequently reducing local activation of microglia (p=0.01). Furthermore, snRNAseq analysis revealed a significant downregulation of BBB-associated markers after TBI compared to controls (p<0.001) and an upregulation of thrombolytic markers (p=0.001). Gene set enrichment analysis identified a strong link between BBB dysfunction and microthrombosis formation.

#### Conclusion

Our study demonstrates the presence of microthrombosis in the traumatic penumbra, contributing to increased BBB permeability in both experimental models and clinical settings, providing novel insights into the pathophysiology of TBI and suggesting a new potential theranostic approach.

### V241

Die Kombination der therapeutischen Antikörper Cetuximab und Trastuzumab mit einem TIGIT-blockierenden Antikörper steigert die Zytotoxizität von NK-Zellen gegen EGFR- und ERBB2-positive primäre Glioblastomzellen The combinatorial use of therapeutic monoclonal antibodies Cetuximab and Trastuzumab with a TIGIT-blocking antibody enhances cytotoxicity of NK cells against primary glioblastoma cells expressing EGFR and ERBB2

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#### Objective

Natural Killer (NK) cells are emerging as promising tools in cellular immunotherapy for cancer treatment. In contrast to T cells, NK cells are devoid of recombined immunoreceptors and recognize tumor cells by a set of inherited natural cytotoxicity receptors as well as activating and inhibitory receptors of the immunoglobulin and lectin superfamily. Glioblastoma (GBM) cells express inhibitory ligands for NK cell receptors, such as CD155/poliovirus receptor (PVR), which dampen NK cell activity by engaging the inhibitory receptor TIGIT (T cell immunoreceptor with Ig and ITIM domains) on NK cells. Interestingly, TIGIT expression is upregulated on both activated NK cells and on NK cells derived from cancer patients. This study aimed to explore whether TIGIT-blockade improves cytotoxic responses of NK cells against GBM cells treated with therapeutic antibodies Cetuximab and Trastuzumab.

#### Methods

Primary NK cells were isolated from the blood of healthy donors. On the day of isolation and after 10 days in coculture with a PC-3 feeder cell line constitutively expressing IL-2, membrane-bound IL-15 and 4-1BBL, NK cells were analyzed by flow cytometry for immune checkpoint molecules and activating and inhibitory receptors. Subsequently, the cytotoxicity of the *in vitro* expanded NK cells against the CD155+ primary GBM cell lines HT7606, HT18584, HT12347, HT16360-1 and HT18328-3 constitutively expressing mKATE2 was investigated by IncuCyte assays employing combinations of TIGIT-blocking antibody, Cetuximab and Trastuzumab.

#### Results

Expanded NK cells showed a higher expression of TIGIT than fresh NK cells from peripheral blood. Blocking of TIGIT lead to an increase in NK cell-mediated specific lysis of GBM cell lines (HT18584: median 21.6%, HT16360-1: median 44.8%) compared to control NK cells (HT18584: median 10.8%, HT16360-1: median 37.2%). The combination of a TIGIT-blocking antibody and either Cetuximab (HT18584: median 34.7%, HT16360-1: median 49.5%) or Trastuzumab (HT18584: median 33.9%, HT16360-1: median 55.1%) lead to an even higher percentage of NK cell-mediated specific killing of GBM cell lines.

#### Conclusion

The results demonstrate that the combination of Cetuximab/Trastuzumab and a TIGIT-blocking antibody leads to an improved cytotoxicity of *in vitro* expanded primary NK cells towards glioblastoma cells by overcoming the immunosuppressive effect of CD155. Therefore, TIGIT serves as promising target structure for future studies and clinical approaches.

## V242

Der neuronale Marker UCHL1 ist in Medulloblastomen reduziert und zeigt onkogene Effekte in hochgradigen Tumoren

The neuronal marker UCHL1 is reduced in medulloblastoma and shows oncogenic effects in high-grade tumors

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#### Objective

The neuron specific UCHL1 belongs to the ubiquitin-proteasome system by maintaining monoubiquitin level to ensure undisturbed protein degradation. Dysfunction of UCHL1 is primarily associated to neurodegenerative diseases, but also connected to cancers (Day and Thompson, 2010). Mostly studied is the protein in glioma, where it serves as oncogene by driving proliferation, migration and invasiveness (Sanchez-Diaz *et al.*, 2017). Controversially, reduced expression was found in high-grade meningioma (Perez-Magan *et al.*, 2012). Childhood tumors, such as medulloblastoma (MB) are not well researched, so that we focused to evaluate UCHL1 in MB and pediatric glioma.

#### Methods

Expression of *UCHL1, NEUN, NSE, Tau* and *TUBB3* was analyzed in 124 pilocytic astrocytoma, glioblastoma (GBM) and MB patients via qPCR. Effect of UCHL1 on proliferation, migration and invasion behavior was analyzed in an adult GBM and pediatric MB cell line *in vitro*. Upregulation was performed using a recombinant expression system, downregulation via siRNA.

#### Results

*UCHL1* gene expression was reduced in tumor compared to healthy tissue (GBM p=0.003; PA p=0.015), which, in glioma turned out to be a secondary effect due to a reduced number of neurons (Fig.1). Upregulation of UCHL1 expression *in vitro* had oncogenic effect on GBM and MB *in vitro*, leading to enhanced migration (Fig.2, MB p=0.0004; GBM p=0.0182) and invasion behavior.

#### Conclusion

The neuronal marker UCHL1 is reduced in MB and serves as oncogene by driving migration and invasion in vitro.

Figure 1 Significant reduced expression of all neuronal marker in glioma compared to peritumoral tissue. Significant reduced expression of UCHL1 in MB compared to peritumoral tissue( $5.07\pm5.1$  vs.  $1.59\pm1.44$ , p=0.0154) with continued strong expression for NEUN, NSE and TUBB3.

Figure 2 Enhanced migration and invasion behavior caused by UCHL1 (D). UCHL1 upregulated cells showed wound closure after 72h (DAOY) and 96h (U87), while a residual wound was recognized at same time points for WT cells (A-C).








## Basic science 2 | Basic science 2

### RC086

Die schützende Wirkung von Nimodipin in Schwann-Zellen ist assoziiert mit der Hochregulation von LMO4 und SERCA3 sowie einer Feinabstimmung des intrazellulären Kalziumspiegels. Protective effect of nimodipine in Schwann cells is related to the upregulation of LMO4 and SERCA3 accompanied by fine-tuning of intracellular calcium level

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#### Objective

Nimodipine is the current gold standard in the treatment of subarachnoid haemorrhage, as it is the only known calcium channel blocker that has been proven to improve the neurological outcome. In addition, nimodipine exhibits neuroprotective properties in vitro under various stress conditions. Furthermore, clinical studies have demonstrated a neuroprotective effect of nimodipine after vestibular schwannoma surgery. However, the molecular mode of action of nimodipine pre-treatment has not been well investigated.

#### Methods

In the present study, we used Schwann cells and investigated the effect of nimodipine under oxidative and osmotic stress using real-time cell death assays. Anti-apoptotic pathways and calcium channel expression were analyzed by Western blot. Furthermore, the expression of genes associated with calcium homeostasis were investigated under the influence of nimodipine using quantitative real-time PCR.

#### Results

Nimodipine not only reduces cell death induced by osmotic and oxidative stress but also protects cells directly at the time of stress induction in Schwann cells. Nimodipine counteracts stress-induced calcium overload and overexpression of the Cav1.2 calcium channel. In addition, we found nimodipine-dependent upregulation of sarcoplasmic/endoplasmic reticulum calcium ATPase 3 (SERCA3) and LIM domain-only 4 (LMO4) protein. Analysis of anti-apoptotic cell signaling showed inhibition of the pro-apoptotic protein glycogen synthase kinase 3 beta (GSK3 $\beta$ ). Nimodipine-treated Schwann cells exhibited higher levels of phosphorylated GSK3 $\beta$  at serine residue 9 during osmotic and oxidative stress.

#### Conclusion

In conclusion, nimodipine prevents cell death by protecting cells from calcium overload by fine-tuning intracellular calcium signaling and gene expression. The results of this study have the potential to provide insights into the development of an optimised clinical treatment strategy to prevent or reduce neuronal damage. This strategy would result in the optimization of therapies and a significant improvement in patients' quality of life.

## Basic science 2 | Basic science 2

### RC087

Untersuchung der Biomechanik im GBM Organoidmodell: Kombination von Brillouin- und Raman-Spektroskopie zur Erfassung der Gewebekomplexität

#### Exploring GBM Organoid Biomechanics: Integrating Brillouin and Raman Spectroscopy to Address Tissue Complexity

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#### Objective

Glioblastomas (GBM) are highly aggressive brain tumors that exhibit considerable heterogeneity. Investigating the biomechanics of whole tissues by Brillouin microscopy is challenging given the complexity of tissue components and the technique has not been utilized to examine GBM tissue. Here, we employed organoids as an in vitro model that recapitulates the typical characteristics and variability of tumors.

#### Methods

Organoids were prepared from patient GBM tissue and were cultivated according to established protocols [Jacob et al. Cell. 2020;180(1):188-204.e22]. Vital, proliferating tumor cells were confirmed by Ki67 immunohistochemistry at all time points. Brillouin and Raman spectroscopic measurements were conducted on a weekly basis for two months using a confocal system as described elsewhere [Rix et al. J R Soc Interface. 2022 (192):20220209].

#### Results

Cluster analysis of the Raman spectra of organoids revealed the existence of five distinct biochemical profiles. Significant differences among the Brillouin shifts and width of the Brillouin bands corresponding of the five profiles were confirmed by ANOVA (P<0.001). Profile 1 has had mean Brillouin shift of 5.20 GHz (n=43) consistent with extracellular medium. Profiles 2 and 3 were predominantly attributed to cytoplasmic proteins in different concentrations. The corresponding Brillouin spectra exhibited mean shifts of 5.25 (low proteins, n=56) and 5.37 GHz (high proteins, n=102), respectively. Profile 4 was dominated by lipids and might represent intracellular lipid droplets (mean Brillouin shift of 5.49 GHz (n=13). The elevated Brillouin shifts observed in profile 3 (high protein content) suggest an increase in tissue stiffness. However, given the known higher refractive index and lower mass density of lipid droplets, the increased Brillouin shifts found for profile 4 and 5 may result from changes in optical properties rather than altered biomechanics.

#### Conclusion

Raman spectroscopy proved an efficacious tool for differentiating the physical, biochemical, and biomechanical factors that contribute to alterations in the shift and width of the Brillouin bands. This comprehensive understanding is essential for accurate interpretation of Brillouin microscopy data in heterogeneous tumor tissue and is the foundation for follow-up studies targeting the role of biomechanics in tumor growth and invasion.

## Basic science 2 | Basic science 2

### RC089

Auswirkung von langfristigen optogenetischen Stimulation auf die elektrophysiologischen Parameter von spreading depolarizations bei Mäusen mit chronischer zerebraler Hypoperfusion oder distalem Schlaganfall *Effect of long-term optogenetic stimulation on electrophysiological spreading depolarization parameters in mice with chronic cerebral hypoperfusion or distal stroke* 

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#### Objective

Even though the relevance of spreading depolarizations (SDs) have been shown for several acute and chronic pathologies, the pathophysiological mechanisms of these waves of neuronal mass depolarizations are still unclear. Moreover, investigation of SD effects in animal experiments so far was mainly limited to an acute short-term set-up. For translational purposes, we developed a long-term experimental schedule with wireless optogenetic SD induction in freely moving mice of different ages after an initial insult.

#### Methods

Chronic experiments were performed in young (3-5 months) and aged mice (~1 year) with chronic cerebral hypoperfusion or distal stroke. In each of these conditions, animals were randomly assigned to a control or stimulation group. After implantation of the optogenetic device, the stimulation groups received a recurrent SD trigger every 6 hours over a period of 3 weeks in their housing cage. To assess the effects of this long-term stimulation on electrophysiological [SH1] SD parameters, simultaneous LSI and ECoG measurement of two SDs was performed on experimental day 14.

#### Results

In both age groups of mice with chronic hypoperfusion, there was a significant difference between the stimulated and non-stimulated animals. The control groups showed prolonged SDs with larger amplitudes. These differences were also represented in a different distribution of waveforms for stimulation and control groups, with stimulation groups being similar to diseaseless mice, whereas the control groups showed a higher amount of double peak SDs. A similar trend was also observed for the experimental groups with a distal stroke.

#### Conclusion

Our results suggest that medical conditions like chronic hypoperfusion or distal stroke induce a change in the SD waveform features, from single peak forms that are mainly found in diseaseless mice, towards double peak forms. On the other hand, a recurrent SD stimulation seems to shift the waveform distribution back to more single peak SDs.

## Basic science 3 | Basic science 3

### V243

Orthotop implantierte Lungenkarzinomzellen metastasieren spontan in das Gehirn und ermöglichen ein murines Model der hirnspezifischen prä-metastatischen Nische Orthotopically implanted lung carcinoma cells spontaneously metastasize to the brain and can be used as a premetastatic niche model

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#### Objective

Brain metastases are becoming increasingly common in neuro-oncology and neurosurgery due to improved oncological treatment options. This study aims to establish suitable spontaneous murine brain metastasis models to investigate the pre-metastatic niche, focusing particularly on lung cancer models due to their high prevalence of brain metastases in the clinical setting.

#### Methods

The study employed two different lung cancer models: Lewis Lung Carcinoma (LLC1) in C57BL/6 mice and the highly metastatic Lacun.3 cell line in Balb/c mice. We transduced both cell lines with a stable luciferase reporter and implanted them orthotopically into the right lung of mice. The experiments included multiple time points (10, 13, 16, and 20 days), after which the animals were sacrificed and brains were isolated and examined for micro- or macrometastases using Luciferase-assay measurements.

#### Results

Analysis using Luciferase-Assay demonstrated now metastasis-positive brains for LLC1-bearing mice at day 5 (0/3), few positive brains at day 10 with LLC1-bearing mice (1/3 animals), and few metastasis-positive brains for LLC1- and Lacun.3-bearing animals at day 13 (1/3 for each). Both LLC1 (2 out of 3) and Lacun.3 (2 out of 4) tumor-bearing mice demonstrate mainly positive signals by day 16, indicating successful spontaneous metastasis formation (Fig. 1). The clear distinction between earlier time points and day 16 enabled the identification of a well-defined pre-metastatic period.

#### Conclusion

The study successfully establishes two spontaneous brain metastasis models that are able to replicate the complete metastatic cascade. These models provide valuable tools for investigating the biology of the pre-metastatic niche, with a clearly defined pre-metastatic time window suitable for further research.





## Basic science 3 | Basic science 3

### V244

Single-Cell Sequencing von Hirnendothelzellen in einem murinen Lugenkarzinommodel der prä-metastatischen Nische deckt eine Gruppe motiler Endothelzellen auf Single-Cell Sequencing demasks endothelial cell remodeling in a group of brain endothelial cells in a spontaneous murine lung cancer metastasis model

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#### Objective

Brain metastases are becoming increasingly common in neuro-oncology and neurosurgery due to improved oncological treatment options. This study investigates the pre-metastatic niche (PMN) in the brain to understand the mechanisms of brain metastasis formation, especially the overcoming of the blood-brain-barrier (BBB) via endothelial cells. The objective was to establish a spontaneous lung cancer metastasis model and leverage it to analyze the transcription of brain endothelial cells in the active PMN setting.

#### Methods

We utilized stably luciferase-expressing LLC1 lung carcinoma cells that were orthotopically implanted into the right lung of C57BL/6 mice. The experimental setup included growth periods of both 10, 13 and 16 days, followed by animal sacrifice and brain analysis utilizing Luciferase-assay measurements. Brain endothelial cell isolation for further analysis was performed using MACS technology. Single-Cell Sequencing was carried out with 10X Genomics processing, with subsequent in-silico analysis for cellular mapping using Seurat and DESeq2 software packages, complemented by Gene set enrichment analysis (GSEA) and Pathway enrichment analysis (PEA) using Metascape.

#### Results

The analysis revealed distinct patterns in luciferase signal detection, with positive signals found in three out of five analyzed brains after 16 days of growth, while only one out of three analyzed brains showed signals after 10 or 13 days. Based on these findings, the 13-day growth period was established as the PMN model (Fig. 1). Further analysis of isolated brain endothelial cells at this specific timepoint uncovered a PMN-specific endothelial cell cluster, with GSEA and PEA revealing upregulation of cellular programs involved in endothelial remodeling and neoangiogenesis (Fig. 2).

#### Conclusion

The research successfully identified a transcriptionally distinct endothelial cell population in LLC1-bearing animals, which exerts transcriptional over-regulation of specific gene sets described for endothelial remodeling, cellular motility and immune response. This population may be linked to structural changes in the blood-brain barrier, potentially creating conditions that facilitate metastasis formation and provide opportunities for further research und possible identification of therapeutic targets.



Abb. 2



## Basic science 3 | Basic science 3

### V246

Die Fibroblasten-Wachstumsfaktor-Rezeptorfamilie ist in BRAF-mutierten Melanom-Hirnmetastasen nach adjuvanter Therapie erhöht. *Fibroblast growth factor receptor family is increased in BRAF mutated melanoma brain metastases after* 

Fibroblast growth factor receptor family is increased in BRAF mutated melanoma brain metastases after adjuvant therapy.

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#### Objective

As receptor tyrosine kinases, the fibroblast growth factor receptor (FGFR) family has various oncogenic effects, such as increased proliferation, invasion or angiogenesis and is thus known to promote metastasis (Korc, M. & Friesel, R. E. 2009). Clinical trials with targeted therapies against FGFR positive tumors have already shown promising outcomes in various cancers. With focus on malignant melanoma, predominantly FGF2 is associated with tumor aggression and progression (Katoh, M. & Nakagama, H. 2014). However, the expression of the FGFR family in brain metastasis of melanoma has not yet been investigated, which therefore was this studies focus.

#### Methods

Brain metastasis of malignant melanoma were collected during neurosurgery. Samples were either grouped according to their *BRAF* gene mutation status or according to the therapy received by the patients. Transcription rate of *FGF1-2* and their receptors *FGFR1-4* was quantified via qPCR and normalized with  $\beta$ -Actin. Statistical analysis was performed with GraphPad Prism.

#### Results

All *FGF* genes, except for *FRFR-4* were higher transcribed in *BRAF* mutated tumors. FGFR1 (2.562 vs. 0.869, p=0.0039), FGF1 (1.264 vs. 0.333, p=0.0208) and FGF2 (4.289 vs. 1.609, p=0.0009) appeared with most significance. With a focus on the patient's therapy prior to resection, an increased expression with received therapy was seen for all genes, again except of FGFR4, with significance for FGFR2 (3.923 vs. 0.372, p=0.0107) and FGFR3 (4.302 vs. 0.617, p=0.0130). Therapy that had highest influence varied between the genes.

#### Conclusion

FGF genes are higher expressed in BRAF mutated tumors and those whose patients received therapy after the primary tumor. FGFR4 showed an opposite expression pattern in all analysis.

Figure 1: mRNA expression levels of FGFR1, FGFR2, FGFR3, FGFR4, FGF1 and FGF2 in melanoma metastasis according to BRAF mutation. The columns determine the mean value and standard error of the mean. The significance is portrayed with asterisks for the following P value: \* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

Figure 2: mRNA expression levels of FGFR1, FGFR2, FGFR3, FGFR4, FGF1 and FGF2 in melanoma metastasis according to their received treatment. The columns determine the mean value and standard error of the mean. Significance is portrayed with asterisks for the following P value: \* p<0.05.



FGFR2























## Basic science 3 | Basic science 3

### V247

# CAR-T Zell Therapie bei Vestibularisschwannomen getestet an einem ex vivo Tumor-Slice-Modell CAR-T cell therapy for vestibular schwannoma tested in an ex vivo tumor slice model

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#### Objective

Vestibular schwannoma (VS) are benign tumors, which grow bilaterally in most cases of neurofibromatosis type 2 (NF2). NF2 patients are characterized by appearance of different other tumor entities, high recurrence rates, invasiveness, and functional deficits. However, long lasting systemic treatment strategies are still missing and urgently needed. We investigated a CAR-T cell therapy for vestibular schwannoma in a tumor slice model.

#### Methods

Freshly obtained tumor tissue (n = 7 patients) was fixed in agarose, cut into 350  $\mu$ m slices and cultured for three days. 5 × 106 CAR-T cells, directed to five different target antigens, including disintegrin and metalloprotease 9 (ADAM9) and CD276 (B7H3), were seeded per slide. Untransduced CAR-T cells served as a negative control. In addition, primary monolayer cell cultures were treated utilizing the same set of CAR-T-cells. Proliferation and apoptosis were analyzed by immunostaining with Ki67 (proliferation), CC3 (apoptosis), and T-cells were identified by CD4. Secretion of IFN-g and IL2 were analyzed by ELISA.

#### Results

Treatment with CARs against Target 1, 2 or 3 had no significant effect in comparison to the control. In contrast, treatment of tumor slices as well as monolayer cell culture with CAR-T cells against ADAM9 and B7H3 resulted in decreased cell numbers. After two days, no living cells were detectable in the monolayer cell culture. In contrast, in tumor slices only half of the cells were dead after 72 h. Correspondingly, after 72 h the apoptotic rate was only 4 - 8 % in the tumor slices, but about 40 % in the monolayer cell culture after 24 h and after 48 h and zero after 72 h. After 72 h, still 50 % of the CD4 positive cells were alive and proliferating, as indicated by Ki67-positivity. The IFN-g concentration increased to 5000 pg/ml after B7H3 and 2500 pg/ml after ADAM9 treatment, respectively, from 1000 pg/ml in the control group. IL-2 showed elevated concentrations only after B7H3 treatment.

#### Conclusion

CAR-T cell therapy could be highly effective against vestibular schwannoma.

## Basic science 3 | Basic science 3

### V248

Wirksamkeit von Tinzaparin im Vergleich zu Enoxaparin zur Thromboembolieprophylaxe bei neurochirurgischen Patienten

Efficiency of Tinzaparin vs. Enoxaparin for prophylaxis of thromboembolism in a neurosurgical patient population

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#### Objective

Thromboembolism prophylaxis is a critical component of the overall treatment concept in neurosurgery, with mostly low molecular weight heparins (LMWHs) serving as the standard thromboprophylactic agents. While the use of enoxaparin as a thromboprophylactic agent is common in neurosurgery, little is known about the efficiency of tinzaparin in comparison.

#### Methods

In 2021, thrombosis prophylaxis was uniformly switched from enoxaparin to tinzaparin in our hospital. A retrospective study has been conducted to investigate the efficacy of both preparations regarding the incidence of thromboembolism. In a time-interval of 2.5 years before and after this regime change, all adult patients who had undergone neurosurgery in our clinic were included. A thromboembolic event was counted as such if a patient became acutely symptomatic, and the diagnosis was subsequently confirmed by imaging (sonography for thrombosis and computed tomography angiography (CTA) for pulmonary embolism).

#### Results

Overall, 6035 patients were included in this study with 3127 patients being in group A (enoxaparin) and 2908 patients being in group B (tinzaparin). In group A, 18 (0.58%) thromboembolic events were recoded, of which 14 were deep vein thrombosis (DVT) and 4 were pulmonary embolisms (PE). For group B, 27 (0.93%) events were identified, including 14 cases of DVT and 13 cases of PE. Statistical analysis showed a significant increase of PEs in the tinzaparin-treated group (p=0.02). The overall incidence of thromboembolic events in the whole cohort was 0.75%. No patient that suffered a thromboembolism died during the in-hospital stay due to that event.

#### Conclusion

In our study, with an overall incidence of only 0.75% of clinically symptomatic thromboembolic events, both agents were quite efficient in preventing thromboembolic events in neurosurgical patients. However, we found a significant increase in PEs in the tinzaparin-treated group.

### V249

Kombinierte Kranioplastik nach Resektion von Tumoren mit ossärer Infiltration: eine retrospektive Auswertung von patientenspezifischen- und PMMA-Implantate Single stage cranioplasty following craniectomy for tumors infiltrating the cranium: a retrospective analysis of patient-specific and PMMA-implants

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#### Objective

Resection of tumors infiltrating the cranium poses the challenge of craniectomy and subsequent cranioplasty to immediately treat the skull defect. While polymethyl methacrylate (PMMA) remains a common implant choice due to its intraoperative moldability, patient-specific implants (PSI) are an increasingly prevalent alternative. To date, limited data exists on PSI cranioplasty. This study assessed the feasibility of single-stage craniectomy and cranioplasty using PSI, comparing complications and cosmetic outcomes with PMMA.

#### Methods

We retrospectively analyzed data from consecutive adult patients undergoing single-stage craniectomy and cranioplasty for tumors infiltrating the cranium at our institution from 2015 to 2024. PMMA implants were shaped intraoperatively, while PSIs were fabricated by external companies based on preoperative CT scans and neurosurgeon specifications. Patient-specific drawing guides were used for craniectomy planning in select cases.

#### Results

Twenty-one patients (16 male [76%], 5 female [24%]) were included. Tumor diagnoses comprised meningioma (n=13, 62%), carcinoma metastasis (n=2, 9%), and primary intraosseous hemangioma (n=2, 9%). Eleven (52%) patients received PMMA and 10 (48%) PSI; drawing guides were used in 6 (29%) cases. Mean surgical time was 197 minutes (SD 84); mean implant size, 48 cm<sup>2</sup> (SD 36.5). Excellent cosmetic results based on CT scan (CT-based Likert scale, 1-4 scale) after surgery were achieved (mean 1.38, mark 1 or 2 in 20 cases, 95.2%). We found no significant intergroup differences. Excluding one reoperation for tumor recurrence, 3 reoperations due to complications (14%) occurred: 2 involving the PMMA subgroup (one of which due to surgical site infection and another one for cosmetic purposes), one in the PSI subgroup due to a lethal intracerebral bleeding caused by bridging vein thrombosis after resection of a large meningioma.

#### Conclusion

PSI cranioplasty after resection of tumor-infiltrated cranium is a feasible alternative to PMMA, providing low complication rates and good cosmetic results. Especially for lesions adjacent to the skull base, PSIs and additional drawing guides can aid craniectomy planning and facilitate safe bone margin resection, thus potentially reducing recurrence risk. Preoperative tumor diagnosis and the estimated recurrence risk should be considered while selecting the appropriate implant material.

### V250

Strukturierte Datenbank-basierte Erfassung von Komplikationen und unerwünschten Vorkommissen zur Etablierung einer Fehlerkultur und Analyse von Trends bei Komplikationsraten Structured database-driven documentation of complications and adverse events to foster an error culture and analyze trends in complication rates

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#### Objective

The documentation of complications and adverse events is a crucial aspect of good clinical practice and a key element for ensuring quality assurance within neurosurgical practice. However, achieving this goal is frequently hindered by insufficient reporting rates and the lack of an appropriate structural framework.

#### Methods

Since 03/2023, all medical and nursing staff (pseudonymized and anonymized, respectively) have been instructed to document mortality and morbidity (M&M) incidents on a weekly basis in a structured format via a database (REDCap). Weekly controls by the M&M team ensured submission of filled forms with description of M&M cases, or negative feedback. These incidents are systematically categorized with the severity of complications being assessed according to the Clavien-Dindo classification (CDC). To ensure comprehensive analysis, monthly M&M conferences have been established, during which all reports are critically evaluated.

#### Results

Over the 21-month analysis period, a total of 7,931 patient cases were treated as inpatients. In total, n=524 reports were submitted, of which 304 were identified as M&M incidents (surgical-related n=244, non-surgical n=60), resulting in an M&M rate of 3.8% of all inpatient cases (surgical-related 3.1%, non-surgical 0.7%). The reporting rate exhibited a consistent linear trend, with an average of 0.5 incidents reported per day, as indicated by linear regression analysis (R<sup>2</sup>=.99). The most frequently reported incidents included cerebrospinal fluid (CSF) fistulas (17.1% of all M&M cases), secondary hemorrhages (16.8%), infections (13.8%) and organizational failures (10.9%). The most prevalent severity grade, according to CDC, was grade 3b (43.0%), followed by grade 2 (14.3%) and grade 1 (13.5%).

#### Conclusion

The risk of selection bias is inherent in both self-reported and externally reported M&M cases. However, the implementation of a structured approach to recording M&M incidents may serve to overcome this challenge by ensuring consistent reporting rates, thereby fostering the development of an organizational culture centered on error identification and improvement. As crucial control step, a weekly evaluation on the successful submission of the report forms is needed and led to high reporting rates. Continuous interim analyses facilitate the early identification of trends in the occurrence of specific complications, thereby enabling the timely implementation of countermeasures.

## V251

Vorläufige Ergebnisse einer monozentrischen Feldstudie zur neurochirurgischen Ergonomie während neuroonkologischen Operationen: ein objektiver Vergleich der OP-Phasen mittels Oberflächen-Elektromyographie-Sensoren.

Preliminary findings of a monocentric field study on surgical ergonomics in neuro-oncological surgery: an objective assessment of surgical steps using surface electromyography sensors.

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#### Objective

The importance of surgical ergonomics is evident, as current research highlights a significant risk of work-related musculoskeletal disorders (WRMSD) among neurosurgeons(1). Involving technical devices like microscopes demands high surgical performance leading to unergonomic muscle activity which is linked to WRMSD(2). This field study investigates the ergonomic challenges faced by neurosurgeons (NS) by using surface electromyography (sEMG) sensors to objectively assess muscular demands during neuro-oncological procedures.

#### Methods

8 surface-EMG are used at a single-center neurosurgical department. NS of varying experience are included. Ethical approval has been obtained and all NS provided informed consent. Sensors are placed on the neck and upper extremities of NS to capture raw sEMG data which are recorded continuously during surgical steps of supratentorial tumor resections (STR). Postoperatively the mean electrical activity (EA\_RVC%) of both Upper Trapezius (UT), Anterior Deltoid (AD), Flexor Carpi Radialis (FCR) and Extensor Digitorum (ED) muscles were processed by EMG normalization to compare different surgical steps.

#### Results

To date, 25 oncological cases have been analyzed. The microscopic tumor resection represented the longest stage. Side different muscle loads were seen in the same surgical stage showing an asymmetric muscle load (EA\_RVC% left FCR vs. right FCR:11,9 vs 7,1). The highest muscle demands in the shoulder muscles (UT and AD) were seen during craniotomy and cranioplasty whereas the microscopic stage revealed the highest demands in FCR and ED bilaterally indicating different surgical stages may entail various risks for developing WRMSDs.

#### Conclusion

SEMG data allow for a detailed analysis of muscular strain in NS during different stages of STR. This ongoing study provides first insights into intraoperative ergonomic challenges in neurosurgery. NS are prone to developing WRMSDs due to asymmetric and long-lasting postures. Findings may discover risk factors and interventions to mitigate the prevalence of WRMSD during surgery.

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### V252

#### OpenOR - Ein Virtual Reality Framework für die medizinische Ausbildung OpenOR – A Virtual Reality Framework for Medical Education

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#### Objective

Virtual reality (VR) has emerged as a transformative tool in medical education, providing immersive and interactive learning environments. Leveraging affordable hardware such as the Meta Quest 3, VR is particularly suited for the immersive and interactive visualization of complex anatomical structures and technical procedures. These capabilities present an opportunity to enhance medical training by offering high-performance, cost-effective solutions.

#### Methods

The VR application "OpenOR" was developed using Unity as a framework for medical education. The application supports multi-user interactions with customizable avatars and incorporates hand-tracking technology for intuitive interaction. The platform is designed for medical students and professionals, enabling the exploration of case studies, visualization of anatomical objects derived from MRI segmentation, and playback of 3D surgical videos. OpenOR provides a collaborative and immersive training environment by integrating multi-user functionalities and high-resolution visualizations. This first version has incorporated several training cases of essential neurosurgical procedures and pathologies. Case descriptions, images, 3D case videos, and interactive 3D Objects of the MRI segmentations with CAD models of implants such as VP-Shunts or Aneurysm Clips have been integrated for prior testing with medical students. The cases have been tested with 20 medical students for user-experience and workability.

#### Results

The initial deployment of OpenOR demonstrated its potential as a robust educational tool. Users reported enhanced engagement and understanding of anatomical structures and surgical workflows. The multi-user feature facilitated collaborative learning while hand-tracking allowed for natural interaction within the virtual environment. Case-based training with a virtual PACS viewer, case descriptions, and immersive 3D models enable realistic theoretical teaching which can be bridged to practical knowledge by watching the cases" 3D surgical miroscope recording in a virtual auditory.

#### Conclusion

OpenOR represents a significant advancement in VR-based medical education, combining immersive technologies with accessible hardware to deliver high-quality training experiences. Future work will focus on expanding its content library, refining user interactions, and assessing its impact on learning outcomes through empirical studies. The platform's versatility and scalability make it a valuable asset for modern medical training.



### Abb. 2



### RC090

Eine detailierte Analyse intraoperativer Blutungen und deren Management bei intraventrikulären endoskopischen Eingriffen. A detailed analyses of intraoperative hemorrhages and the intraoperative management in intraventricular endoscopic procedures.

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#### Objective

Reports on intraoperative hemorrhages during neuroendoscopic procedures inside the ventricular system range around 3 percent. These intraoperative hemorrhages might have potential devastating consequences. There is no overall common grading system concerning a detailed analysis of intraoperative hemorrhages. Therefore, the authors present a detailed grading system of bleeding types, bleeding time and intraoperative measurements.

#### Methods

A detailed retrospective analysis of full endoscopic intraventricular procedures in our department over a ten years time period were performed. Only procedures with full recorded video documentation were included. The videos were analysed in detail for bleeding typ (Grade I streak bleeding, Grad II blurred vision with anatomy detectable, Grad III heavily blurred vision without anatomy landmarks, Grad IV complete lose of vision), analysis of the bleeding time and management of the bleeding. Clinical data and follow ups were obtained. The procedures were divided into two observational groups. Group A includes procedures associated with tumour or tumour-like lesions and group B includes non-tumour associated procedures like ETVs or septostomies.

#### Results

Out of the 106 tumour associated procedures, an intraoperative hemorrhage was noted in 89 cases. Grade IV occurred in 12% (11 cases). Most of the bleedings were controlled by irrigation and coagulation (75%). More particular techniques like the dry-field technique were necessary in 13%. A conversion to the microscope due to the bleeding was only necessary in one case. In group B 44% (72/162) cases had an intraoperative bleeding with only two cases of grade IV (1.4%). All haemorrhages were controlled by irrigation and coagulation and mostly lasted less than three minutes (78.8%).

#### Conclusion

This is one of the first detailed reports on intraventricular neuroendoscopic procedures concering hemorrhages. It is obvious that tumour and tumour-like lesions bear a higher risk for an intraoperative bleeding, however fatal consequences are rather rare, when certain aspects are considered. The majority of intraoperative hemorrhages can be controlled by constant irrigation and/or coagulation. More advanced techniques can be applied safely and ensure control of the hemorrhages and avoid the need for a microsurgical conversion.

### RC091

Räumlich basierte metabolische Klassifizierung durch Graph Attention Deep Learning *Spatially informed metabolic classification through graph attention deep-learning* 

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#### Objective

Metabolic analysis of tumor of the central nervous system is a key component of the preoperative diagnostic work-up in neuro-oncology. In recent years, there has been an increasing interest in deepening the prediction capabilities of preoperative radiologic tools to better understand tumor genetics. With the help of artificial intelligence, we aimed at connecting these two very important pillars.

#### Methods

Data were obtained by the Phase I SPORT Trial (DRKS00019855) including n=134 patients who underwent MR-Spectroscopy. We developed a graph attention network (GAT) model to predict MR spectroscopy outcomes by focusing on key connections betweenneighborhood metabolic patterns. The model uses explainable AI tools to highlight key relationships and provides interpretable results to understand which metabolic pattern drives the prediction of genetic tumor subgroups.

#### Results

All 134 patients were classified accordingly to the 2021 WHO classification into 15 different tumor types. The GAT classified the tumor types in a 10-fold cross-validation with a mean accuracy of 98,7% (Precision 0.9892 Recall 0.9889 and F1-score 0.9890). Using computational AI tools such as attention and integrated gradients, we found that spatial patterns of metabolic changes were more important for accurate predictions than local spectra. Decreasing the size of neighborhood spectra significantly reduces the prediction accuracy.

#### Conclusion

Leveraging spatial relationships of metabolic alterations in CNS tumors significantly increases the accuracy of tumor classification in MR-Spectroscopy. Our novel model can provide explainable results in the diagnosis and interpretation of MR spectroscopy.

### V253

Wie die Invasion eines Glioblastoms in den inferioren fronto-okzipitalen Fasciculus Sprach- und visuell-räumliche Funktionen beeinträchtigt

How glioblastoma invasion of the inferior fronto-occipital fasciculus affects language and visuospatial functions

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#### Objective

The preservation of language and cognitive functions is critical for the postoperative quality of life in glioblastoma patients. The inferior fronto-occipital fasciculus (IFOF), a white matter tract, is essential for language and visuospatial processing but is often affected by invasively growing gliomas. This study aimed to investigate the lateralization of cognitive deficits associated with IFOF lesions and their implications for surgical planning.

#### Methods

We analyzed data from 203 glioblastoma patients enrolled in a German multicenter study. Preoperative cognitive performance was assessed using 11 neurocognitive tests, normalized to percentile ranks (PR) considering age, gender, and education. Seven neurocognitive domains were identified through data-driven cluster analysis. Lesion and peritumoral edema volumes were segmented using BrainLab Elements and normalized to the MNI152 template. Lesion overlaps with the IFOF were determined using the NatBrainLab atlas. Kendall's Tau rank correlation coefficients were calculated to assess relationships between lesion volumes and cluster scores, with p-values corrected for multiple comparisons using the Benjamini-Hochberg procedure.

#### Results

Lesions in the left IFOF were significantly correlated with deficits in language tasks, including verbal memory (e.g., HVLT retention,  $\tau = -0.23$ , p < 0.001) and fluency ( $\tau = -0.19$ , p = 0.001). Surprisingly, right IFOF lesions also affected language functions (e.g., HVLT recognition,  $\tau = 0.13$ , p = 0.05), suggesting a potential bihemispheric interplay. FLAIR imaging outperformed T1-CE for identifying lesion overlaps, with significantly stronger correlations between FLAIR-derived edema volumes and neurocognitive impairments.

#### Conclusion

To reduce postoperative impairments in patients with glioblastoma, precise intraoperative navigation including advanced imaging and tractography techniques is extremely helpful. The involvement of the right IFOF in language functions suggests contralateral compensatory mechanisms, emphasizing the importance of preserving interhemispheric connections during surgery.

### V254

Präoperative Dexamethasongabe in Glioblastompatienten führt zu signifikanten Veränderungen des myeloiden Immunkompartiments und beeinflusst die CXCL2/IL8-CXCR2 Achse Pre-operative Dexamethasone application in glioblastoma patients leads to significant changes in the myeloid immunological compartment and affects the CXCL2/IL8-CXCR2 axis

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#### Objective

Dexamethasone (DEX) is applied routinely for symptomatic anti-edematous treatment in newly diagnosed glioblastoma (GBM). Recently published meta-analyses have pointed out detrimental long-term effects of DEX on overall survival (OS), and altering effects on the immunological tumour microenvironment (TiME) have been described. In an *ex vivo* model we have found interactions between DEX treatment, the CXCR2-CXCL2 axis and the microglial compartment. Now, we investigate the corresponding impact of DEX treatment in human GBM samples.

#### Methods

We identified a cohort of n=16 DEX-naïve GBM patients, n=20 matched patients with >3d high-dose, and n=8 patients with <3d low-dose pre-operative DEX-treatment with sufficient tissue available in our biobank. We conducted RT-qPCR to evaluate M1 (iNOS) and M2 (Arg1) marker as well as the CXCR2, CXCL2 and IL8 gene expression. Moreover, we performed immunofluorescence stainings (IF) on the corresponding formalin-fixed paraffin-embedded (FFPE) samples, delineating the CD3+ cell frequencies, and the myeloid (Iba1+) and microglia (TMEM119+) cell compartment.

#### Results

OS was reduced significantly (p=0.023) in our DEX-treated compared to the matched DEX-naïve cohort. On the gene expression level, we found a significant reduction of iNOS (M1) and a significant enhancement of Arg1 (M2), but only after >3d high-dose DEX treatment, and the CXCL2-CXCR2/IL8 signalling axis was significantly elevated (see *Fig. 1*). On the cellular level, T-cell depletion was detectable in the >3d high-dose DEX treated group (49 vs. 26 CD3+ cells per 20x field of view (FoV), n=85 FoV per sample). With a 3-plex IF (Iba1, TMEM119, Hoechst33342) we found that the myeloid/microglia ratio (Iba1+/TMEM119+) shifted from 3.7 in DEX-naïve samples to 2.6 with DEX-treatment by trend.

#### Conclusion

With our comparative study we showed significant changes within the tissue TiME due to DEX treatment. We delineated a distinct shift from inflammatory M1 towards immunosuppressive M2 myeloid configuration. T-cell depletion and changes in the myeloid/microglia ratio reinforce the pronounced impact of DEX that could be jointly responsible for the worse long-term effects on OS and affect novel immune targeted therapies negatively. Parallel investigations on brain metastases and further studies on the protein level are under way to enhance contextualisation of our findings.





### V255

Bewertung der Rolle der PET-Bildgebung beim Glioblastomrezidiv: Eine retrospektive Analyse zur diagnostischen Genauigkeit und klinischen Nutzbarkeit

Assessing the Role of PET Imaging in Glioblastoma Recurrence: A Retrospective Analysis of Diagnostic Accuracy and Clinical Utility

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#### Objective

Glioblastoma (GBM) remains a clinical challenge due to its high recurrence rate and the difficulty of distinguishing true progression from treatment-induced changes. Positron emission tomography (PET) can clarify ambiguous findings from standard imaging by assessing metabolic activity. The aim of this study was to evaluate both sensitivity and specificity of PET positive findings referenced with the target lesion histology.

#### Methods

We performed a retrospective, single-center study correlating PET findings with histopathological results during multiple GBM recurrences. A molecular subgroup analysis stratified by MGMT status was conducted for "true-positive" and "true-negative" PET findings.

#### Results

960 patients with GBM were treated at our department between 2006 and 2021, of whom 347 (36.1% of total) had one tumor recurrence during follow-up with 156 (45.0%) PET scans available. 95 patients (9.9%) had a second recurrence with a PET conducted in 37 of these (39.0%), whereas 23 patients (2.4%) had a third recurrence with a PET available in 8 patients (34.8%). For a positive PET finding, the sensitivity achieved 95%, 96% and 83% in the first, second, and third recurrences, respectively, while the specificity amounted to 13%, 0%, and 0%. Stratification by molecular subtype revealed no differences in sensitivity (p=0.498 first recurrence, p=1.0) for MGMT status.

#### Conclusion

PET imaging demonstrated high sensitivity for detecting GBM recurrence but showed variable specificity depending on the classification of uncertain cases. Notably, sensitivity declined with an increasing number of recurrences, suggesting that cumulative treatment effects and greater tumor heterogeneity over time may affect diagnostic performance. Further prospective studies are needed to refine diagnostic thresholds and improve clinical decision-making.

### V256

#### Mortalität in neurochirurgischen Kliniken in Deutschland im Jahr 2023 In-patient Neurosurgical Mortality in Germany: A Comprehensive Analysis of 2023 In-Hospital Data

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#### Objective

Neurosurgical conditions are associated with varying mortality rates, which serve as critical indicators of treatment quality. This study aims to evaluate in-hospital mortality rates in neurosurgical departments across Germany in 2023.

#### Methods

A cross-sectional analysis was conducted on all cases treated in German neurosurgical departments in 2023. Data included demographics, primary and secondary diagnoses, and procedures. Mortality was defined as inhospital fatality (discharge status: deceased).

#### Results

In 2023, neurosurgical departments in Germany treated 222,158 inpatient cases, 49% of whom were female, and 48% were aged  $\geq$ 65 years. In 8,338 cases patients died, reflecting an overall mortality rate of 3.8%. Of these, 43% involved females, and 75% patients aged  $\geq$ 65 years. Mortality rate was significant lower for females (3,3% vs 4,2%, p<.0001, Chi-square test).

The four most common fatal primary diagnoses were traumatic subdural hematomas (OPS code S06.5; 1,278 cases), subcortical intracerebral hemorrhages (I61.0; 611 cases), traumatic subarachnoid hemorrhages (S06.6; 504 cases), and cerebral metastases (C79.3; 344 cases).

Cases coded with the primary diagnoses of malignant brain tumors (C71) had a mortality rate of 4% (385/9,800 cases), cerebral metastases of 6% (344/5,944 cases, C79.3) and benign meningeal tumors of 1.3% (85/6,634 cases; D32.0). Non-traumatic subarachnoid hemorrhages as main diagnosis (I60) showed a 7% (619/3,660 cases), intracerebral hemorrhages a 29% (1,609/5,513 cases, I61), traumatic epidural hematomas a 3% mortality rate, while subdural hematomas reached 12%. Mortality rates of spinal infections as primary diagnoses were 6% (128/2,227 cases, M46.2-.4), and of cervical spine injuries 8% (214/2,626 cases, S12).

Mortality rates for selected procedures were as follows: 3% for primary brain tumor resections (5-015.0), 5% for non-primary tumor resections (5-015.1), 8% for vascular occlusions (5-025), and 9% for vascular reconstructions (5-026), 1% for spinal fusions (5-836), 2 for dynamic stabilizations (5-83b), and 4% for vertebral body replacements (5-837).

#### Conclusion

This study provides a comprehensive benchmark for neurosurgical mortality rates in German hospitals. The data highlight that older adults and men are disproportionately affected, with traumatic brain injuries, cervical spine injuries, tumors, intracerebral hemorrhages, and non-traumatic subarachnoid hemorrhages remaining associated with high mortality.

## V257

Transkriptomweite Profilierung bei Patienten mit zystischem vestibulärem Schwannom enthüllt molekulare Signaturen von langen nichtkodierenden RNAs als Kandidaten *Transcriptome-wide Profiling in Cystic Vestibular Schwannoma Patients Reveal Candidate Long noncoding RNA molecular signatures* 

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#### Objective

**Objective**: Cystic vestibular schwannoma (cVS) represent 10% of vestibular schwannomas and are associated with an unpredictable growth behavior and poor surgical outcomes compared with solid vestibular schwannoma (sVS). Long non-coding RNAs (IncRNAs) belong to the class of non-coding RNAs and are known to regulate gene transcription and involved in chromatin remodeling via various mechanism. Despite accumulating evidence demonstrating the crucial roles of IncRNAs in multiple cancers, their global identification in cVS disease remains unknown. The objective of this study is to identify IncRNAs associated with cVS using patient cohorts.

#### Methods

**Methods:** Using patient tissue samples we performed RNA-seq to identify lncRNAs in cVS. The top selected lncRNAs were identified using bioinformatics and were further validated by qRT-PCR.

#### Results

**Results:** Our results identified 65 lncRNAs and 308 protein coding genes (PCGs) to be differentially expressed between cVS and sVS (padj<0.05), Fig 1. Among these, we selected top 8 differentially expressed lncRNAs (*TENM3-AS1, ADIRF-AS1, PCA3, RP11-108K14.12, RP11-728F11.4, AC132217.4, RP11-43F13.3, and EGFLAM-AS1*), each of which had significant correlative expression with more than 20 differentially expressed PCGs. The differential expression status of the top lncRNAs, PCA3, ADIRF-AS1, and EGFLAM-AS1 in cVS was further confirmed by qRT-PCR analysis.

Figure legend:

**Fig 1: B**: Scatter plot showing 65 differentially expressed lncRNAs and **C**: 308 differentially expressed protein coding genes (PCGs) in cVS compared to sVS. The red and blue circles above represent up- and down-regulated lncRNAs and PCGs in cVS. The yellow dots represent the key significantly differentially expressed transcripts. **D**: qRT-PCR validation of top three lncRNAs. Bar diagrams representing the fold change mean ± SEM in *PCA3*, *ADIRF-AS1*, and *EGFLAM-AS1* lncRNAs mRNA levels in human brain cVS tissue samples.

#### Conclusion

**Conclusion**: Here, by transcriptome-wide approach we demonstrate that lncRNAs are prevalent in cVS disease and are likely to play critical roles in regulating important signaling pathways involved in the disease pathogenesis.





### V258

Tatsächlicher versus vorhergesagter Verlauf gemäß bestehenden prognostischen Modellen bei älteren Patienten, die sich einer chirurgischen Behandlung von Hirnmetastasen unterziehen Actual versus predicted outcome according to existing prognostic models in elderly patients undergoing surgical treatment of brain metastases

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#### Objective

Due to an increasingly aging population, more elderly patients (i.e. 65 or more years) need to be considered for microsurgical treatment of brain metastasis. However, concerns about the uncertain risk-benefit ratio and resource limitations often results in rather conservative management for this subset of patients. Although prognostic scores for survival in cancer patients exist, none of these are tailored for elderly patients. We therefore aimed to analyse outcomes for surgical treatment of intracranial metastasis in elderly patients and to assess the reliability of existing prognostic scores for this subset of patients.

#### Methods

Survival rates and outcomes of patients with an age of 65 or older, who underwent surgery for intracranial metastasis between 2015-2022 were retrospectively reviewed by 2 investigators (AG & AS) independent from the operating surgeons. Patients were divided into two groups: group A (65-74) and group B (75+). Overall survival and functional independence at six weeks post-operatively (assessed by an Eastern Cooperative Oncology Group (ECOG) score <3) were analysed. Accuracies of the recursive partitioning analysis (RPA) and the disease-specific graded prognostic assessment (ds-GPA) were evaluated through a log-rank and confusion matrix analyses.

#### Results

Among a total of 83 patients (mean age 73.2 years), 1-, 2-, and 3-year survival rates in group A were 31%, 23%, and 16%, respectively and 38%, 23%, and 23% for patients in group B (p=0.61), respectively (Figure 1). Eighty-eight per cent and 90% of patients in group A were independent before and after surgery, respectively; for patients in group B these frequencies were 84% and 81%, respectively (p>0.05). No significant difference was found between the groups in length of stay.

The 6 months, 1-, 2-, and 3-year survival probabilities were 47%, 36%, 24%, and 18%, whereas the predictions estimated survival probabilities of 3%, 0%, 0%, and 0% for the RPA model, and 25%, 6%, 1%, and 0% for the ds-GPA model (p<0.005), respectively. The RPA model had recall, precision, and F1-scores of 0.41, 0.17, and 0.24, while the ds-GPA scored 0.39, 0.36, and 0.31 (Figure 2).

#### Conclusion

Surgical outcomes and survival rates in patients with brain metastases were not age-dependent, suggesting that age alone should not preclude surgery in selected elderly patients. The significant discrepancies between predicted and actual survival outcomes in our cohort highlight the need for age-specific prognostic models.





Figure 1: Kaplan-Meier curve of survival after brain metastasis resection stratified by age category.





Figure 2: Kaplan-Meier curve of overall survival as observed (blue curve) and as predicted by the RPA model (orange curve) and ds-GPA model (green curve)

### V259

Präoperative Automatisierte Schraubenplanung in der Lumbalen und Thorakalen Wirbelsäulenchirurgie: Dreijährige Einzelzentrumerfahrung und Korrelationsanalyse Preoperative Automated Screw Planning in Lumbar and Thoracic Spine Surgery: Three-year single center experience and correlation analysis

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#### Objective

Automated pedicle screw planning in spine surgery has been available for a few years with intent to facilitate and accelerate preoperative planning in instrumentation cases. Here we analyze the deviation between automated and actual implant sizes.

#### Methods

In a single center analysis, all thoracic and lumbar spine instrumentation cases with preoperative automatic screw planning were reviewed from 1/2021 - 1/2024. Automated planning (widely established navigation software) without manual correction was compared to actual implants used by the surgeon. Automated and manual planning were performed by one of two experienced surgeons also performing the surgery. Standard statistical methods were applied.

#### Results

Out of a total 988 spine surgeries during the study period, 103 thoracic and lumbar instrumentation surgeries including 296 segments were performed. 89.3% were elective cases. Degenerative, infection, tumor and trauma cases were almost equally distributed. 72.8% were performed in percutaneous technique, 17.5% with Carbon-PEEK implants. Preoperative automated screw planning (ASP) was performed for all cases with a total 694 pedicle screws. Notably, ASP suggested different sizes in the same vertebra in up to 30%, in these cases the longer ASP was included in statistics. Average screw diameter was 5,25 mm for ASP compared to 5.98 mm actual implant size (AIS). Average length was 46.5 compared to 46.9 mm respectively. Pearson and Eta correlation analysis revealed a strong positive correlation and relationship between ASP and AIS with r=0.743 and  $\eta$ =0.752. A significant linear relationship between groups was found (p<0.001, F=199.247).

#### Conclusion

Automated screw planning offers realistic screw dimensions; however, margins seem conservatively calculated, especially regarding screw diameter. Asymmetric screw proposals for the same vertebra rarely match surgical reality and experience.

### RC093

Klinische und epidemiologische Faktoren, die Ergebnisse bei pädiatrischer Spondylodiszitis beeinflussen: Eine systematische Übersicht.

Clinical and Epidemiological Factors Influencing Outcomes in Pediatric Spondylodiscitis: A Systematic Review

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#### Objective

Spondylodiscitis is an infection of the spine, often of bacterial origin, which, although rare in childhood, represents a serious condition. This study aims to assess how clinical and epidemiological aspects influence the outcomes of pediatric patients diagnosed with spondylodiscitis.

#### Methods

A review was carried out on the PubMed database using the term "child spondylodiscitis". Reports and case series involving children and adolescents (0-18 years) diagnosed with spondylodiscitis were included. Studies without detailed information or unavailable in full version were excluded. For statistical analysis, the Mann-Whitney U-test, chi-square and Kruskal-Wallis tests were applied, considering significance for p < 0.05.

#### Results

43 studies were included, with a total of 87 patients, with an average age of 6.4 years. Of these, 43 patients were male, 43 female, and one did not have this information available. There was no significant correlation between age or gender and clinical outcome. 47 patients underwent surgery, while 40 received conservative treatment, with no significant difference in outcomes between the groups. The average duration of antibiotic treatment was 20.34 months, which was shorter for infections caused by gram-negative bacteria. However, there was no correlation between the duration of antibiotics or the type of bacteria and the outcomes. In addition, blood culture and biopsy showed similar efficacy in identifying the pathogen.

#### Conclusion

Conservative treatment proved to be non-inferior to surgical treatment in pediatric spondylodiscitis, indicating that both approaches are viable, depending on the case. Biopsy was not superior to blood culture in identifying the pathogen. However, it still remains useful for differential diagnosis with other inflammatory conditions of the spine.

### RC094

Prädiktoren für die Ein-Jahres-Mortalität bei pyogener Spondylodiszitis: Eine retrospektive Studie Predictors of One-Year Mortality in Pyogenic Spondylodiscitis: A Retrospective Study

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#### Objective

Pyogenic spondylodiscitis is a severe spinal infection often requiring surgical intervention. Despite advancements in surgical techniques, mortality within one year remains significant. Understanding the factors influencing this outcome is crucial to improving patient care and guiding clinical decision-making. This study identifies predictors of one-year mortality following instrumented surgery for pyogenic spondylodiscitis, providing insights for optimizing surgical strategies and postoperative management.

#### Methods

A retrospective analysis was conducted on 370 patients who survived initial hospitalization after instrumented surgery for pyogenic spondylodiscitis (2013–2022). Univariate and multivariate logistic regression analyzed predictors of one-year mortality, including age, Charlson Comorbidity Index (CCI), neurological deficits, CRP levels, number of spinal levels treated, complications, surgical duration, and revision surgery. ROC analysis determined optimal cutoff values for significant predictors.

#### Results

Of 370 patients, 33 (8.9%) died within one year. Significant predictors in univariate analysis included:

- Last CRP (Coefficient: 0.0093, p=0.00038): Elevated levels increased mortality risk.

- Total number of spinal levels treated (Coefficient: 0.3013, p=0.0294): Greater surgical extent was linked to higher mortality.

- Neurological deficits (Coefficient: 1.0354, p=0.0158): Increased mortality risk.

Multivariate analysis confirmed last CRP (OR 1.01, 95% CI 1.004–1.016, p=0.001) and number of spinal levels treated (OR 1.345, 95% CI 1.006–1.799, p=0.046) as independent predictors of mortality. Neurological deficits (OR 1.676, 95% CI 0.621–4.522, p=0.308) were not statistically significant.

ROC analysis established optimal thresholds: last CRP >47.1 (AUC 0.767) and spinal levels >2 (AUC 0.638) predicting mortality.

#### Conclusion

Elevated last CRP levels and extensive spinal surgery (more than two levels) independently predicted one-year mortality in pyogenic spondylodiscitis patients. These findings underscore the need for infection control, optimized surgical strategies, and careful patient selection. Neurological deficits and age showed limited statistical significance in predicting mortality.

### V260

Arachnoidales Web- eine effektiv behandelbare Ursache für Rückenmarkskompression und Syringomyelie- eine retrospektive monozentrische Erhebung Arachnoid web- a rare but surgically effectively treatable cause of spinal cord compression and syringomyelia- a retrospective single center study

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#### Objective

A very rare but potentially still underdiagnosed cause of spinal cord compression and syringomyelia has been identified as dorsal arachnoid web (AW), which is indicated on MRI by a dorsal indentation of the spinal cord ('scalpel-sign'), and sometimes associated with syringomyelia resulting from alterations of CSF flow-dynamics. We evaluated patients with the scalpel-sign regarding demographics, clinical presentation and imaging findings, and compared surgically and non-surgically treated patients' outcome.

#### Methods

A retrospective chart study was conducted on patients with scalpel-sign on MRI, which were treated at a neurosurgical spine-center between 2016 and 2023. Treatment outcome was assessed using the thoracic Japanese Orthopedics Association (tJOA) score.

#### Results

16 patients (mean age 56 ± 11 yrs, 8 males) were identified. Predeliction site of AW was the thoracic spine (T4-T6), with associated spinal cord lesions found in 56% of patients, mostly cranial (T2-T4) to the dorsal myelon indentation. Clinical manifestation comprised sensory deficits (69%), weakness and/or hyperreflexia of the legs (69%), ataxia (56%), back pain (56%), neuropathic pain (50%) and bladder dysfunction (6%). Median latency between symptom onset and diagnosing AW was 12 months. 63% of patients underwent surgery with mono- or bisegmental hemilaminectomy, durotomy, web removal with adhesiolysis and duroplasty. Median follow-up was 31.5 months. Symptoms worsened postoperatively in 1 patient, but improved (tJOA mean pre-/postoperatively:  $8 \pm 1.6/9 \pm 1.8$ ) in the majority of cases (70%), while conservatively treated patients did not improve: tJOA tO/t1:  $9.5 \pm 1.2/9.0 \pm 1.9$ ). Follow-up MRI showed regression of syringomyelia in surgically treated patients.

#### Conclusion

Surgical intervention appeared beneficial in the majority of patients, even in those with longstanding symptoms and spinal cord lesions, and may prevent further progression of the disease. Patients should be carefully screened for AW, as it identifies a rare but surgically effectively treatable cause of spinal cord compression and syringomyelia. Prospective longitudinal studies of both, surgically and non-surgically, treated AW patients should be conducted in order to gain a better understanding of the natural history of the disease, and to obtain further guidance in treatment decisions.

### V261

Risikofaktoren für Zementaustritt bei dorsaler Stabilisierung der BWS und LWS mittels Zementaugmentation: Eine retrospektive Analyse von 121 Patienten Risk Factors for Cement Leakage in Dorsal Stabilization of the Thoracic and Lumbar Spine with Cement Augmentation: A Retrospective Analysis of 121 Patients

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#### Objective

This study aimed to identify risk factors for cement leakage (CL) in dorsal stabilization of the thoracic and lumbar spine using cement augmentation.

#### Methods

We retrospectively analyzed data of patients who underwent dorsal stabilization of the thoracic or lumbar spine, or both, with cement augmentation between April 2017 and November 2021 at our institution. CL was evaluated based on postoperative CT scans.

#### Results

Data from 121 patients were analyzed. Mean age was  $73.40 \pm 10.1$  years, with 77 patients (63.6%) being female and 44 (36.4%) male. The majority of patients was diagnosed with osteoporotic fracture (n=50, 41.3%) or trauma (n=40, 33.1%). There was CL in 83 patients (68.6%), but it was not clinically relevant or symptomatic in any patient. There was no association between screw location within the vertebral body (VB) (side, superior/middle/lower portion of the VB, anterior/middle/lower portion of the VB) or volume of cementation with CL (p>0.05 for all). VB L2, with the lowest HU value (74 ± 30), exhibited the highest rate of CL (n=17, 14.1%), especially laterally (n=8, 6.6%). VB T7 bilaterally showed no leakage (HU 100 ± 45), while VB T6 right had 1.7% leakage and HU 117 ± 40.

#### Conclusion

CL of any form occurs frequently after augmented screw placement, but it was not clinically relevant in our series. Lower Hounsfield units may correlate with increased cement leakage, but further studies are necessary to substantiate our findings. Volume of cementation as well as screw placement did not influence CL.
### Wirbelsäule 5 | Spine 5

### RC095

Classification

Klinische Erfahrungen mit der Behandlung von osteoporotischen Wirbelbrüchen mit und ohne Anwendung der OF-Klassifikation Real-life Clinical Experience of Treatment of Osteoporotic Vertebral Fractures with and without Use of the OF

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### Objective

The osteoporotic fracture (OF) classification provides a reliable and reproducible basis for deciding on the available treatment options. In addition, it's a sensitive tool for a faster decision-making. We aimed to restrospectively describe the clinical practices prior to and after implementation of the OF classification.

#### Methods

A total of 200 patients were evaluated; 100 were treated based on the OF classification<sup>1</sup> (OF group) from november 2016 until february 2019 and 100 were treated without use of the OF classification and score (non OF group) from dezember 2019 until may 2021. The OF classification<sup>1</sup> was assessed prospectively in the OF group und retrospectively in the non OF group using spinal CT imaging. Treatments and outcomes were compared between the two groups using Fischers" exact test.

#### Results

**Results**: The study examined 252 fractures (122 in the non OF group and 130 in the OF group) in all patients aged 79 (70 - 88) years, 81% females. In the non OF group, 105/122 fractures (86%) were treated with kyphoplasty, regardless of fracture type: 13 (11%), OF3 48 (39%), OF4 39 (32%) or OF5 5 (4%). 5 (4%) were treated with posterior instrumentation only (OF4 1 (1%), OF5 4 (3%)). 12 (10%) (all OF5) were treated conservatively. (p=0.12). In the OF group OF1 1 (1%) were treated conservatively, OF2 29 (22%), 18 (14)% were treated conservatively, while 11 (8)% received kyphoplasty after failure of conservative treatment. In OF3 53 (41%), 48 (37%) underwent kyphoplasty and 5 (4%) stabilization. All patients with OF4 34 (26%) were treated with stabilization and in all OF5 13 (10%) were treated with stabilization and vertebral body replacement (VBR) exclusively.2 (p=0.018).<sup>2</sup> 18% of patients in the non-OF group experienced recurrent pain after treatment which required multimodal pain therapy. Fewer complications occurred in the OF group where 5% suffered a new fracture and were referred for further surgical treatment.

### Conclusion

The OF classification is helpful and essential to ensure adequate therapy for patients with osteoporotic fractures and to improve outcome and prevent complications. The OF classification should be used uniformly in all institutions to ensure that each patient receives the best possible treatment.

### Wirbelsäule 5 | Spine 5

### RC096

Spinalanästhesie und digitale Anxiolyse (SPIDA) zur Behandlung der lumbalen Spinalkanalstenose – Eine Machbarkeitsstudie Spinal Anesthesia and Digital Anxiolysis (SPIDA) for the treatment of lumbar spinal stenosis - A feasibility study

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### Objective

Lumbar spinal stenosis (LSS) is a prevalent condition characterized by a clinical syndrome that includes buttock or lower extremity pain, especially in elderly patients. The surgical management of these is challenging due to higher rates of comorbidities and increased risks of experiencing complications such as postoperative delirium, leading to intensive care and prolonged hospital stays. Awake surgery under spinal anaesthesia (SA) has been associated with advantages concerning the occurrence of complications and the clinical outcome after surgery. Within this study, we aim to investigate the combination of spinal anesthesia without administration of any systematically effective medication and digital anxiolysis for patients suffering from one-level lumbar spinal stenosis who were treated via microsurgical decompression.

#### Methods

This is a single-centre feasibility study. We included patients with LSS that were treated via microsurgical decompression. The patients were divided into groups according to the anaesthetic technique employed: (a) classical GA (GAG) or (b) Spinal Anaesthesia and Digital Anxiolysis via Virtual Reality Goggles (SPIDAG). Demographic, clinical, and radiographic patient data were retrospectively extracted from clinical records and documentation. For SPIDAG patients Odom's criteria (excellent/good/fair/poor) were additionally routinely assessed. Matched pair analysis was performed to compare the outcomes of both groups.

#### Results

The final study population consisted of 65 patients. The surgical and clinical outcomes between GAG and SPIDAG are equivalent. 86.7% of the SPIDAG patients described their surgical experience as excellent, and 13.3% described it as good. All patients treated with the SPIDA-Bundle indicated that they would undergo the surgery again in the SPIDA setting. In 2 patients, the lumbar puncture was unsuccessful (punctio sicca), leading to the switch to GA. One patient reported an inadequate sensitive distribution of the spinal anesthetic, necessitating a switch to GA as well. Furthermore, in one patient, the intrathecal application caused a dural leak. This had to be surgically closed with sutures during the surgery.

### Conclusion

The combination of digital anxiolysis and spinal anesthesia is a feasible and promising approach for the microsurgical treatment of LSS. Patients report compelling satisfaction, and clinical outcomes are comparable to GA.

### Wirbelsäule 5 | Spine 5

### BO-08

### Risk factors for Surgical Site Infections (SSI) after Spinal Surgery: a systematic review and meta-analysis

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### Objective

Surgical site infections (SSIs) are significant complications following spinal surgery, contributing to increased healthcare costs, extended hospital stays, and poor patient outcomes. This systematic review and meta-analysis aimed to synthesise current evidence on clinically modifiable risk factors for SSIs in spinal surgery to identify areas for intervention, to inform clinical guidelines and improve patient care.

### Methods

A comprehensive search of five academic databases (MEDLINE, Embase, Scopus, Academic Search Ultimate, and CINAHL) was performed on March 10, 2024. Data extraction and risk of bias assessments were performed using the Newcastle-Ottawa Scale and ROBINS-E tool. A random-effects meta-analysis was conducted to calculate pooled odds ratios (ORs) with 95% confidence intervals (CI), and heterogeneity was assessed using I<sup>2</sup> statistics.

### Results

A total of 44 studies, with 637,032 patients and 9,745 SSIs, were included. Significant modifiable risk factors identified included high BMI, diabetes, insulin-dependent diabetes, coronary artery disease, smoking, and chronic steroid use. Notably, the use of intraoperative vancomycin powder was associated with a significant reduction in SSI risk. Non-modifiable risk factors included increased subcutaneous tissue thickness (>30mm), operative time (>2 hours), ASA  $\geq$ 3, and procedures involving three or more vertebral levels. Conversely, age, instrumentation, alcohol use, pre- and post-operative albumin levels (<3.5 g/dL), and preoperative blood transfusion were not significantly associated with SSI risk. High heterogeneity was observed for several factors, particularly BMI and diabetes.

### Conclusion

This systematic review highlights several clinically significant and modifiable risk factors for SSIs in spinal surgery, including high BMI, diabetes, smoking, and chronic steroid use, while confirming the protective role of intraoperative vancomycin powder. These findings offer practical guidance in identifying actionable risk factors which can be targeted to improve surgical outcomes. Future efforts should focus on developing perioperative optimisation strategies, such as weight management, glycemic control, smoking cessation programs, and steroid dose adjustments. Furthermore, the implementation of vancomycin powder as a cost-effective prophylactic measure should be considered. Addressing these factors will help reduce SSIs, improve patient outcomes, and inform clinical practice guidelines for spinal surgery.

### V262

Die Bedeutung der Zeitmustern von Zerebralen Vasospasmen im Transkraniellen Doppler Ultraschall bei Patienten mit Subarachnoidaler Blutung The Value of Temporal Patterns of Carebral Vasospasm in Transsranial Doppler Ultrasound for Patients with

The Value of Temporal Patterns of Cerebral Vasospasm in Transcranial Doppler Ultrasound for Patients with Subarachnoid Hemorrhage

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### Objective

Transcranial Doppler (TCD) ultrasound is a widely utilized and well-established diagnostic tool for monitoring patients with aneurysmal subarachnoid hemorrhage (aSAH). However, its moderate sensitivity and specificity in detecting vasospasm limit its application in clinical practice. This study aimed to analyze the predictive value of distinct temporal patterns of vasospasm observed via TCD for delayed cerebral ischemia (DCI) and unfavorable outcomes following aSAH.

### Methods

A total of 729 consecutive aSAH cases treated at a single institution between January 2003 and June 2016 were included. Daily TCD observations were used to record the onset and duration of cerebral vasospasm. DCI occurrence was determined based on the presence of new hypodensities on follow-up computed tomography scans documented >48 hours after aneurysm treatment. Primary endpoints included DCI, in-hospital mortality, and unfavorable outcomes at six months post-aSAH, defined as a modified Rankin Scale >3.

### Results

TCD-detected vasospasm was observed in 392 cases (53.8%) with a median onset on day 4 post-aSAH (interquartile range: day 2–6) and a median duration of 1 day (interquartile range: 0–4 days). Vasospasm identified on TCD was independently associated with DCI (adjusted odds ratio [aOR] = 3.46, p < 0.0001), inhospital mortality (aOR = 2.67, p = 0.003), and unfavorable outcomes (aOR = 1.62, p = 0.024). Furthermore, longer vasospasm duration (aOR = 1.15 per-day increase, p < 0.0001) and recurrence after at least one day without vasospasm (aOR = 1.76, p = 0.03) were significantly associated with an increased DCI risk. However, the timing of vasospasm onset (p = 0.168) and persistence despite intra-arterial spasmolysis (p = 0.550) showed no correlation with DCI. Baseline characteristics independently associated with TCD vasospasm included younger age (aOR = 0.94 per-year increase, p < 0.0001), poor initial clinical condition (WFNS grade 4–5: aOR = 1.44, p = 0.011), acute hydrocephalus (aOR = 1.84, p = 0.003), and treatment modality (clipping: aOR = 2.09, p < 0.0001).

### Conclusion

Our findings confirm the utility of daily TCD measurements in predicting cerebral vasospasm and emphasize the significance of specific temporal patterns in TCD monitoring. Extended vasospasm duration and its recurrence are strong indicators of an elevated risk of DCI and poor outcomes, underscoring the need for proactive interventions to mitigate cerebral perfusion deficits following aSAH.

### V263

2-jahre postoperative Ergebnisse von 35 Patienten mit atherosklerotischer, steno-okklusiver Vaskulopathie nach zerebraler Revaskularisationsoperation: Ein single-center, retrospektive Analyse 2-years postoperative outcome of 35 patients with atherosclerotic steno-occlusive vasculopathy after cerebral revascularization surgery: a single-center, retrospective analysis

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### Objective

The aim of our retrospective study was to analyze the 2-years clinical outcome of our patients with chronic atherosclerotic steno-occlusive vasculopathy and cerebral hypoperfusion treated with extra-intracranial bypass surgery (EC-IC Bypass)

### Methods

We analyzed the clinical records of our patients who were treated with EC-IC Bypass surgery between 2019 and 2022. The results of multimodal imaging of the cerebrovascular reserve capacity, as well as the modified Ranking Score (mRS) were retrospectively analyzed preoperatively and 2 years after surgery.

### Results

During the examined period 50 EC-IC Bypass operations were performed in 49 patients. Due to compliance reasons the 2-years clinical follow up could be performed in 35 patients. 19 of the examined patients had chronic cervical internal carotid artery occlusion, 16 patients were treated due to symptomatic middle cerebral artery occlusion. 9 indirect and 26 superficial temporal artery to middle cerebral artery bypass were performed. The mean preoperative mRS was 1.45. After 2-years postoperatively the mean mRS was 1.22. The increase of the cerebral reserve capacity could be observed in all operated patients 2 years after surgery using dynamic CT-perfusion with acetazolamide-challenge, BOLD fMRI with Apnoe Paradigm, transcranial doppler sonography and digital subtraction angiography.

### Conclusion

Patients with symptomatic atherosclerotic steno-occlusive vasculopathy could be treated successfully with EC-IC Bypass surgery. The 2-years postoperative follow-up showed significant improvement of the measured clinical parameters. In our opinion cerebral revascularization surgery is an effective therapy for selected group of patients with steno-occlusive vasculopathy.

### V264

### Arteriovenöse Malformationen mit intrakraniellen Aneurysmen: Welche Risikofaktoren führen zu einer Blutung? Risk Factors Associated with Bleeding in Patients with Arteriovenous Malformations Associated with Intracranial Aneurysms

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#### Objective

Natural history of brain arteriovenous malformations (bAVMs) with associated intracranial aneurysms (IAs) reveals a higher rate of hemorrhage. We aimed to identify the prevalence and risk factors for hemorrhage in a subgroup of patients with bAVMs and associated arterial IAs.

#### Methods

The authors conducted a bicentric retrospective study of patients with ruptured and unruptured bAVMs with associated IAs treated at tertiary centers between 2013 and 2024. Sociodemographic data, clinical characteristics, and radiological parameters in patients with bAVM and associated IAs were analyzed.

#### Results

Of 944 patients with bAVM, 137 individuals with 191 associated arterial IAs were included in the final analysis. The mean age of patients at presentation was  $48.0 \pm 17.0$  years, and 73 (53.3%) patients were females. Bleeding was documented in 85 (62.0%) cases. The mean nidus size was  $3.0 \pm 1.5$  cm. The most common Spetzler-Martin grade of bAVMs was grade II in 35.8% of patients. The mean size of bAVM-associated IAs was  $6.8 \pm 4.8$  mm. Multiple intracranial aneurysms (MIA) were present in 35 (25.5%) patients. bAVM-associated IAs were classified as nidal in 19.0%, flow-related in 73.7%, and unrelated in 7.3% of cases. Univariate analysis revealed that arterial hypertension (OR 4.37, 95% CI 1.52-12.57, p = 0.004), history of smoking (OR 5.77, 95% CI 1.26-26.53, p = 0.013, and high-grade bAVMs (>grade III, OR 0.35, 95% CI 0.15-0.87 p = 0.02), were associated with rupture risk. In the multivariable analysis, only arterial hypertension remained significantly associated with the bleeding event (aOR 3.37, 95% CI 1.07-10.58, p = 0.038).

#### Conclusion

Observational data from our large bicentric cohort of patients with bAVM and associated IAs identified arterial hypertension as a risk factor associated with an increased risk of bleeding.

### V265

Konzentrisches Gefäßwand-Enhancement bei Moyamoya-Angiopathie: Ein Prädiktor für Krankheitsprogression und -manifestation

# Concentric Vessel Wall Enhancement in Moyamoya Angiopathy: A Predictor of Disease Manifestation and Progression

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### Objective

Concentric contrast enhancement of the vessel wall (CE-VW imaging) reflects the disease activity of Moyamoya angiopathy (MMA), however its underlying pathomechanism remains unclear. The incidence and significance of CE-VW in diagnostics and therapy planning is the subject of current research.

### Methods

A total of 216 initial MRTs from patients with a first diagnosis of MMA were analyzed for CE-VW sequences and matched with clinical data. All CE-VW imaging was performed on a 3Tesla scanner with a 64 Channel Head/Neck Coil. Evaluation of CE-VW was performed blinded to the clinical data of patients.

### Results

The cohort consisted of mainly Caucasian (n=200, 92.6%) patients, the female-to-male ratio was 2.7:1, the mean age 40.6 years  $\pm$  13.5. CE-VW sequences were available in 154 MMA cases (71.3%). Contrast agent uptake of the vessel walls (posCE-VW) was present in 66.9 % of all MMA patients with available CE-VW MRI. posCE-VW was most commonly seen in the M1 segment of the middle cerebral artery (MCA) (right M1 26.6%; left M1 24.0%) and the terminal parts of the internal carotid artery (right C7 17.5%; left C7 20.1%). Prevalence of posCE-VW was significantly associated with the type of disease manifestation: transitory ischemic attacks (TIA) or prolonged reversible ischemic neurological deficit (PRIND) (p=.0234; OR 2.2 (95%CI 1.05 - 4.4)) or ischemic stroke (p=.0190; OR 2.1 (95%CI 1.1 - 4.1)) were seen most commonly. Conversely, the absence of posCE-VW (negCE-VW) was significantly associated with intracerebral hemorrhage (ICH) (p=.0164; OR 3.28 (95%CI 1.25 - 8.59)), only minor neurological deficits (p=.0049; OR 2.64 (95%CI 1.34 - 5.22)) or incidental diagnoses (p=.0121; OR 13.79 (95%CI 1.50 - 126.34)). Among eight cases with contralateral disease progression (CDP), posCE-VW was a significant prognosticator (p=.0009; OR 18 (95%CI 3.1 - 105.3)) and seen in six of eight cases. Our analysis revealed no other conditions (age, gender, BMI, arterial hypertension, ethnicity) to be associated with posCE-VW.

### Conclusion

posCE-VW in vessel wall imaging is seen in almost three third of all MMA patients. Therefore, CE-VW MRI should be performed in all MMA patients routinely, as it is a crucial component of MMA diagnostics and a potentially valuable predictor of disease activity and disease progression.

### V266

# Einschätzung des Rupturrisikos von kleinen intrakraniellen Aneurysmen: Sind morphologische und hämodynamische Risikofaktoren zuverlässig? Rupture Risk in Small Intracranial Aneurysms: Are Morphological and Hemodynamic Risk Factors Reliable?

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### Objective

Small intracranial aneurysms (IAs) (<5 mm) are increasingly detected due to advancements in imaging techniques. Despite their low rupture risk, rupture can lead to devastating subarachnoid hemorrhage (SAH). Accurate prediction of rupture risk remains challenging, as the role of morphological, hemodynamic, and clinical parameters is not fully understood. This study aims to evaluate these factors to improve risk stratification for small IAs.

### Methods

A total of 141 small IAs were analyzed using semi-automatic neck curve reconstruction for morphological analysis and computational fluid dynamics (CFD) based on 3D surface models reconstructed from 3D rotational angiography. Morphological and hemodynamic parameters were extracted from the reconstructed models, and clustering was applied to address multicollinearity. Cluster representatives were selected based on univariate logistic regression, and forward selection was performed to identify predictors of rupture. Clinical variables, including age, sex, and comorbidities, were also assessed for their predictive value. The models were validated on an independent test set.

### Results

Four morphological and four hemodynamic parameters were identified as cluster representatives. Forward selection identified Hmax1, Mean\_AWSS\_parent, Neck\_inflow\_rate, KE\_vessel, and alpha as predictors, but only Hmax1 was significant. The full model achieved a pseudo-R2 of 0.193 on the training set but dropped to 0.019 on the test set, indicating overfitting. A simpler model using only Hmax1 performed worse (pseudo-R2 = -0.039 on the test set). None of the clinical variables, including age, hypertension, and obesity, reliably predicted rupture risk.

### Conclusion

Morphological and CFD analyses, as well as clinical variables, failed to reliably predict rupture risk in small IAs. These findings suggest that traditional predictors are insufficient, emphasizing the need for prospective studies and multimodal approaches integrating imaging biomarkers and comparative analyses between small and large aneurysms.

### V267

Extrakranielle-Intrakranielle-Bypasschirurgie bei Patienten mit instabiler hämodynamischer Insuffizienz – eine bizentrische Fallserie

*Extracranial-Intracranial-bypass surgery for patients with unstable hemodynamic insufficiency – a bicentric case series* 

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### Objective

The role of EC-IC bypass surgery in patients with intracranial atherosclerotic disease (ICAD) involving the internal carotid artery (ICA) or middle cerebral artery (MCA) remains controversial. However, little data exist for the subset of patients that present with unstable hemodynamic insufficiency, i.e. patients that require induced hypertension to prevent neurological deterioration and/or stroke. This study aimed to evaluate the safety and efficacy of EC-IC bypass surgery in ICAD patients with unstable hemodynamic insufficiency.

### Methods

We included all patients from our centers that underwent EC-IC bypass surgery for unstable hemodynamic insufficiency due to ICAD involving the ICA or MCA between 2018-2024. Efficacy was assessed through clinical improvement (resolution of blood pressure-dependent symptoms) and/or radiological improvement (resolution of CT perfusion deficits). Additionally, bypass patency rates were evaluated. Safety outcomes were measured by the peri- and postoperative stroke rates within 30 days and surgical complications associated with the EC-IC bypass procedure.

### Results

We identified a total 22 patients who underwent 23 EC-IC bypass surgery because of symptomatic cerebral ischemia resolving after blood-pressure augmentation. This patient population comprised 8.6% of all ICAD patients that were treated with EC-IC bypass surgery at both centers. Resolution of blood-pressure dependent symptoms after cessation of induced hypertension and postoperative reduction of CT perfusion deficits occurred in 86.4% of the patients. In one patient with a persistent CT perfusion deficit and necessity for blood-pressure augmentation, a second ipsilateral bypass was performed. Two patients developed a new stroke within 30 days of follow-up. No surgical complications were observed. The postoperative bypass patency rate was 100%.

### Conclusion

Our study highlights that EC-IC bypass surgery in this subset of critically ill patients is safe and may effectively address blood pressure-dependent clinical symptoms of cerebral ischemia in patients with unstable hemodynamic insufficiency due to ICAD involving the ICA or MCA.

### V268

Der Zusammenhang zwischen der WHO-Einstufung und den Langzeitergebnissen sowie der Wirksamkeit der Strahlentherapie bei solitären fibrösen Tumoren The association between WHO grading and the long-term outcomes and radiotherapy efficacy of solitary fibrous tumors

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### Objective

Intracranial solitary fibrous tumor (ISFT) is a rare mesenchymal tumor of fibroblastic origin in the central nervous system (CNS). The 2021 WHO classification of CNS tumor has updated the entity and grading criterion of ISFT. We aimed to compare the predictive value of the 2021 WHO grading criterion (2021-WGC) and 2016 WHO grading criterion (2016-WGC) on prognosis and radiotherapy (RT) efficacy.

### Methods

This is a retrospective study involving 223 consecutive ISFT patients who received tumor resection in our neurosurgical center from 2013 to 2021. Univariable and multivariable Cox regression analyses were utilized to identify prognosis-related factors and evaluate the efficacy of RT. A risk model was constructed to predict the long-term recurrence.

### Results

A total of 223 ISFT patients were included in this study. During a median follow-up period of 3.36 years, 80 (35.87%) patients experienced tumor recurrence and 14 (6.28%) experienced extracranial metastasis. Recurrent ISFT patients exhibited significantly older age at diagnosis, higher Ki-67 index and mitotic count. Of note, the survival analysis revealed that 2016-WGC (P=0.002) and 2021-WGC (P<0.001) demonstrated better ability to distinguish patients with shorter and longer PFS, respectively. We further proposed a novel risk stratification method that demonstrates superior prognostic predictive value compared to the 2021-WGC and 2016-WGC. Additionally, RT could significantly prolong the PFS of ISFT patients, especially 3 years after surgery (P=0.032). Further efficacy analysis showed that RT could prolong PFS in the 2016-grade 3 tumors. While for the 2021-WGC and novel risk stratification, RT could prolong PFS in the 2021-grade 2 and intermediate risk tumors, respectively.

### Conclusion

The 2016-WGC and 2021-WGC demonstrated better ability to distinguish patients at high recurrence risk and low recurrence risk, respectively. RT significantly prolonged PFS in ISFT patients, especially 3 years after surgery. Notably, the RT efficacy was significantly higher in the 2016-grade 3, 2021-grade 2 and intermediate risk tumors.

### V269

### Automatisierte Tumorranddiagnostik in vivo mittels mikroskopintegrierter MHz-OCT Technologie Near-Real-Time In Vivo Detection of Brain Tumor Margins Using Microscope-Integrated MHz-OCT with Automated Analysis

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### Objective

Aiming for supramarginal resections in cerebral tumor surgery in order to optimize tumor-free intervals and patient survival times remains a neurosurgical challenge. Optical coherence tomography (OCT) has shown potential for real-time classification of tumor tissue by visualizing structural and optical image features. However, in vivo on-site classification has not yet been fully integrated into a working system. In this study, we developed and investigated a functioning system with near-real time artificial intelligence-based image analysis.

### Methods

In vivo OCT volume scans (Fig 1B) were taken with a customized high-speed Mega-Hz OCT system integrated into a surgical microscope (Fig. 1A) from brain tumor surfaces and resection cavities of 34 patients. OCT signal intensity, signal attenuation and scan homogeneity, along with a variety of signal-based features that were identified through principal component analysis, were distracted from specified regions of interest (ROI). Tissue biopsies were taken from the same ROI and analyzed by a neuropathologist. OCT scan features were used to classify tissue via a support vector machine (SVM) approach and an autoencoder network (AEN) was trained using C-scans as the input. A classifier was generated to create color-maps to distinguish white from grey matter and tumor tissue (Figure 2D).

### Results

Each MHz OCT scan, with a tissue penetration depth of 1 - 2mm and 1,600,000 A-scans, could be completed in 1 - 2 seconds. The extracted features showed highly significant differences when comparing tumor and non-tumor tissue. Analysis and color-mapping took less than 10 seconds to complete and successfully separated tumor tissue from white and grey matter. Sensitivity and specificity were 73% and 82%, respectively, for the a-scan based SVM approach and 80% and 86%, respectively, for the AEN approach. Mapping correlated well with sodium fluorescein accumulation in the tissue (Fig. 2B/D).

### Conclusion

The microscope-integrated Mega-Hz OCT represents a significant advance in the field of OCT brain tumor margin detection, due to its rapid scanning and analysis capability and high precision of its detection accuracy, potentially complementing current intraoperative methods. Automated scan analysis and its implementation will be crucial for further development of this system and has shown promising results. Whether this approach will then impact the extent of tumor resection is subject to future observation.





Abb. 2



### V270

Ein Diagnosetool auf Satzebene für Sprachfunktionen während der Wachkraniotomie bei infiltrierenden Hirntumoren bietet eine viel höhere Sensitivität als Standardtests A sentence-level diagnostic tool for language functions during awake craniotomy for infiltrating brain tumors provides much higher sensitivity than standard tests

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### Objective

The preservation of language functions despite the goal of supramaximal resection for infiltrating brain tumors, necessitates precise intraoperative identification of language-associated areas. Currently, the standard for language assessment addresses mainly word-level articulation, word retrieval or identification and semantic-relatedness. To move beyond words, we adopted a linguistic complexity approach, focused on language comprehension, and measured error rates in a test battery comprising of a variety of sentence types, known to recruit the language areas. Our results were used to evaluate the feasibility and sensitivity of our newly developed tests.

#### Methods

In this prospective study, 140 patients planned for awake craniotomy performed (peri- and intra-operatively) an app-based linguistic language test (sentence comprehension of 6 different syntactic and semantic types at varying degree of syntactic and semantic complexity, in addition to 11 standard tests like those mentioned earlier. We applied these three test types (standard, simple, complex) peri- and intra-operatively, with the goal of comparing their sensitivity.

### Results

We report the peri-operative results of 41 of them, selected on the sole basis of having a complete set of scores for all 17 tests we used. Their data were subjected to a series of non-parametric, permutation tests (105 iterations):

a. the sentence-level test battery is highly feasible: all patients could perform it at all stages. b. Patients" performance on standard word-level tests and simple sentence-level tests was high and similar preand post-surgically (the former even tends to be at ceiling pre-operatively); the complex sentence tests are significantly more sensitive than all others: in both pre- and post-op tests, error level for the totality of complex tests was significantly lower than the total standard, as well as simple, tests (p< 10\*e-6). Comparisons between pairs of individual tests were mostly significant as well.

### Conclusion

Our results demonstrate (i) the feasibility of the linguistic test application at all stages; (ii) the resolution of the complex test is higher at all stages, uncovering impairments in critical linguistic functions that are not revealed by standard testing. This result strongly suggests that the current standard of care can be improved with the new tool.

### V271

Die Bedeutung sozialer Netzwerkcharakteristika hinsichtlich Ego-Alter Verbindungen auf den klinischen Verlauf bei neuroonkologischen Patient\*innen: Eine prospektive Studie zu sozialer Integration und Lebensqualität The Impact of Ego-Alter Social Network Characteristics on Clinical Outcomes in Neuro-Oncological Patients: A prospective study on Social integration and Quality of life

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#### Objective

In neurooncological diseases, patients often experience a decline in quality of life (QoL), increased psychosocial stress (distress), and cognitive deterioration. The structure of connections from the patients (ego) to their social contacts (alteri), can provide social support, buffering the impact of stressors or increase emotional burden for patients. But the role of theses patients' social embedding remains unexplored. We investigate the effects of ego-alter network characteristics on QoL, distress, and cognitive functioning

### Methods

This prospective, exploratory, single-center study includes patients who underwent surgical treatment for brain tumors. Egocentric network analysis is employed to obtain quantitative measures of social networks. Network data is collected during patient interviews supported by the Network Canvas software. We assess QoL through the EORTC QLQ-C30/BN-20 questionnaire and measure distress using a distress scale (DT). Linear regression is used to evaluate the effect of ego-alter network characteristics including network size, diversity, mean contact frequency (MCF), mean distance (MD) and the proportion of close-kin ties (CKT) on clinical outcomes.

### Results

Preliminary data analysis includes 62 patients (f:35/ 51y; m:27 males/ 50.7y). Linear regression analyses, using the social and cognitive functioning and Appetite loss symptom scales and the DT as dependent variables, revealed distinct effects: CKT significantly increased distress ( $\beta$ =0.353, p=0.018) and appetite loss ( $\beta$ =0.354, p=0.033) and reduced social functioning ( $\beta$ =-0.468, p=0.006). Network diversity increased distress ( $\beta$ =0.366, p=0.038) but showed no significant effect on other outcomes. MCF reduced appetite loss ( $\beta$ =-0.343, p=0.050). Neither network size nor mean distance of social networks demonstrated consistent effects.

#### Conclusion

The findings highlight the complex interplay between social network characteristics and clinical outcomes in neurooncological patients. Patients with predominantly ties to close family members can experience increased distress due to emotional burden. Conversely, greater network diversity was linked to higher distress levels, indicating that diversity alone may not always serve as a protective factor. In contrast, findings from our previous analyses suggest that strong ties between alteri can reduce distress. Patients with exclusive reliance on familial networks may benefit from integration into peer groups to alleviate distress and enhance overall functioning.

### V272

Modifizierte Concorde-Lagerung in Kombination mit dem lateralen supracerebellären infratentoriellen Zugang A Modified Concorde Position for Combining with the Lateral Supracerebellar Infratentorial Approach

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### Objective

The lateral supracerebellar infratentorial (SCIT) approach offers advantages over the median SCIT approach, including a gentlerslope of the cerebellum and fewer bridging veins. Most neurosurgeons prefer the semi-sitting position, which involves complex patient positioning, monitoring, and risks including tension pneumocephalus and venous air embolism. The Concorde position provides a safer and simpler alternative, but its neutral head positioning makes the lateral SCIT challenging. We propose a modified Concorde position to enable seamless integration with the lateral SCIT approach.

### Methods

For the lateral SCIT approach in Concorde position, head positioning involves three key adjustments: inclination, lateral tilting, and contralateral rotation. The surgeon stands near the patient"s buttocks, adopting a perspective that aligns the surgical view perpendicularly to the tentorial space. The table is tilted into a reverse Trendelenburg position with the head slightly over the heart to prevent venous air embolism and congestion, while gravity facilitates cerebellar descent.

### Results

Between 04/2020-10/2024, 28 patients were included. Diagnoses comprised 15 cavernomas (54%), 3 metastases (11%), 2 pilocytic astrocytomas (7%), 2 meningiomas (7%), and one case each (4%) of mesenchymal tumor, teratoma, pineal cyst, arteriovenous malformation and fistula, and pineoblastoma. Lesions were located in the thalamus, pineal region, pons, midbrain, and cerebellum, all of which were successfully accessed. The average skin-to-skin time was  $111 \pm 39$  minutes. Bridging vein transection was reported in 6 patients (21%), with 2 cases of consecutive intracerebellar hemorrhage that required no revision but necessitated temporary CSF drainage. Additionally, 7 patients (25%) experienced new or worsening neurological deficits, attributed to the location of the resected lesions.

### Conclusion

The modifications described in this study represent a significant advancement in enabling the lateral SCIT approach within the Concorde position. By implementing key adjustments—inclination, lateral tilt, contralateral rotation, and a revised surgeon positioning strategy—this technique overcomes the ergonomic and surgical limitations of prior methods. These refinements not only facilitate a more direct and ergonomic surgical trajectory but also bridges the advantages of both the lateral SCIT approach and the benefits of the Concorde position, including a simple and swift surgical setup.

### V273

Perioperative Thromboseprophylaxe und Risikofaktoren für thromboembolische Ereignisse bei Meningeom-Operationen

Perioperative Thromboprophylaxis and Risk Factors for Thromboembolic Events in Meningioma Surgery

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### Objective

Postoperative thromboembolic events (TE) are significant complications following meningioma surgery. This study evaluates the impact of different thromboprophylaxis regimens—certoparin, enoxaparin and enoxaparin combined with pneumatic stockings (PS)—on TE incidence and investigates patient-specific, procedure-specific, and histological risk factors.

#### Methods

We prospectively analyzed data from 874 meningioma patients. Risk factors such as age, gender, intraoperative blood loss, surgery duration, histological subtypes, and thromboprophylaxis regimens were evaluated. Patients were stratified into three groups: (1) certoparin, (2) enoxaparin and (3) enoxaparin combined with PS. Statistical tests, including chi-square and ANOVA, were used to identify significant predictors.

#### Results

Among the 874 patients, 3.1% experienced TE (n=27). The TE rates across the groups were comparable: certoparin (3.5%), enoxaparin (3.5%) and enoxaparin with PS (2.6%, p > 0.05). Advanced age (>65 years) (p=0.045) and intraoperative blood loss >200 ml (p=0.016) were significant independent risk factors for TE, particularly pulmonary embolism.

Histological subtypes were analyzed in detail. The most common subtype, meningothelial meningiomas (44.3% of cases, n=387), accounted for 48.1% of all TE (n=13). Fibrous meningiomas (16.7% of cases, n=146) were linked to 18.5% of all TE (n=5). Rare subtypes such as psammomatous, secretory, and transitional meningiomas collectively represented 16.1% of cases (n=141) and accounted for 3.6% of all TE (n=1). No TE cases were observed in even rarer subtypes, including clear-cell and chordoid meningiomas.

### Conclusion

Thromboprophylaxis with certoparin, enoxaparin or enoxaparin combined with PS demonstrated similar efficacy in reducing postoperative TE. Patient-specific factors like advanced age and higher intraoperative blood loss were significant predictors of TE. Meningothelial meningiomas, the most frequent subtype, were associated with nearly half of all TE cases. While histological subtypes such as fibrous meningiomas showed a moderate association with TE, rare subtypes had minimal or no TE incidence. These findings emphasize the need for individualized thromboprophylaxis and careful perioperative management, particularly for patients with common histological subtypes or other risk factors.

### V274

Zytomegalovirus-Expression im Tumorgewebe von pädiatrischen Medulloblastom-Patienten: Ein neuer Prädiktor für das Überleben? - Eine Einzelzentrumsstudie *Cytomegalovirus Expression in Tumor Tissue of Pediatric Medulloblastoma Patients: A Novel Predictor of Survival? - A Single-Center Study* 

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### Objective

Medulloblastoma (MB) represents the most common malignant pediatric brain tumor. Previous studies showed a correlation between Cytomegalovirus (CMV) expression in glioblastomas and survival in adults. CMV presence in MB has been reported. This study aims to evaluate the correlation between CMV expression and survival in pediatric MB patients.

### Methods

Retrospective study of MB patients treated from 2007-2023. Tumor tissue microarrays were analyzed by immunohistochemistry for CMV (IE and LA). CMV expression was categorized as high ( $\geq$ 25% positive cells) or low (<25%). Bivariate analysis (X<sup>2</sup>-test) assessed relationship between molecular subtypes and clinical data. Kaplan-Meier and Cox's analyses determined the risk, p<0.05 was considered statistically significant.

### Results

47 patients were included (mean age 8.21 years). Molecular subtypes: 17% WNT, 17% SHH, 61.7% non-WNT/non-SHH (Group 3 n=12, Group 4 n=17). Among non-WNT/non-SHH 58% showed fourth ventricle infiltration. Metastasis were present in 38.3%. Metastasis were present in 38.3%. Gross-total resection (GTR) was achieved in 78%. 49% of patients were high-risk MB. Mean FU was 55.7 months (SD=49.97).

CMV-LA was positive in 40 (85%) samples, 24 (60%)showing high expression. Mortality was 19.1%, recurrence 43%. Mean PFS was 12.7 months, mean OS 61.9 months. There was worse OS for high CMV-LA expression (48 vs.137 months, p<0.001). Among non-WNT/non-SHH, high expression correlated with poorer OS (44 vs. 122 months, p<0.001). Group 3 with high expression presented worst outcomes (8 months, p<0.001). Cox analysis identified high expression (HR=4.791, p=0.041) and metastasis (HR=6.770, p=0.024) as independent OS risk factors.

### Conclusion

This study represents the first survival analysis in pediatric MB patients in correlation to CMV expression. High CMV-LA expression was significantly associated with poorer outcomes. These results need to be confirmed in larger cohorts. An existing CMV infection might become a therapeutic target.

### V275

Intraoperative Magnetresonanztomographie (ioMRI) in der pädiatrischen Neurochirurgie bei Hirntumoren: Vorteile, Risiken und Wirksamkeit über ein Jahrzehnt Intraoperative Magnetic resonance imaging (ioMRI) in Pediatric Neurosurgery for Brain Tumors: Benefits, Risks, and Efficacy Over a Decade

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### Objective

Intraoperative Magnetic resonance imaging (ioMRI) has established itself as a reliable diagnostic tool in brain tumor surgery over the past two decades, enabling accurate assessment of resection extent and identification of intraoperative complications. This study aims to evaluate the benefits and risks of intraoperative MRI in pediatric neurosurgery by analyzing our series of cases.

### Methods

This single-center, retrospective study includes all patients who underwent ioMRI during brain tumor surgery at our institution from January 2011 to December 2023. We assessed variables including surgeon experience over time, patient age, follow-up duration, diagnoses, surgical and non-surgical complications, and the impact of ioMRI on surgical outcomes.

### Results

A total of 151 patients (mean age  $10.2 \pm 5.3$  years, 49% male) received ioMRI during brain tumor surgery. Among them, 21.9% were undergoing reoperation for recurrent tumors. The most common diagnosis was pilocytic astrocytoma (33.8%), followed by medulloblastoma (9.9%). The mean follow-up period was  $55.2 \pm 43.9$  months (range: 0.23-148.4 months), and the average surgical time was  $355 \pm 104.4$  minutes. ioMRI procedures took in average 33 minutes. Before intraoperative MRI, surgeons estimated gross total resection in 69.5% of cases (105 patients); however, ioMRI confirmed this in only 25.8% (39 patients). Additional resection was subsequently performed in 65.6% of cases (99 patients). Postoperative MRI confirmed gross total resection in 53% of cases (80 patients) and subtotal resection in 29.1% (44 patients). Intraoperative MRI-related events, such as pupil asymmetry or pressure marks, occurred in 4.6% (7 patients). Non-surgical adverse events were observed in 11.3% of cases, while surgical adverse events were noted in 13.9%.

### Conclusion

ioMRI is a highly effective tool that enhances the extent of tumor resection in pediatric brain surgery. Given its low incidence of adverse events and acceptable complication rates, intraoperative MRI should be considered essential in the surgical management of pediatric brain tumors.

### V276

Chirurgische Zugänge zur Entfernung von Tumoren der hinteren Schädelgrube im Kindesalter und postoperativer cerebellärer Mutismus

Surgical approaches for resection of posterior fossa tumors in children concerning early postoperative cerebellar mutism syndrom

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### Objective

Cerebellar mutism syndrome (CMS) can occur after posterior fossa tumor removal and surgery-related lesions are regarded relevant. Here, we present our series focusing on speech loss occurring early postoperatively as the most severe form of CMS and analyze its association with tumor entity, size and location, surgical approach and hydrocephalus.

### Methods

All pediatric patients, who underwent a tumor resection in the posterior fossa during a period of 15 years, were included. Demographic data, clinical and radiological data, and the occurrence of early postoperative CMS was examined in relation to the surgical approaches.

#### Results

A total of 60 patients were included with a median age of 7.5 years (range 0-18 at surgery). The most common tumor type was pilocytic astrocytoma in 26 cases (43%), medulloblastomas in 18 cases (29%), anaplastic ependymomas in 6 cases (9%) and 10 other tumor entities (17%). Complete resection was achieved in 40 patients (67%), subtotal resection in 14 patients (23%), and 6 patients (10%) underwent partial resection. A telovelar approach was used in 28 patients (47%), a partial transvermian approach in tumors infiltrating and destroying the lower vermis in 5 patients (8%) and in 29 patients (48%) other approaches (transcerebellar, retrosigmoidal or supracerebellar) were used. In the early postoperative phase, 10 patients (16.7%) developed severe CMS. Four patients belong to the telovelar group (14.3%) and 3 patients to the transvermian group (60%). Six out of 10 patients with CMS were diagnosed with medulloblastoma, 3 with pilocytic astrocytoma and one with anaplastic ependymoma. All patients with severe CMS showed marked early improvement during hospital stay but with residual neurological symptoms in their follow-up (2-13 years). 43/60 patients (72%) presented with hydrocephalus preoperatively, of which 21 patients (35%) required implantation of a ventriculo-peritoneal shunt.

### Conclusion

Early severe CMS after surgical removal of tumors involving midline structures was seen more often using a transvermian approach. The telovelar approach is safer but still carries a risk of postoperative CMS. Medulloblastoma and other malignancies are associated with a higher incidence of CMS.

### V277

# Strategie der chirurgischen Behandlung der pädiatrischen niedriggradigen Gliomen mit Hirnstammbeteiligung Role of surgery in the treatment of pediatric low-grade glioma with various degrees of brain stem involvement

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### Objective

Posterior fossa pediatric low-grade glioma involving the brainstem and cerebellar peduncles (BS-pLGG) are a subgroup with higher risks at surgery. We retrospectively analyzed the role of surgery in our institutional series of BS-pLGG with various degrees of brainstem involvement.

#### Methods

We analyzed data of 52 children with BS-pLGG after surgical intervention for clinical/molecular characteristics, neurological outcome, factors influencing recurrence/progression pattern, and tumor volumetric analysis of exclusively surgically treated patients to calculate tumor growth velocity (TGV). Tumors were stratified in 4 groups: (1) cerebellar peduncle, (2) 4th ventricle, (3) pons, (4) medulla oblongata.

#### Results

The mean FU was 6.44 years. Overall survival was 98%. The mean PFS was 34.07 months. 2 patients had biopsies only. 52% of patients underwent remission or remained in stable disease (SD) after initial surgery. Patients with progression underwent further 23 resections, 15 chemotherapies, 4 targeted treatments, and 2 proton radiations. TGV decreased after the 2nd surgery compared to TGV after the 1st surgery (p < 0.05). The resection rates were significantly higher in Groups 1 and 2 and lowest in medulla oblongata tumors (Group 4) (p < 0.05). More extended resections were achieved in tumors with KIAA1549::BRAF fusion (p = 0.021), which mostly occurred in favorable locations (Groups 1 and 2). 31 patients showed postoperatively new neurological deficits. A total of 27/31 improved within 12 months. At the end of FU, 6% had moderate deficits, 52% had mild deficits not affecting activities, and 36% had none. 50% of patients were free of disease or showed remission, 38% were in SD, and 10% showed progression.

### Conclusion

The first surgical intervention in BS-pLGG can control disease alone in overall 50% of cases, with rates differing greatly according to location (Groups 1 > 2 > 3 > 4), with acceptable low morbidity. The second look surgery is warranted except in medullary tumors. With multimodality treatments almost 90% of patients can obtain remission or stable disease after > 5 years of follow-up. An integrated multimodal and multidisciplinary approach aiming at minimal safe residual disease, combining surgery, chemo-, targeted therapy, and, as an exception, radiation therapy, is mandatory.

### V278

### Stereotaktische Eingriffe in der Kinderneurochirurgie: Erfahrungen mit dem Leksell-G-frame Stereotactic procedures in pediatric neurosurgery: experience with the Leksell G-frame

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#### Objective

This study examines the use of the Leksell G-frame in pediatric neurosurgery, focusing on its versatility, safety, and precision across a range of stereotactic procedures, including biopsies, catheter placements, electrode insertions, and interstitial brachytherapy. Special attention is given to unique challenges associated with pediatric anatomy and innovative techniques such as prone positioning for posterior fossa access.

#### Methods

A retrospective analysis was conducted on 73 stereotactic procedures performed in 58 pediatric patients between September 2021 and November 2024. Patients were stratified into three age groups (0–2, 3–6, and 7– 17 years) to assess the impact of age-related skull anatomy on procedural outcomes. Procedures were analyzed for surgical indications, duration, positioning, and complications.

### Results

The cohort comprised 32 males and 27 females (mean age:  $9.5 \pm 5.3$  years). The procedures included 28 biopsies (38.8%), 31 catheter/reservoir placements (42.5%), 7 stereoelectroencephalography (9.6%), and 5 cyst/abscess drainages (6.8%). Histological diagnoses were successfully obtained in 92.9% (26/28) of biopsies. Fluid drainage was effective in 83.3% (5/6) of cases, while catheter placement for cystic lesions achieved 100% success, maintaining effective drainage in 92.3% (12/13) over a mean follow-up of 14.6 months. Electrode and catheter placement success rates were 97.1% (67/69) and 96.9% (32/33), respectively. Procedure duration averaged 100  $\pm$  69 minutes, with biopsies taking 74  $\pm$  32 minutes. Complications occurred in 5.4% of cases, none life-threatening. Pin-related findings (6.8%) were more frequent in younger patients but not significantly different between age groups (p = 0.16).

**Figure 1.** Pin site findings in the intraoperative cCT scan: A) visible impressions on the tabula externa at the left frontal pin in a 7-year-old male patient B) unintended pin perforation through the skull of the right frontal pin in a 5-year-old male patient due to excessive pressure during fixation.

### Conclusion

The Leksell G-frame demonstrates reliability, precision, and adaptability in pediatric neurosurgery. Its low complication rate and versatility, including innovative positioning techniques, support its use in treating complex pediatric neurological conditions. This study highlights the importance of anatomical considerations and tailored surgical approaches in ensuring safe and effective outcomes. Further prospective studies are warranted to validate these findings.





### RC097

### DTI-basierte Traktografie des Sprachnetzwerks in der pädiatrischen Neurochirurgie – eine Machbarkeitsstudie DTI-based tractography of the language network in pediatric neurosurgery - a feasibility

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### Objective

Preoperative tractography of the language network is an established method for determining the surgical strategy and assessing the risk of postoperative language deficits in adults with language-eloquent brain tumor. This method has not yet been established in pediatric neurosurgery. This study aims to investigate whether and to what extent preoperative DTI-based tractography of the language network is feasible and can be meaningfully applied for patients prior to a pediatric neurosurgical intervention.

#### Methods

In a retrospective study, 18 pediatric patients (average age 12.5 years, 14 male) were included from April 2018 to January 2023, who underwent surgery (tumor resection or epilepsy surgery) and in whom there was a suspicion of proximity to or impairment of the language areas. All children underwent preoperative MRI with a DTI sequence and tractography of the following tracts: arcuate fasciculus, inferior longitudinal fasciculus, inferior frontooccipital fasciculus, uncinate fasciculus, and frontal aslant tract. The pathology, language development, and tractography parameters such as tract volume and average fractional anisotropy (FA) values were assessed.

#### Results

The pathology (tumor: 67%, dysplasia: 17%, hypoxic brain injury: 11%, encephalitis: 5%) was located in the left hemisphere in 15 cases (83%). In 17 cases (94%), tractography was successfully performed for all five language pathways. In one case (6%) with hypoxic brain damage after left middle cerebral artery occlusion, only two tracts could be visualized. The tract volumes in four tracts (AF, FAT, IFOF, ILF) were on average more than twice as large in patients with tumors compared to those without (19.63cm<sup>3</sup> to 9.81cm<sup>3</sup>, p=0.0054) and in patients with age-appropriate language development compared to those with below-average speech development (20.78cm<sup>3</sup> to 9.2cm<sup>3</sup>, p=0.0056). For the uncinate fasciculus (UF), no such significant differences in tract volume were observed. The average FA values showed only non-significant differences among the examined subgroups for all tracts.

### Conclusion

DTI-based tractography of the language network is feasible even in children with heterogenous pathologies. A correlation between the volumes of the language tracts, the underlying pathology, and the language development of the children could be demonstrated in this cohort. Further studies are needed to investigate whether other factors may influence language tractography and to better assess its utility in estimating surgical risks.

### RC098

Mikroskopische und endoskopische bimanuelle Dissektions- und Resektionstechnik: Technischer Bericht mit Fallillustration

Seamless microscopic and endoscopic bimanual dissection/resection technique – Case illustrated technical note

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### Objective

The QEVO® microinspection tool which is an integrated part of the Zeiss Kinevo® visualization system has demonstrated significant potential in optimizing visualization around corners during minimally invasive neurosurgical procedures in confined and complex anatomical regions. However, an effective integration into a bimanual dissection/resection workflow is currently impossible as there is no Qevo® specific holding device, that can securely position the tool in delicate environments to enable bimanual surgery under angled endoscopic vision. This technical note describes our solution of the problem with an existing retractor system.

### Methods

Our operative setup integrates the QEVO<sup>®</sup> tool with the DORO COBRA<sup>®</sup> flexible rotary arm, for which a mini vice adaptor exists that - by chance - is perfectly fitted to hold the inspection tool firmly and immobilized. This way the tool can be securely positioned in even very narrow spaces close to neurovascular structures without hampering the surgeons hand movements.

### Results

In 10 pediatric brain tumor cases the QEVO<sup>®</sup> was easy to position, remained safely immobilized in a way that the surgeon could freely perform bimanual dissection and resection. All surgical goals of total or near total resection were reached. We selected 4 examples to illustrated its save use in different surgical approaches and head positions: a pineal tumor approached via supracerebellar route in semi-sitting position, a craniopharyngioma approached subfrontally in supine position, and a lower and upper cerebellopontine angle ependymoma each, approached prone via median suboccipital route or supine via lateral retrosigmoid route in Jannetta head position.

#### Conclusion

The described marriage of QEVO<sup>®</sup> tool and COBRA flexible arm solves the current limitation of QEVO assisted microsurgery and transitions the tool from a predominantly exploratory device to an active role in dissection/resection "around the corner", thus increasing radicality without compromising on patients safety and functional outcomes .

Abb. 1



### P001

# B16-F10 Melanome induzieren eine funktionelle prä-metastatische Nische in C57BL/6-Mäusen B16-F10 melanoma induces a functional brain pre-metastatic setting in C57BL/6 mice

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### Objective

Brain metastases are becoming increasingly common in neuro-oncology and neurosurgery due to improved oncological treatment options. This study aims to investigate the pre-metastatic niche (PMN) in the brain and establish suitable animal models, as understanding the biological mechanisms of brain metastasis formation is crucial for developing preventive strategies.

### Methods

The study utilized three different primary tumor models: B16-F10 melanoma cells, EO771.Imb breast cancer cells, RM1(BM) prostate cancer cells. Animals were orthotopically implanted with one of these tumors and allowed to grow for specified periods (20 days for B16-F10 and EO771.Imb; 13 days for RM1(BM); Fig. 1). Following primary tumor explantation, luciferase-expressing tumor cell suspensions (either one of B16-F10, EO771.Imb or RM1(BM)) were injected into the cerebral circulation via retrograde cannulation of the external carotid artery. After 10 additional days, brain luciferase signals were measured.

### Results

Animals previously bearing B16-F10 primary tumors showed a higher presence of luciferase-positive brains (2/4 with injected EO771.lmb, 1/3 with injected RM1(BM), 3/6 with injected B16-F10; Fig. 2) compared to other primary tumors, indicating enhanced tumor cell establishment in the brain.

### Conclusion

B16-F10 melanomas create a favorable environment for secondary tumor cell growth in the brain, making them a suitable model for studying brain-specific PMN formation. This model could be particularly valuable for understanding transcriptional changes at the blood-brain barrier and cerebral metastasis mechanisms.





Abb. 2



### P002

Chemotherapie-induzierte Dormanz führt zu Überexpression von NKG2D-Liganden in Hirnmetastasen Chemotherapy-induced dormancy of brain metastases leads to overexpression of NKG2D ligands

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### Objective

Brain metastases of breast and lung cancer are the most common secondary brain tumors. Despite aggressive radio- and chemotherapy, brain metastases often reoccur due to radio- and chemoresistance. Dormancy, which is a non-proliferative, quiescent state in the cell cycle, is a known mechanism of chemoresistance. Dormant cells also seem to escape the immune system, but underlying mechanisms are not fully decoded. The NKG2D system consists of NKG2D ligands (NKG2DL), which are expressed on tumor cells, and NKG2D receptors, which are expressed on immune effector cells, and thereby identify and eliminate tumor cells. On the contrary, tumor cells are known to use the NKG2D system as a mechanism of immune escape, e.g. by shedding NKG2D ligands. In the following study we used a newly established murine model of dormant and non-dormant brain metastases to analyze NKG2DL expression in vivo and in vitro.

### Methods

Dormancy was induced in the murine breast cancer cell line E0771 and the murine lung cancer cell line LLC by in vitro treatment with Cisplatin. Development of dormancy was controlled by qrtPCR. Next, dormant and non-dormant cells were stereotactically injected into the right frontal cortex of naïve C57BL6 mice. Mice were sacrificed after 14 and 28 days. Tumor volume and expression of the dormancy markers and the NKG2DL mult1 and tsp1 was analyzed via qrtPCR and immunohistochemistry.

### Results

In-vitro treatment of E0771 and LLC with Cisplatin led to a significant upregulation of dormancy markers and the NKD2DL mult1 and tsp1 in a dose and time dependent manner. In vivo, dormant tumors were significantly smaller than non-dormant tumors. Mice with dormant tumor cells survived significantly longer than those with non-dormant cells. Dormant tumors showed a significantly higher expression of mult1 and tsp1, especially in the center of the tumor.

### Conclusion

The NKG2D system could play a key role in immunologic dormancy of brain metastases. As NKG2DL can be addressed therapeutically, the link between dormancy and NKG2DL expression could be of potential therapeutical relevance in the treatment of chemoresistant brain metastases.

### P003

Zell-Zell-Kontakt zwischen Prostatakrebszellen und Knochenmark-Endothelzellen fördern vaskuläres Remodeling und könnten den metastatischen Knochentropismus erklären *Cell-cell contact between prostate cancer cells and bone marrow endothelial cells promotes vascular remodeling suggesting a mechanism for metastatic bone tropism in a murine prostate cancer model* 

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### Objective

To investigate the molecular mechanisms underlying the strong bone-specific metastatic behavior of RM1 prostate cancer cells, based on our observation of their primary tumor-independent bone metastasis pattern in a murine metastasis model.

### Methods

We first assessed the influence of different primary tumors on the metastatic patterns in a challenging tumor experiment analyzing the metastasis distribution after tail artery and common carotid artery (CCA) injections using three different tumor cell lines (EO771.lmb, RM1(BM), and B16-F10). Following the observation of RM1's consistent bone tropism, we investigated the underlying mechanisms by treating bone marrow cells ex vivo with either RM1-derived factors alone or in combination with RM1 cells for 24 hours. Endothelial cells were isolated using MACS technology and transcriptional changes were analyzed after bulk RNA sequencing using differential analysis.

### Results

Initial in vivo experiments revealed that RM1 cells demonstrate a consistent bone-specific metastatic pattern (5/5 after tail artery and CCA injections positive cases), independently of the primary tumor origin. Subsequent RNA sequencing analysis of bone marrow endothelial cells exposed to RM1 revealed significant enrichment in pathways related to vascular remodeling, particularly tube morphogenesis (GO:0035239), extracellular matrix organization (GO:0030198), and tissue morphogenesis (GO:0048729) (p < 0.001).

### Conclusion

These findings suggest that RM1 cells possess an intrinsic ability to modify the bone marrow vascular niche locally, potentially explaining their efficient bone metastasis. The identified pathways provide new insights into the molecular mechanisms of bone-specific metastasis and may offer novel therapeutic targets for preventing bone metastasis in prostate cancer.

### P004

### Vergleichende Primärzellkultur-Analysen von Hirnmetastasen Comparative primary cell culture analysis of brain metastasis

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### Objective

Brain metastases are the most common malignant intracranial neoplasms. They are significantly involved in the mortality of metastatic tumors and often severely limit the quality of life of affected patients. However, there are hardly any established models for research on primary brain metastatic cells. Our goal was to establish a primary cell culture model that is physiologically representative of metastatic cells. Of particular interest was the comparison of different culture media, as well as the immunohistochemical analysis of the cultured cells.

#### Methods

We examined 25 primary brain metastasis samples. These tumor samples were prepared and incubated immediately after surgery in three different culture media (DMEM, RPMI 1640, HPLM). The outgrowth of the cultures was documented under microscopic visual control, cell count and viability tests were performed using trypan blue staining. Furthermore, all primary cell cultures of a tumor were passaged onto chamber slides for immunohistochemical investigations. The election of immunohistochemical markers was based on the neuropathological findings of the corresponding tumor.

#### Results

We established a cell culture model with a growth rate of 56% across the 3 media and all tumor types. The brain metastases grew slightly better in HPLM (48%;12/25) than in DMEM (44%;11/25) and RPMI (40%;10/25). After correlation of cell growth and primary tumor we could show that adenocarcinomas made up the largest percentage and grew particularly in HPLM (55.6%), compared to DMEM (33.3%) and RPMI (33.3%). All other tumor types grew at the same rate across the three media. Only HPLM and RPMI showed a significant difference in cell count and viability. Immunohistochemical staining of the cells using the tumor-typical antigens HEA, MNF116 and MelanA verifed the growth of carcinoma cells in the primary cell cultures.

### Conclusion

A primary cell culture model for brain metastases was successfully established. Immunohistochemical staining shows that the growing cells are indeed representative carcinoma cells. Furthermore, we have shown that there is no significant disadvantage for growth and viability of the cells if the culture medium HPLM is chosen in contrast to the widely used classical culture media DMEM and RPMI.

### P005

Der Einfluss von klinischen Patientenparametern auf die Qualität von chirurgisch gewonnenen Tumorproben für erweiterte genetische und zelluläre Analysen

# The impact of clinical patient parameters on the quality of surgically obtained tumor samples for advanced genetic and cellular analysis

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#### Objective

To identify clinical, pre-operative parameters influencing quality of fresh cerebral metastasis tissue samples obtained directly from the operating theater for advanced genetic and cellular analysis.

#### Methods

Fresh tissue samples from cerebral metastases (n = 55) were obtained using an established sampling and communication protocol within our metastasis research cooperation. Quality of samples was assessed histologically/immunohistochemically (HE staining/KI67 staining) and categorized as: "useful" (viable tumor tissue with no/minimal necrosis) and "not useful" (extensive necrosis/minimal viable tumor tissue). Tissue quality was correlated with clinical parameters: age, tumor volume, state of disease, primary entity, previous radiation treatment, cytostatic chemotherapy, target-specific therapeutics (TST) (small molecules/antibodies) and MRI-verified tumor/necrosis ratio (T/N ratio) using Mann-Whitney test for metric variables and the Chi-square test for categorical variables.

#### Results

The T/N-ratio in preoperative MRI was significantly elevated in not useful samples (mean SD 18.0%  $\pm$  18.6%) compared to useful samples (mean SD 8.3%  $\pm$  11.8%), with a p-value of 0.0273. Treatment with target-specific therapeutics (TST) was associated with poor sample quality in 53% of patients, compared to 21% in those without such treatment, displaying a significant difference with a p-value of 0.018. The extent of MRI-derived necrosis and prior treatment with TST were identified as the most influential factors on sample quality. Although showing some differences, age, metastasis volume, primary site, gender, localization, state of disease, prior radiation therapy, and prior cytostatic medication did not significantly affect the tissue quality.

### Conclusion

Tumors with high intratumoral necrosis and previous targeted molecular treatment represent significant risk factors for obtaining poor quality tumor samples. These risk factors should be considered when relying on advanced genetic/cellular analysis of human brain tumor samples to design clinical treatment strategies.



assays, the tissue is picked up by reaserchs and transfered to the reasearch facility.

Brain Metastasis Research Pipeline

### P006

Mechanische Eigenschaften als Unterscheidungskriterium zwischen Hirntumor- und peritumoralem Gehirngewebe

Mechanical properties as a differentiation criterion between brain tumor and peritumoral brain tissue

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### Objective

Biological tissue is characterized by its viscoelastic properties, properties that are also exhibited by brain and brain tumor tissue. Consequently, these tissues possess relaxation properties, which entail their capacity to yield to an applied force over time, thereby reducing the tension. The objective of this study was to investigate the relaxation properties of peritumoral brain and brain tumor tissue.

### Methods

Immediately following collection, obtained human samples were standardized examined within 3 minutes in the operating room for their relaxation properties. The results were divided into two classes: tumor vs. tumor-free, and then examined with regard to differentiability.

### Results

A total of 105 samples from 44 patients were measured. Of these, 11 samples were tumor-free, while 93 were tumorous (32 gliomas, 53 meningiomas, and 8 metastases). The dataset was then split into two sets: a training set ( $n_{Train} = 69$ ) and a test set ( $n_{Test} = 35$ ). A classification algorithm, specifically a Support Vector Machine (SVM) of the C-classification type, was employed. The algorithm's parameters included a polynomial kernel with a degree of 3, a gamma of 1, and a cost of 1.

We reached an overall-accuracy of 0.94 (95% CI = 0.81, 0.99; p = 0.41) with a sensitivity of 0.97, a specificity of 0.67 and a balanced accuracy of 0.82.

### Conclusion

Despite the lack of statistical significance and the modest sample size, our findings suggest that the relaxation behavior of tumorous and non-tumorous brain tissue may exhibit substantial disparities. However, further studies involving a more substantial number of cases are necessary to verify these results.

Moreover, the findings of these study form the foundation for subsequent investigations in vivo of other mechanical parameters (stiffness, hysteresis, creep, and work) employing Air-Jet excitation with OCT-based analysis.

### P008

CD40 und TRAF1 beeinflussen die Tumorzellmigration und Apoptose beim pädiatrischen Medulloblastom CD40 and TRAF1 influence tumor cell migration and apoptosis in pediatric medulloblastoma

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### Objective

CD40, as member of tumor necrosis factor receptor (TNFR) superfamily, mediates proapoptotic and antiapoptotic pathways (Elgueta *et al.* 2009). TNFR-associated factors (TRAFs) are cytoplasmic adapter proteins that interact directly with the transmembrane TNFR superfamily. Seven TRAF members are known, regulating cell proliferation or apoptosis (Arch *et al.* 1998). CD40-induced apoptosis involving TRAF proteins has been shown in urothelial and renal carcinoma (Georgopoulos *et al.* 2006; Ibraheem *et al.* 2019). In glioma, anti-CD40 antibodies showed antitumor effects *in vitro* (Chonan *et al.* 2015). However, an increased neovascularisation and cell growth was also associated to CD40 activation (Xie *et al.* 2010). So far, the role of CD40 and TRAF proteins on medulloblastoma (MB) has not been investigated, which is the aim of this study.

#### Methods

To upregulate CD40 and TRAF1 expression levels *in vitro*, a recombinant expression system was transfected into DAOY, a MB cell line, via nucleofection. Successful transfection was proved with qPCR, Western Blot and immunofluorescence staining. For functional analysis, migration and apoptosis assay were performed on transfected cells (T+) and untreated cells (WT).

### Results

Reduced expression of CD40 (p<0.0001) and TRAF1 (p=0.026) was shown in patient samples of MB prior to *in vitro* experiments. CD40 expression induced strong upregulation of TRAF1 (WT 0.7687 vs. TCD40+ 8.253, p<0.0001). Recombinant expression of CD40 and TRAF1 led to delayed wound closure in comparison to WT. Additional co-transfection of CD40 and TRAF1 seemed to enhance this effect (*Fig.1*, p=0.0476). Instead, CD40 and TRAF1 induction as well as simultaneous upregulation of both induced apoptosis (*Fig.2*, WT vs. TCD40+ p=0.0125; WT vs. TTRAF1 p<0.0001; WT vs TCD40/TRAF1+ p=0.024).

#### Conclusion

Enhanced CD40 and TRAF1 level led to reduced migration behavior, due to enhanced apoptosis in MB.

**Figure 1 Impaired wound closure due to CD40 and TRAF1 overexpression.** Wound width over time is shown. P value was assessed by comparing migration rates (mm/h). NT: 0.0168±0.0025; TCD40+: 0.0119±0.0008; TTRAF1+: 0.0121 ± 0.0001; TCD40/TRAF1+: 0.0111 ± 0.0015).

**Figure 2 Increased amount of apoptotic cells due to CD40 and TRAF1.** Percentage of apoptotic cells after induced expression of CD40, TRAF1 and CD40+TRAF1 is shown. WT: 5.15±0.544; TCD40+: 8.35±0.814; TTRAF1+: 10.43±1.844; TCD40/TRAF1+: 8.06±1.922.

Abb. 1






### P009

# Genomweite CRISPR-Cas9 Screens identifizieren DNMT1 als therapeutische Zielstruktur in Sonic hedgehog Medulloblastomen

#### Functional screening reveals DNMT1 as a druggable dependency in sonic hedgehog medulloblastoma

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#### Objective

Sonic hedgehog subgroup of medulloblastoma (SHH-MB) is characterized by aberrant activation of the SHH signaling pathway. An inhibition of the positive SHH regulator Smoothened (SMO) has demonstrated promising clinical efficacy, but durable responses are limited due to primary and acquired resistance mechanisms to SMO inhibitors. Thus, additional targets to inhibit oncogenic SHH signaling in these tumors are urgently needed.

#### Methods

We performed genome-wide CRISPR/Cas9 knockout screens in order to decipher cancer dependencies and synthetic lethal interactors for promising therapies in a mouse model of SHH-MB (SMB21). The hits identified were validated genetically and pharmacologically in *in vitro* assays, while further molecular analyses including RNAseq and differential methylation were also conducted. Combination therapies were tested in patient-derived xenograft organoids of medulloblastoma. Last, the identified hits were evaluated in *in vivo* mouse models representing normal cerebellar, as well as SHH-MB development.

#### Results

Our screens reinforce SMB21 cells as a faithful model system for SHH-MB, as opposed to DAOY cells, and identify members of the epigenetic machinery including DNA methyltransferase 1 (DNMT1) as druggable targets in SHH-dependent tumors. We show that Dnmt1 plays a crucial role in normal murine cerebellar development and is required for SHH-MB growth in vivo. Additionally, DNMT1 pharmacological inhibition alone and in combination with SMO inhibition effectively inhibits tumor growth in murine and human SHH-MB cell models and prolongs survival of SHH-MB mouse models by inhibiting SHH signaling output downstream of SMO.

### Conclusion

In conclusion, our data highlight the potential of inhibiting epigenetic regulators as a novel therapeutic avenue in SMO-inhibitor sensitive as well as resistant SHH-MBs. Furthermore, we provide evidence that DNMT1 is a suitable target for the treatment of SHH-MB, alone and in combination with SMO inhibitors.

### P010

### Expressionsverhalten von TRAF1-7 und CD40 in Ependymomen Expression of TRAF1-7 and CD40 in ependymoma

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### Objective

Tumor necrosis factor receptor-associated factors (TRAFs) are cytoplasmic adapter proteins interacting with proteins of the TNFR superfamily, such as CD40. Using kinase cascades, TRAF1-7 activate transcription factors and thus regulate cell proliferation or apoptosis (Arch *et al.* 1998). A higher expression of TRAF4 has been shown in glioblastoma (GBM), promoting cell proliferation and migration (Ruan *et al.* 2022). TRAF5 expression is correlated with poor outcome in low grade glioma (Zhang *et al.* 2022) and TRAF7 mutations in grade 1 meningioma have been associated with a lower risk of malignant transformation (Clark *et al.* 2016). In this study, we now assessed expression of TRAF1-7 and CD40 in pediatric brain tumors and ependymoma grades.

#### Methods

Patient samples were resected during surgery, snap frozen in liquid nitrogen and stored at -80 °C afterwards. Transcription rate of TRAF1-7 and CD40 were first measured in pediatric pilocytic astrocytoma, GBM, medulloblastoma, ependymoma, craniopharyngioma, ganglioglioma, neurofibroma, plexus papilloma and dysembryoplastic neuroepithelial tumor via qPCR. Further measurements were done in ependymoma separated by grade (G) 1, G2 and G3 (n=20 per grade) and peritumoral tissue (C, n=10).

### Results

Higher expression of TRAF3 was detected in pediatric ependymoma in comparison to GBM (p<0.0001) and pilocytic astrocytoma (p=0.02). Increased malignancy in ependymoma correlated with decreased gene expression of TRAF1 (G1 vs. G3, p=0.0047), TRAF6 (G1 vs. G3, p=0.02) and CD40 (G1 vs. G3, p=0.0027). In contrast to this, TRAF4 (p=n.s.) and TRAF5 (G2 vs. G3, p=0.0229; G3 vs. C, p=0.0002) showed reverse correlation to ependymoma grade. Increased TRAF3 and TRAF7 mRNA levels were found in all ependymoma grades in comparison to C (TRAF3 G2 vs. C, p=0.0013; TRAF7 G1 vs. C, p=0.0077).

#### Conclusion

Higher degree tumors exhibit decreased gene expression of *TRAF1 and TRAF6*. As *TRAF3* and *TRAF7* were upregulated in ependymoma, regardless to tumor grade, they serve as potential therapeutic targets.

**Figure 1 mRNA expression levels of TRAF1-7 and CD40 in ependymoma.** Mean is plotted as columns and standard deviation is depicted by error bars. Significance is defined as: \* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

















### P011

Rapalink-1 hemmte die durch oxidativen Stress verursachte Seneszenz in Endothelzellen und blockierte die Aktivierung von NF-kB und MAPKs P38 und ERK Rapalink-1 Inhibited Oxidative Stress-Induced Senescence in Endothelial Cells and Blocked the Activation of NF-kB and MAPKs P38 and ERK

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### Objective

Oxidative Stress is the major cause of cardiovascular diseases, leading to DNA damage and cellular senescence. Senescent cells increase the expression and release of pro-inflammatory molecules and matrix metalloproteinase, which are known to play a vital role in the initiation and progression of cardiovascular and cerebrovascular diseases.

### Methods

In this study, we treated the oxidative stress exposed endothelial cells with Rapalink-1 to investigate senescence. Human umbilical vein endothelial cells (HUVECs) were treated with 300  $\mu$ M hydrogen peroxide (H2O2) with or without 100 pM Rapalink-1. For oxidative stress, DCFH-DA staining was performed, and DNA damage was observed by performing immunofluorescence (IF) staining for 8-OHDG. Senescent cells were visualized by β-gal staining and IF staining for Lamin B1 (LB1). Protein analysis was performed by Western blot. All experiments were performed in biological triplicates. For statistical analysis, One-way ANOVA was performed.

### Results

Rapalink-1 prevented oxidative stress (percentage of DCFH-DA positive cells: Control=1.90 $\pm$ 0.32, H2O2=66.09 $\pm$ 4.05, Rapalink-1=4.76 $\pm$ 3.68, H2O2+Rapalink-1= 47.00 $\pm$ 15.12, p<0.0001) and oxidative stress-induced DNA damage (percentage of 8-OHDG positive cells: Control=1.55 $\pm$ 0.91, H2O2=9.23 $\pm$ 1.67, Rapalink-1=4.00 $\pm$ 0.90, H2O2+Rapalink-1=5.65 $\pm$ 1.20, p=0.0004) in H2O2-treated HUVECs. It reduced  $\beta$ -gal activity (percentage of positive cells: Control=4.06 $\pm$ 0.81, H2O2=31.39 $\pm$ 6.23, Rapalink-1=3.22 $\pm$ 1.20, H2O2+Rapalink-1=2.82 $\pm$ 1.28, p<0.0001), improved the relative protein expression of LB1 (percentage of LB1 positive cells: Control=96.64 $\pm$ 4.31, H2O2=77.51 $\pm$ 1.95, Rapalink-1=92.86 $\pm$ 3.20, H2O2+Rapalink-1=92.17 $\pm$ 4.85, p=0.0121) in HUVECs exposed to oxidative stress. Rapalink-1 also inhibited the activation of NF-kB, (relative protein expression of phosphorylated NF-kB subunit P65: Control =1.00  $\pm$ 0.11, H2O2=3.67 $\pm$ 0.23, Rapalink-1=1.15 $\pm$ 0.09, H2O2+Rapalink-1=2.12 $\pm$ 0.24, p<0.0001) and MAPKs P38 (relative protein expression of phosphorylated P38: Control=1.00 $\pm$ 0.16, H2O2=2.44 $\pm$ 0.35, Rapalink-1=0.91 $\pm$ 0.51, H2O2+Rapalink-1=1.88 $\pm$ 0.11, p= 0.0011) and ERK (relative protein expression of phosphorylated ERK: Control=1.00 $\pm$ 0.37, H2O2=3.59 $\pm$ 1.32, Rapalink-1=2.77 $\pm$ 0.72, H2O2+Rapalink-1=2.48 $\pm$ 0.13, p= 0.02) in HUVECs treated with H2O2 induced oxidative stress as compared to the untreated control.

### Conclusion

Rapalink-1 inhibited oxidative stress -induced senescence in endothelial cells by blocking the action of NF-kB and MAPKs P38 and ERK.

### P012

CD19-spezifische, chimäre Antigen-Rezeptoren mit DAP12-Signaladapter zur NK-Zell-Immuntherapie von primären ZNS-B-Zell-Lymphomen CD19-specific chimeric receptors with DAP12 signaling adapter for natural killer cell immunotherapy of primary central nervous system B-cell lymphoma

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### Objective

This study focuses on first generation NK cell chimeric antigen receptors (CARs) for NK cell immunotherapy of primary B-cell lymphoma of the brain. This particular type of lymphoma is a rare tumor, which has been estimated to account for  $\leq$ 1% of all lymphomas of all extranodal lymphomas and ~1–3% of primary central nervous system (CNS) tumors. The incidence of primary diffuse large B-cell lymphoma of the CNS is increasing. Allogeneic NK cells do not bear the risk of graft vs. host disease and have a favorable cytokine/chemokine profile when compared to T cells, which limits unwanted side effects. In this study, the killing capacity of the NK cell line YTS engineered to express DAP12-based CARs against CD19-positive B-cell lymphoma target cell lines and K562 cells engineered with a CD19-ectodomain (CD19-ECD) was assessed. Furthermore, the cytokine/chemokine release of CD19-CAR-YTS cells were analyzed.

### Methods

The NK cell line YTS was transduced with DAP12-based CARs specific for CD19 and a control CAR recognizing EGFRvIII. After antibiotic selection, CAR expression was confirmed by flow cytometry analyses using fluorochrome-labeled idiotype antibodies and recombinant CD19-ECD. The presence of death ligand receptors on NK cells and cognate CD95/FAS and TRAIL-receptors on target cells was accomplished flow cytometry using fluorochrome-labeled antibodies. The cytotoxicity of the CAR-engineered YTS cells against target cells was assessed by Europium-release assay and time-lapse video imaging. Cytokine and chemokine release was investigated by multiplex beads immunoassays, ELISA and flow cytometry analysis.

### Results

YTS-NK cells equipped with DAP12-based CD19-CARs were devoid of death ligands. They specifically lyse CD19positive target cells when compared to YTS equipped with a CAR for EGFRVIII. Alike, target cells devoid of CD19 were not affected by CD19-CAR-YTS cells. Of note, after confronting with target cells, all CD19-CAR-YTS cells were not induced to secrete inflammatory cytokines/chemokines.

### Conclusion

Our results demonstrate the feasibility of DAP12-based CD19-CARs for redirecting NK cells to lymphoma cells. Due to the absence of the release of inflammatory mediators, such engineered NK cells might be suitable for administration in the CNS, since they may not lead to unwanted side effects such as neurotoxicity. Further *in vitro* and *in vivo* studies using primary CD19-CAR-NK cells might confirm applicability for future clinical translation.

### P013

Studie zur Bohrlochtrepanation in Lokalanästhesie bei Patienten mit chronischem Subduralhämatom (ABC-SDH-Studie I): eine Sicherheits- und Machbarkeitsstudie Trial of Awake Burr Hole Craniotomy in Patients with Chronic Subdural Hematoma (ABC-SDH trial I): a safety and feasibility randomized controlled trial

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### Objective

Chronic subdural hematoma (cSDH) is a prevalent disorder among elderly patients with increasing incidence and relevance. Awake burr hole craniotomy under local anesthesia (LA) may offer a viable alternative to surgery under general anesthesia (GA), which has been independently associated with a higher risk of complications in older patients. The ABC-SDH I trial evaluated the safety, feasibility, and impact of LA versus GA on postoperative complications and outcomes in patients undergoing surgery for cSDH, with a focus on delirium.

#### Methods

In this single-center, prospective randomized safety and feasibility trial, 50 adult patients undergoing burr hole evacuation for symptomatic unilateral cSDH were randomly assigned to either the GA or LA group in a 1:1 allocation. The primary outcome was the rate of postoperative complications and delirium. Secondary outcomes included additional clinical parameters and health economic evaluations.

### Results

Over a 13-month study period, 38 male and 12 female patients with a mean age of 77.7  $\pm$  9.7 years (range 50 – 92 years) were included. The groups did not differ in terms of gender distribution, age, hematoma volume, use of anticoagulation or antiplatelet medication, or the severity of clinical symptoms. Our study demonstrated that the primary aim was achieved with statistical significance: postoperative delirium was significantly more common in the GA group compared to the LA group, according to the Confusion Assessment Method (CAM: 32% vs. 4%, p = 0.027). No intraoperative complications were reported, and postoperative complications up to the time of discharge occurred more frequently in the GA group, without reaching statistical significance (32% vs. 8%, p = 0.077). There was no significant difference in the severity of complications between the groups, as assessed by the Comprehensive Complication Index (CCI:  $36.5 \pm 27.9$  vs.  $59.3 \pm 20.4$ , p = 0.316). The mean length of hospital stay was similar ( $4.6 \pm 3.6$  vs.  $5.3 \pm 5.7$  days, p = 0.597). At 30 days postoperatively, no differences were observed in the modified Rankin Scale (mRS) and Markwalder Scale scores or in cSDH recurrence rates.

### Conclusion

In patients with symptomatic unilateral cSDH, burr hole craniotomy under LA is a safe and feasible alternative to surgery under GA, with similar postoperative complications and lower rates of delirium in the LA group. Further multicenter trials are warranted to confirm generalizability and strengthen the level of evidence.

### P014

### Prädiktoren für ein Rezidiv bei chronischem Subduralhämatom Predictors of Recurrence in Chronic Subdural Hematoma

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### Objective

Introduction: Chronic subdural hematoma (CSDH) is a common neurosurgical condition, particularly in elderly patients, associated with significant risks of recurrence. Identifying predictive factors is crucial for optimizing patient care and improving outcomes. This study aims to investigate the influence of clinical, radiological, and therapeutic factors on recurrence risk.

#### Methods

Methods: A retrospective cohort analysis was conducted, including 214 consecutive patients who underwent surgical evacuation of CSDH between 2018 and 2022 at our institution. Demographic, clinical, laboratory, pharmacological, and radiological data were extracted from electronic medical records. Associations were examined between various factors, such as medications (e.g., anticoagulants), cardiovascular conditions, organ functions, clinical symptoms, and radiological characteristics, and the risk of recurrence. Multivariate linear and logistic regression models were used to identify predictors of recurrence and complications. Variables were categorized based on their directional impact (positive or negative) on these outcomes.

#### Results

Results: A total of 214 cases were analyzed, with an average hospital stay of 10.4 days. The cohort included 75.7% male and 24.3% female patients. Recurrence occurred in 38 cases, representing 17.7% of the total population. Significant predictors of recurrence included mixed-density hematomas (p = 0.020), statin use (p = 0.002), warfarin therapy (p = 0.032), and preoperative paresis (p = 0.004).

### Conclusion

Conclusion: This study identified several significant predictors of recurrence, including mixed-density hematomas, statin use, and warfarin therapy. These findings may help identify patients who could benefit from targeted interventions, such as middle meningeal artery (MMA) embolization, to reduce recurrence risk.

### P015

Operationsstrategien für die Entlastung chronischer Subduralhämatome und postoperativer Pneumocephalus Surgical strategies for evacuation of subdural hematoma and postoperative pneumocephalus

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#### Objective

Evacuation of chronic subdural hematoma is a common procedure in neurosurgery and frequently leads to pneumocephalus postoperatively. Several surgical methods such as twist drill craniostomy (TDC), burr hole evacuation (BHE) with or without drainage and craniotomy can be performed with different characteristics concerning for example operation time and anesthesia. The aim of this study was to analyze the incidence of pneumocephalus after surgical evacuation of chronic subdural hematoma, to identify its predictors and its impact on outcome and recurrence. Moreover, we aimed to compare different types of surgery.

#### Methods

Data of 165 patients (mean age 76 yrs [27-96 yrs], 53 females) with first diagnosed chronic subdural hematoma were analyzed retrospectively. Pneumocephalus was defined as space-demanding amounts of air in the subdural space on early postoperative CT scans (maximum 7 days). Multiple linear regression analysis was performed to identify relevant patient and surgery related factors predicting postoperative pneumocephalus. Chi-square tests were used to analyze the relation of pneumocephalus with postoperative neurological deterioration, recurrence rate, functional outcome and surgery type (TDC vs. other methods including BHE with or without drainage and craniotomy). Rates of insufficient surgeries (requirement of second surgery) were compared between surgery types.

#### Results

69 patients (42%) developed pneumocephalus postoperatively (43% within the group of patients treated with TDC, 41% with other surgery types, n.s.). Patients treated with TDC needed second surgery significantly more often than with other methods (p<0.001). Regression analysis revealed larger initial hematoma volume and less volume reduction as predictors of pneumocephalus (p<0.001 and p=0.024). Pneumocephalus was associated with higher risk of recurrence (p=0.004). Neurological deterioration after surgery and functional outcome were not associated with pneumocephalus.

### Conclusion

Pneumocephalus is a common complication after evacuation of chronic subdural hematoma, especially in case of larger hematomas. It seems to be associated with higher recurrence rates, which may require more surgeries and further hospital stays with a negative impact on patients' quality of life and costs. Treatment with TDC seems to be less efficient than other surgical methods and should not be the first choice.

### P016

Operative Behandlung von Patienten über 65-jährigen mit akutem Subduralhämatom - Erfahrung zweier neurochirurgischer Kliniken

Evacuation of acute subdural hematomas in patients aged 65 or older – a bicentric experience

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### Objective

The optimal treatment of elderly patients with space-occupying acute subdural hematomas (aSDH) remains a subject of ongoing debate. This study aimed to analyze the clinical course of patients aged 65 or older who underwent craniotomy for aSDH evacuation and to identify risk factors for poor clinical outcomes, as these factors have not been thoroughly reported in larger cohorts.

### Methods

We retrospectively reviewed patient records, imaging studies, and surgical protocols from two tertiary neurosurgical centers involving patients who underwent craniotomy for acute or subacute subdural hematomas between 2013 and 2022. Clinical status at admission was assessed using the Glasgow Coma Scale (GCS) and preoperative pupillary status. We also documented cardiovascular comorbidities, histories of malignancy, and anticoagulant use. Primary outcome measures included in-hospital mortality and clinical outcome on discharge from hospital, evaluated using the Glasgow Outcome Scale (GOS), with GOS scores of 4 or 5 defined as a good outcome.

### Results

A total of 161 patients were included, with a median age of 77 years (range 65-93 years); 38.5% were female. Forty-six patients (28.6%) underwent hemicraniectomy, while the remainder received osteoplastic craniotomy. In-hospital mortality was 44.1%, and 26.1% of patients achieved a good clinical outcome at discharge from hospital. Risk factors for mortality included midline shift on pre- (p=0.03) and postoperative CT scan (p=0.001), preoperatively dilated pupils (p=0.001), preoperative GCS  $\leq$ 8 (p=0.01), and the presence of additional intraparenchymal hemorrhage (p=0.01). A smaller diameter of the craniotomy was associated with better outcomes (p=0.03), alongside the previously mentioned factors. The choice of surgical method—craniotomy versus craniectomy—did not affect mortality. However, hemicraniectomy was linked to worse overall functional outcomes (p=0.001). Neither chronological age nor the number of comorbidities predicted mortality or GOS at discharge. Among patients discharged with GOS scores of 2 or 3, 12 of 35 (34.3%) were able to return to their homes and regained a mostly independent functional status after rehabilitation.

### Conclusion

Our study demonstrated high morbidity and mortality rates following craniotomy for aSDH evacuation in elderly patients. The extent of intracranial injury emerged as the primary prognostic factor for poor clinical outcomes.

### P017

Die operative Behandlung von akuten Subduralhämatomen - Experten und Sprachmodell Entscheidungsprozesse in 15 stratifizierten Fallbeispielen The operative treatment of goute subdural homatome, ownert and language model design making on 15

The operative treatment of acute subdural hematoma – expert and language model decision-making on 15 stratified individual cases

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### Objective

Traumatic acute subdural hematomas (aSDH) often lead to significant brain swelling and may necessitate surgical intervention to alleviate intracranial pressure. Given the complexities associated with underlying parenchymal injury, the choice between craniotomy and decompressive craniectomy remains a vaguely defined but critical clinical decision. We attempted to further understand this decision process by presenting several experienced neurosurgeons, as well as ChatGPT as a recent language model, with a list of case reports of patients with aSDH and asked them whether they would either perform a craniotomy or decompressive craniectomy.

### Methods

We recruited a group of expert neurosurgeons (> 6 years of experience) and presented them multiple case reports of patients with aSDH and the accompanying CT scans (15 in total). The reports (age, trauma, GCS, pupillary motor function) were stratified into three groups: (1) *correct craniotomy* with excellent recovery, (2) *correct craniectomy* with recovery according to expectation, and (3) *incorrect craniotomy* which required revision operation promptly due to alleviate intracranial pressure. We also presented ChatGPT, which had been presented the RESCUE-ASDH trial (Hutchinson et al., 2023), with the reports and asked it to decide on the operative treatment.

### Results

Our preliminary results on a subgroup of expert neurosurgeons indicate that the decision making process on how to operatively treat aSDH reaches an especially high consensus on the operative treatment of primary decompressive hemicraniectomies (73% consensus), slightly lower on primary craniotomies without secondary intervention (67% consensus), and drastically lower on cases with primary craniotomy and secondary revision via decompressive hemicraniectomy (50% consensus). These results are concurrent with the evaluation of ChatGPT (80% decompressive hemicraniectomy, 60% craniotomy).

### Conclusion

There remains an ambiguity and heterogeneity in the decision making process of expert neurosurgeons on the operative treatment of aSDH, as already indicated by the current literature (Hutchinson et al., 2023), confirming that it is often an individual decision based on clinical status and imaging made by the responsible neurosurgeon.

### P018

Minibohrlochtrepanation und Embolisation der Arteria meningea media bei Patienten mit symptomatischem chronischem Subduralhämatom: Eine monozentrische Observationsstudie. Mini-burr hole trephination and middle-meningeal artery embolization in symptomatic chronic subdural hematoma: a mono-institutional observational study.

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#### Objective

Embolization of the middle meningeal artery (MMAE) was shown to lead to a decrease of treatment failure and the need for surgical rescue of chronic subdural hematomas (cSDH). Nevertheless, symptomatic patients with large cSDH often require immediate surgical drainage. The standard surgical management in most centers includes single or extended burr hole trephination or craniotomy, usually under general anesthesia, which is associated with a poor clinical outcome and a perioperative mortality rate in older patients of 32%. Based on these findings, at our center we perform a frontal 2mm mini burr hole trephination (MBT) under local anesthesia.

#### Methods

The aim of this study was to evaluate the effect of MBT in combination with MMAE, compared to MBT alone. Primary endpoints were postoperative mRS, rate of secondary surgery and hematoma diameter reduction. All patients treated for cSDH at our center in 2024 were screened. Adult patients with a neurological deficit at admission, and primary treatment with MBT were included. Statistical analysis was performed using Mann-Whitney test and Wilcoxon matched pair test for non-parametric data.

#### Results

21 patients were included. Median age was 68 years. 53 % received primary MBL versus 47 % MBL + MMAE. Both groups were similar regarding preoperative neurological status. Most patients presented with a Markwalder Score of 2. Median mRS at admission was 2,7. mRS at discharge was significantly better than mRS at admission (p=0.0005) in both groups. MBL led to a significant immediate reduction of hematoma diameter (p=0.0003) in both groups. MMAE did not result in an immediate reduction of hematoma diameter. 66,7% of patients in the MBL-group required immediate secondary surgery versus 62,5% in the MBL+MMAE group. Hematoma diameter at discharge was significantly smaller in both groups. Interestingly, only the MBL + MMAE group showed a significant prolonged decrease in hematoma diameter 6-8 weeks after the last procedure (p=0.027). Combination of MBL with MMAE led to a lesser grade of severity of secondary surgeries.

### Conclusion

We conclude that MBL is a feasible and effective method to treat cSDH in symptomatic patients. Combining MBL with MMAE leads to similar results regarding mRS and hemtoma diameter at discharge when compared to MBL without MMAE, but leads to a better radiographic outcome on a longer follow up.

### P019

# Beeinflusst die präoperative MRT- oder CT-Bildgebung die Behandlung des chronischen subduralen Hämatoms? Does preoperative MRI or CT imaging influence surgical decision-making and outcomes in chronic subdural hematoma management?

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### Objective

Chronic subdural hematoma (cSDH) is among the most frequently encountered conditions in neurosurgery. While computed tomography (CT) is considered the gold standard for diagnosis, magnetic resonance imaging (MRI) offers several advantages. This study aims to evaluate the impact of MRI on surgical decision-making and outcome in patients with cSDH.

#### Methods

We analyzed the data of 100 patients diagnosed with cSDH, comparing those who underwent CT with those who received MRI primarily in terms of demographic data, surgical interventions, and neurological outcomes.

#### Results

: Out of the 100 patients, 25 underwent MRI at the time of admission. The MRI group was significantly younger than the CT group (p = 0.02). The majority of patients in the CT group had an unfavorable ASA-score (ASA  $\ge 3$ ; 76%), whereas only 32% of patients in the MRI group exhibited an unfavorable ASA-score (; p = 0.0002). There were no significant differences between both groups regarding initial GCS (p = 0.57), the prevalence of paresis and aphasia (both p > 0.99). The size of the hematoma before and after surgery did not differ significantly between the two groups (p = 0.68). Minicraniotomy was performed more frequently in the CT group than MRI group (n=18 vs N=1, p = 0.03). A subanalysis of patients who underwent minicraniotomy in the CT group showed the following indications for minicraniotomy: septation of the hematoma based on CT imaging (61%), partially acute bleeding parts (22%), intraoperative insufficient burr-hole evacuation (11%), und unclear decision-making (6%). Overall, there were no significant differences in surgical or neurological outcomes measured in mRS between the two groups in follow up time (25.92 ± 3.19 months).

#### Conclusion

Although MRI influences surgical decision-making, it does not significantly affect neurological outcomes. CT imaging may be sufficient for decision managing in cSDH.

### P020

Einfluss des Drainagetyps und des Hämatomvolumens auf die Ergebnisse bei chronischem Subduralhämatom: Eine retrospektive Analyse Impact of Drainage Type and Hematoma Volume on Outcomes in Chronic Subdural Hematoma: A Retrospective

Analysis

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### Objective

Chronic subdural hematoma (cSDH) is a common neurosurgical condition with a high recurrence rate, particularly in elderly patients. Despite advancements in surgical techniques, factors such as drainage placement and hematoma volume remain pivotal in determining outcomes. This study investigates the influence of drainage type and pre-operative hematoma volume on recurrence, hospital stay duration, and mortality.

#### Methods

A retrospective study was conducted at our institution, from 2018 to 2022. A total of 182 patients who underwent burr hole surgery with subdural or subgaleal drainage were included. Pre- and post-operative hematoma volumes were measured using BrainLab© I Plan software. Primary outcomes included recurrence, length of hospital stay, and 30-day mortality. Statistical analysis was performed using Chi-square, Fisher''s Exact, ANOVA, Kruskal-Wallis, Mann-Whitney U tests, and logistic regression.

### Results

The mean age of the patients was 74.4 years, with a male predominance (76.4 %). Of the 182 patients, 25 (13.7 %) experienced recurrence, while the 30-day mortality rate was low. Subgaleal drainage (n = 111) was associated with shorter hospital stays compared to subdural drainage (n = 71) (mean: 9.0 vs. 11.2 days, p < 0.05). No significant association was found between drainage type and recurrence (p = 0.098, HR: 2.97, 95% CI: 1.31 - 6.72). Pre-operative (V = 168.13 ml, p = 0.842) and post-operative (V = 119.45 ml) hematoma volumes did not significantly correlate with recurrence (p = 0.819).

### Conclusion

This study underscores the critical role of drainage type in determining the duration of hospital stays for patients with cSDH, while showing no significant impact of drainage choice on recurrence rates. The findings advocate for the use of subgaleal drainage over subdural drainage in surgical management to minimize complications and enhance clinical outcomes.

### P021

Prädiktiver Wert von Trauma-CT-Scores und Fisher-Skalen bei der Entwicklung eines posttraumatischen Hydrozephalus nach einer dekomprimierenden Kraniektomie Predictive value of trauma CT Scores and Fisher Scales in the development of post-traumatic hydrocephalus after decompressive craniectomy

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#### Objective

Decompressive craniectomy (DC) plays a pivotal role in the management of traumatic brain injury (TBI). However, there is limited understanding of post-traumatic hydrocephalus (PTH) in patients undergoing this procedure. This study aims to explore the predictive value of trauma CT scores and Fisher scales in identifying risk factors and predictors associated with the development of PTH following DC.

### Methods

We retrospectively analyzed TBI patients who underwent DC, categorizing them into two groups: those without post-traumatic hydrocephalus (Non-PTH group) and those who developed PTH (PTH group). Trauma CT scores, including Marshall, Rotterdam, Helsinki, and Stockholm, as well as both the original and modified Fisher scales, were assessed in all patients "first CT.

### Results

Our cohort included 126 patients, with 27% (n = 34) in the PTH group. Based on the Marshall CT score, patients were categorized into Groups I-III or IV-VI. In the PTH group, 82.4% (n = 28) were classified as Group IV-VI, compared to 87% (n = 80) in the non-PTH group (p = 0.569). Using the Rotterdam CT score, 55.9% (n = 19) of PTH patients scored 5-6, compared to 41.3% (n = 38) in the non-PTH group (p = 0.162). For the Helsinki CT score, 35.3% (n = 12) of PTH patients scored 9-12, compared to 16.3% (n = 15) in the non-PTH group (p = 0.028). The Stockholm CT score indicated that a score of  $\geq$ 3 was associated with PTH (p = 0.001). In the PTH group, 47.1% (n = 16) scored  $\geq$ 3, compared to 17.4% (n = 16) in the non-PTH group. Based on the Fisher scale, 84.2% (n = 30) of PTH patients were graded as III-IV, compared to 66.3% (n = 61) in the non-PTH group (p = 0.015). Using the modified Fisher scale, 38.2% (n = 13) of PTH patients scored  $\geq$ 2, compared to 18.5% (n = 17) in the non-PTH group (p = 0.033).

### Conclusion

In conclusion, the Helsinki CT score, Stockholm CT score, and Fisher scale showed significant differences between PTH and non-PTH cohorts, unlike the Marshall and Rotterdam scores. This suggests that Helsinki, Stockholm, and Fisher scales may be more effective in evaluating the likelihood of development of PTH in this context.

### P022

# Maßgeschneiderte, dünne Cranioplastik aus reinem Titan: Tragfähigkeit und Designvorteile *Custom-made, thin pure-titanium cranioplasty: load-bearing capacity and design advantages*

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### Objective

Adequate and stable coverage of cranial contour and continuity defects of any origin is a common challenge in neurosurgical clinics. This study presents the results of investigations concerning the mechanical load-bearing capacity and design advantages of custom-made implants made from a thin, pure-titanium sheet for cover in complex cranial defects.

#### Methods

In 9 test series, the stability of three differently shaped and sized thin titanium sheet implants was tested using vertical, uniaxial compression with 3 different compression stamps, to investigate the behaviour of these implants in relation to punctiform as well as planar forces.

### Results

All 9 model implants showed elastic behavior in the synchronously recorded force/displacement diagrams at an impression of up to 2 mm. The forces at 2 mm deformation were between 170.1 and 702.7 Newton.

### Conclusion

Cranioplasty using a thin, pure-titanium sheet is a stable procedure for covering skull defects, even those of large dimensions. An added advantage is the significant reduction in effort required to prepare the area of the bone margins compared to other current techniques of cranioplasty.











Abb. 2



### P023

PMMA-Kranioplastie mit 3D-gedruckten, patientenspezifischen Epoxidharzschablonen - eine retrospektive Analyse von zwei neurochirurgischen Zentren.

*PMMA cranioplasty using 3D-printed, patient-specific epoxy resin templates - a retrospective analysis from two neurosurgical centers.* 

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### Objective

Cranial reconstruction of large skull defects, often following decompressive craniectomies, has been performed in recent years at two neurosurgical centers using polymethylmethacrylate (PMMA) implants, which are intraoperatively molded using 3D-printed, patient-specific epoxy resin templates. The initial results using this novel cranial reconstruction method at the first center were published in 2021. We now present a larger retrospective follow-up analysis with a multicenter patient cohort.

### Methods

From June 2020 to July 2023, 64 cranioplasties were implanted using the described technique at the first center. Similarly, the technique was established at the other center, where 28 cranioplasties were performed from March 2022 to May 2024. For this study, data focusing on the following parameters were analyzed: cause of craniectomy, time until cranioplasty, preoperative presence of sinking flap syndrome or parenchymal bulging, and complication rates (e.g. hemorrhage, infection, cerebrospinal fluid fistula).

### Results

The most common reasons for craniectomy were trauma (46%), stroke (21%), and aneurysmal subarachnoid hemorrhage (17%), the remaining causes were infection, non-traumatic intracerebral hemorrhage and miscellaneous. The median time interval from craniectomy to cranioplasty was 79 days (range 10-1206). Complications requiring revision surgery occurred in 18% of implants, most of which were early complications (<30 days) and primarily epidural hematomas (70%), with postoperative infections being much less frequent (12%). Other complications included wound healing disturbances and cerebrospinal fluid fistulas. The complication rates are within the range of those reported in the literature. Postoperative CT scans showed highly satisfactory reconstruction of the preoperative skull shape.

### Conclusion

PMMA cranioplasty using 3D-printed, patient-specific epoxy resin templates is a safe and cost-effective technique with excellent skull shape reconstruction, even in a multicenter patient cohort. Future studies will aim to compare different materials for cranioplasty and assess postoperative patient satisfaction regarding cosmetic outcomes.

### P024

Risikofaktoren für eine aseptische Knochendeckelnekrose nach autologer Kranioplastik: Eine retrospektive Single-Center Studie.

*Risk factors aseptic bone-flap resorption after autologous Cranioplasty after Decompressive Craniectomy: A single-center retrospective study.* 

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#### Objective

Aseptic bone-flap resorption (ABFR) is a frequent complication following cranioplasty (CP), often necessitating reoperations with potential harm to patients. We already demonstrated that time between decompressive craniecotomy (DC) and CP effects incidence of ABFR. Aim of this study was to evaluate further risk factors for the incidence of ABFR.

#### Methods

A total of 279 patients underwent autologous CP at our institution between January 2015 and December 2022. A retrospective analysis of patient characteristics, including comorbidities and laboratory parameters, and the occurrence of ABFR was conducted.

#### Results

ABFR was observed in 24 (8.6%) patients. According to univariate analysis, multi-part bone flaps (p=0.020) and time between DC and CP less than 5 months (p=0.029) were risk factors for ABFR. On the other hand, hypertension was less common in patients with ABFR (68.8% vs. 37.5%, p=0.006).

In multivariate analysis, only multi-part bone flaps (p=0.023, OR 3.6; 95% CI 1.2–10.9) and hypertension (p=0.007, OR 0.29; 95% CI 0.12–0.72) were independent predictors for ABFR.

#### Conclusion

Multi-part bone flaps seem to be a risk factor for aseptic bone-flap resorption after cranioplasty and should therefore be avoided. On the other hand, hypertension may be protective for aseptic bone-flap resorption, but further studies are needed.

### P025

Kann die navigierte transkranielle Magnetstimulation (nTMS) Unterschiede zwischen dem M1 proper und nonproper Areal detektieren?

Can we use standard mapping techniques to detect the difference between the proper and non-proper areas of M1 using navigated transcranial magnetic stimulation (nTMS)?

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### Objective

In 2021, Lorenzo Bello's research group succeeded in translating findings from animal studies of an anatomical subdivision of the M1 area into neurosurgical practice. He and his team took up the findings of Witham and Rathelot et al. who were able to demonstrate a division of the primary motor cortex into an anterior part, with lower excitability and slower motor responses, and a posterior part, with higher excitability and faster motor responses in monkeys and developed a stimulation algorithm to reliably identify both parts intraoperatively. We designed a nTMS study to test whether this anatomical subdivision can also be reproduced using a non-invasive mapping procedure.

### Methods

In this trial, 15 healthy volunteers were included. Using navigated TMS we divided the motor area at hand knob level into 4 distinct strips parallel to the central sulcus (anteprecentral, precentral nonproper, precentral proper and postcentral). After determining the resting motor threshold (RMT), 10 stimulation points in each strip were stimulated with 150%RMT.

Electromyographic (EMG) amplitudes and latencies of the different stimulation strips were later compared in order to detect differences.

### Results

Comparing the precentral nonproper and proper area, no differences in mean EMG amplitude and latency could be detected. Furthermore, no significant differences in mean amplitude and latency were observed when comparing anteprecentral and precentral nonproper with precentral proper and postcentral. Among the four strips, non showed a significant difference compared to the other in terms of mean amplitude and latency.

### Conclusion

With the presented protocol, a delineation of M1 proper and non proper is not possible. However, it is noteworthy that the application of relatively high stimulation intensity may obscure subtle, otherwise discernible differences. Further examinations at the lower end of the stimulation spectrum (e.g. 90%RMT) may differentiate the two anatomical areas.

### P026

### Prediktoren für Responsiveness auf TMS-gestützte Sprachtherapie Markers for Responsiveness to Repetitive Transcranial Magnetic Stimulation Therapy of Language Function

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### Objective

Repetitive transcranial magnetic stimulation (rTMS) combined with language training is investigated as a new treatment option for individuals suffering from aphasia, yet there is considerable variation in responsiveness to this therapy. To increase the clinical relevance of this intervention and personalize treatment, a better understanding of predictors for responsiveness is needed. This study aims to identify predictors for improving language function following rTMS therapy in healthy German speakers.

### Methods

Ten German speakers (six males and four females, aged 22–29) were randomly assigned to rTMS treatment (n=5) or sham (n=5). The treatment group received 1 Hz rTMS to the right superior posterior temporal gyrus and 10 Hz to the left homolog during language training; the sham group used a plastic adapter. Pre-intervention MRI data were processed with fMRIPrep and analyzed in the CONN toolbox. We then examined whether improvements in verbal fluency in the treatment group were associated with connectivity measures from pre-intervention neuroimaging data and graph theory metrics of ROI-to-ROI connectivity, with adjacency matrices thresholded at the top 10%. Statistical tests used p-FDR correction at p<0.05 (two-sided).

### Results

There were significant improvements in verbal fluency in the treatment group compared to sham. Greater language gains were linked to higher eigenvector centrality in the right Occipital Fusiform Gyrus (OFusG r, p-FDR of 0.0482), a region tied to object recognition and reading. No significant effects were found for other regions, language outcomes, or correlations with reaction time.

### Conclusion

These findings suggest that pre-treatment connectivity efficiency in OFusG r may predict verbal fluency outcomes, offering the potential for patient stratification in rTMS interventions. Future studies should investigate if these effects are mostly related to the task used for language training during rTMS or represent a general predisposition for better language learning.

### P027

### Perioperative Risikostratifizierung für Patient:innen mit intrakraniellen Metastasen mithilfe von nTMS Motormapping

Perioperative risk stratification for patients with intracranial metastases with the help of nTMS motor mapping

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### Objective

Numerous studies supplied evidence for the predictive value of navigated transcranial magnetic stimulation (nTMS) motor mapping for postoperative neurological outcome and risk stratification after brain tumor surgery. Yet, the critical distance between functionally active areas and tumor tissue for an increased risk of postoperative neurological deficits is still undetermined. In the present study we assessed patients suffering from brain metastases.

### Methods

All patients undergoing nTMS motor mapping before brain tumor surgery for intracerebral metastases between 2018 and 2023 have been identified and evaluated for pre- and postoperative clinical status. The minimal distance between the functionally active areas and the tumor was then measured and statistically correlated.

### Results

93 patients underwent nTMS motor mapping. 26 patients (12 male, 14 female) suffered from brain metastases and were included in the study. The median age was 62,5 years (range: 31-81). On average the distance between tumor and nTMS positive areas was 5,8 mm (SD: 8,4). Histologically the most frequent primary tumors were bronchial carcinoma (n=15) and malignant melanoma (n=5). Tumor locations comprised pre- and/or postcentral gyrus (n=18), prefrontal lobe (n=5) and parietal or temporal lobe (n= 3). Preoperative motor deficits were present in 16 patients (arm paresis n=13, leg paresis n=10). In one patient (3,8%) we saw a new postoperative hemiparesis with intact motor function before surgery. In 8/26 patients (31%) motor function decreased after surgery. The middle distance between nTMS positive zones and the tumor in patients without postoperative motor deficits was 10,8 mm (SD: 11,9) and therefore significantly larger than in patients with postoperative motor deficits at 3,1 mm (SD: 4,2) (Student's T-test p=0,024). No worsening of motor function was observed when the distance was greater than 11 mm.

### Conclusion

nTMS motor mapping can be a useful tool to better inform patients and surgeons about the expectable neurological outcome after brain metastasis extirpation near eloquent areas. The risk for worsened motor function is especially increased when the tumor is 11 mm or closer to the nTMS positive regions.

### P028

Der Einfluss von Stimulationsgebiet und Spulenausrichtung auf die intrakortikale Erregbarkeit der unteren Extremität bei der navigierten transkraniellen Magnetstimulation (nTMS) The influence of stimulation area and coil orientation on the intracortical excitability of the lower limb during navigated transcranial magnetic stimulation (nTMS)

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### Objective

Transcranial magnetic stimulation (TMS) is an increasingly utilized method for the non-invasive investigation of corticomotor excitability in the human brain. Among various influencing factors, coil orientation and stimulation location are particularly critical for eliciting motor-evoked potentials (MEPs) and determining resting motor thresholds (RMT). The cortical representation of the foot area, situated along the medial longitudinal fissure, poses significant challenges for precise examination using nTMS. Consequently, the determination of an optimal coil rotation angle and stimulation site is of critical importance to ensure accurate and reliable assessments in this anatomical region.

### Methods

A cohort of 11 healthy volunteers underwent nTMS mapping following a standardized protocol. Stimulation was applied at six distinct locations surrounding the motor hotspot of the tibialis anterior (TA) muscle, with the coil orientation systematically adjusted in 45° increments. For each stimulation site and coil rotation angle, five stimulations were administered, resulting in a total of 240 stimulations per participant. The mapping was conducted using the Nexstim NBS 5.0 system, with statisical analyses performed in R.

### Results

The statistical analysis revealed significant differences between stimulation sites (p < 0.001), with a preference for stimulation laterally to the hotspot at the same anterior-posterior level. An analysis of coil rotation angles using ANOVA demonstrated a significant effect of stimulation direction, favoring orientations perpendicular (90°) or almost perpendicular (135°9 to the midline (p = 0.02). Post-hoc comparisons indicated significantly higher amplitudes for these directions. However, not all pairwise comparisons reached statistical significance. No significant differences were observed with respect to latency measurements.

### Conclusion

This study highlights the importance of coil orientation in nTMS mapping of the TA muscle. Stimulation sites lateral to the motor hotspot showed significant advantages compared with the other stimulation sites. Further, a stimulation direction perpendicular to the midline and at 135° relative to the midline resulted in significantly higher amplitude values compared to other tested angles. These findings emphasize the critical role of optimizing coil orientation to enhance the reliability and precision of motor mapping, providing valuable insights for refining nTMS protocols in both research and clinical applications.

### P029

Zusammenhang zwischen dem WHO Grading von Gliomen und kortikaler Exzitabilität in der navigierten transkraniellen Magnetstimulation (nTMS) Associations between WHO grading of gliomas and cortical excitability measured with navigated transcranial magnetic stimulation (nTMS)

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### Objective

Navigated transcranial magnetic stimulation (nTMS) motor mapping is an important tool for preoperative risk stratification of functional outcome prior to resection of brain tumors. Published data indicate altered cortical excitability between lower and higher grade gliomas.

### Methods

Patients with histologically confirmed gliomas undergoing nTMS mapping for motor function (Nexstim NBS 5, Nexstim Oy, Helsinki, Finland) were retrospectively evaluated.

Clinical examinations, imaging studies, WHO grading, IDH status, nTMS examinations and tractography were analyzed. The interhemispheric rMT-ratio (rMTTumor/rMTControl) was calculated for each extremity and considered pathological if it was >110% or <90%. An excitability score was calculated for each pathological rMT-ratio with possible scores between 0 and 2 points.

### Results

48 patients were evaluated. 25 (52.1%) were female and mean age was 57.1 years. Eight (16.7%) had astrocytomas CNS WHO grade 2, 6 (12.5%) had astrocytomas CNS WHO grade 3 and 34 (70.8%) had CNS WHO grade 4 tumors. 25 (52.1%) had a pathological rMT ratio for the upper and 31 (64.6%) had a pathological rMT ratio for the lower extremity. Correspondingly, 9 (18.8%) had an excitability score of 0 points, 22 (45.8%) had an excitability score of 1 point and 17 (35.4%) had 2 points. The interhemispheric rMT-ratio of the upper limb was more frequently pathological in grade 4 tumors than in grade 2 and 3 tumors (p=0.002) and the excitability score increased with increasing CNS WHO grade (p=0.014). Other possible confounders such as motor status, distance to the corticospinal tract, tumor volume, recurrence and intake of anticonvulsants were not significant different among the categories of the excitability score.

### Conclusion

nTMS-data corresponded with the WHO grading of infiltrating brain tumors. The results of our study support hypotheses concerning a greater disruption of the motor system with increasing malignancy of the lesion.

### P030

Untersuchung der Somatotopie des supplementär-motorischen Areals (SMA) mittels repetitiver navigierter transkranieller Magnetstimulation (rnTMS) Investigation of the Functional Somatotopic Organization of the Supplementary Motor Area (SMA) using Repetitive Navigated Transcranial Magnetic Stimulation (rnTMS)

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### Objective

Electrostimulation research has shown the supplementary motor area (SMA), a cortical region crucial for planning, execution, and sequential processing of movements, to exhibit a somatotopic organization with anterior-to-posterior progression, representing lower extremities, upper extremities, and orofacial movements. Lesions of the SMA are associated with the Supplementary Motor Area Syndrome, producing deficits aligning with the somatotopic organization. Despite its clinical relevance, non-invasive techniques for mapping functionally relevant SMA subregions remain sparse and have not addressed this somatotopic organization. This study aims to investigate the proposed SMA somatotopy using rnTMS.

### Methods

The study included 20 healthy participants (11 Female, average age =  $28.4 \pm 6.9$ ). In addition to a baseline without stimulation, participants received rnTMS (20 Hz, 120–140% RMT) at six SMA and six non-motor targets while performing the Nine-Hole Peg Test, the lower extremity motor coordination test, and a novel test for orofacial movements developed for this study. A high-speed camera recorded movement, and pre-trained convolutional neural networks were applied to the footage to obtain kinematic data. For each test, linear mixed models analyzed the effects of stimulation condition (SMA, non-motor, and baseline) and stimulation location within the SMA on test performances and kinematic data (Speed, Acceleration and Jerk).

### Results

Stimulation over the SMA selectively disrupted upper extremity performance, corroborating the SMA's involvement in motor coordination and sequence execution. For lower extremities, stimulation effects were strongest in non-motor regions, followed by SMA stimulation and baseline. Specifically, within the SMA posterior stimulation caused greater disruptions in both upper and lower extremity tasks. No significant effects were observed for orofacial movements.

### Conclusion

This study confirmed the utility of rnTMS for functional mapping of SMA motor representations, particularly for upper and lower extremity movements. However, no clear somatotopic segregation between extremities was observed, suggesting technical limitations.

### P031

### OnTrack: Eine intraoperative Evaluation der Traktographie OnTrack: An intraoperative evaluation of tractography

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### Objective

Tractography enables us to visualise functional white matter tracts revealing their spatial relation to pathologies. In neurosurgery, diffusion tensor imaging (DTI)-based tractography is often used. However, alternative approaches may improve the accuracy of tractography. Fibre orientation distributions (FOD) model multiple diffusion maxima per voxel accounting for complex fibre arrangements, as opposed to one main direction in DTI. While both DTI- and FOD-based approaches traditionally use anatomical landmarks to define seeding regions, navigated transcranial magnetic stimulation (nTMS)-based tractography identifies functional cortical areas from which to propagate the tract. It remains uncertain which tractography method has the highest fidelity to the underlying anatomy and whether nTMS-based tractography is more accurate with a DTI or FOD approach due to the lack of ground truth.

### Methods

Here we present the initial results of an evaluation of DTI-, FOD-, nTMS-DTI, and nTMS-FOD-based tractography. Intraoperatively, we used direct subcortical stimulation near the corticospinal tract and recorded muscle responses in the face, back, limbs, feet, and hands yielding positive and negative stimulation points. Additionally, we used navigated ultrasound to correct for brain-shift. For each tractography method, we measure the distances between stimulation points and tract providing information about missing and false-positive parts of tractography. We calculate accuracy, ROC analyses, and Bland-Altman plots to evaluate which tractography method shows the highest correspondence to the surgically-relevant intraoperatively identified corticospinal tract.

### Results

As of yet, 5 patients were recruited (46.60( $\pm$ 21.82) years; 3 females/2 males; 3 glioblastomas WMH 4°, 2 astrocytoma WHO 2°/3°). Motor and general functioning were preserved pre- to postoperatively on the lesioned (non-lesioned) side (finger tapping: p=.372 (p=.816); hand dynamometer: p=.051 (p=.053); MRC: p=.216 (p=.117); NIHSS: p=.317; KPS: p=.420). In total, 77 stimulation points were acquired with ≥1.5cm between each stimulation location. Participant recruitment and data analysis are ongoing. The results of the accuracy analysis and 3-month follow-ups will be presented.

### Conclusion

A quantified evaluation of tractography after brain-shift correction may inform the selection of tractography method to support surgical planning and risk stratification and may improve the balance between extent of resection and preservation of function.

### P032

Pixelbasierte Anomaliedetektion für eine verbesserte Visualisierung und Abgrenzung von infiltrativen Tumorgewebe in fluoreszenzbegleiteter Glioblastomresektion *Pixel-wise anomaly detection for improved visualization and delineation of infiltrative tumor tissue in fluorescence-guided glioblastoma resection* 

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### Objective

Maximizing the extent of resection is the primary goal in glioblastoma (GBM) surgery directly affecting the patient's prognosis. However, radical cytoreduction might increase the risk of neuronal deficits. Reliably identifying tumor tissue and differentiating it clearly from normal tissue is not possible with current intraoperative imaging and fluorescent labeling. We present a novel approach for improved real-time visualization during fluorescence guided GBM resection based on machine learning (ML) and anomaly detection (AD) in individual pixels of neurosurgical microscope (NSM) images.

### Methods

NSM images of liquid fluorescent phantoms with known protoporphyrin IX concentration, ranging from visible to non-visible fluorescence, were acquired under blue light. Using this labeled image data, three classifiers (Support Vector Machine, Naive Bayes, Neural Network) and three variational autoencoder (VAE) AD models with varying beta factor (1, 2, and 3) could be trained to discriminate pixels depicting fluorescent samples. A dataset containing intraoperative images from both fluorescence-guided GBM resections and conventional surgery under blue light for control was acquired and the most predictive model was trained for real anatomy image data. Model identified fluorescent areas were compared with the annotations of four experienced neurosurgeons in 10 GBM resection images.

### Results

The investigated models achieved areas under the receiver operating characteristic (AUROC) of 0.87-0.93 and accuracies of 0.8-0.84. However, the AD approach using VAE at a beta=1 was found superior with an overall detection rate of 57.84% at a fixed specificity of 99%. The specificity of the real intraoperative images model was found to be > 99.9%. The fluorescent area detection by ML outperformed the visual identification by surgeons with up to 240 % larger found fluorescent, and thus cancer cell infiltrated, areas (see Fig. 1).

### Conclusion

Despite numerous research efforts to improve the visualization and delineation of GBM tissue during resection using new camera technologies, there is currently no approach that provides a data-driven solution for conventional imaging. We demonstrate that ML-based pixel-wise detection of vague and non-visible fluorescence can serve as a valuable tool for more precise and objective intraoperative decision-making, aiming for a more radical removal of tumor tissue.





### P033

nnU-Net basierte Detektion und Segmentierung von Hirnmetastasen Modified nnU-Net Detection and Segmentation of Brain Metastases

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### Objective

Detection, especially early detection and segmentation of brain tumors, is an ongoing challenge in medical imaging. Manual detection and segmentation nowadays represent the gold standard but are complex, time-consuming, and user-dependent. Reliable, precise, and efficient procedures are required to detect and outline brain tumors for diagnostics, therapy planning, and monitoring of the state of disease, which can be supported by semi-automatic, artificial intelligence (AI)-based algorithms.

### Methods

For automated detection and segmentation of brain metastasis with its surrounding edema and contrastenhancing parts to further quantify characteristics of the lesion itself, modified nnU-Nets, an adaption of a U-Net, a convolutional neuronal network for image segmentation, were utilized in a 2D and 3D manner for deep learning-based self-adapting image segmentation. The nnU-Net was trained with data from the BRATS 2023/2024 Brain-MET Challenge and validated within the presented pilot study. Therefore, manual segmentations of the lesion, its contrast-enhancing components, and the lesion with its surrounding edema were performed in magnetic resonance imaging (MRI) data of 18 patients with singular brain metastasis from lung cancer. These segmentations were compared to the presented automated approach's results utilizing the Dice coefficient, a measure of spatial overlap routinely used in analysis of segmentation performance.

### Results

All metastases have been detected by the automated approach yielding a mean volumes of  $5.38 \pm 7.93$  cm<sup>3</sup> (tumor),  $3.06 \pm 2.60$  cm<sup>3</sup> (contrast-enhancing component), and  $53.10 \pm 18.00$  cm<sup>3</sup> (tumor and edema). Based on the integrated 2D segmentation approach, Dice Coefficients of  $0.86 \pm 0.07$  (tumor),  $0.81 \pm 0.09$  (contrast-enhancing component) and  $0.86 \pm 0.06$  (tumor and edema) were reached. The integrated 3D approach resulted in Dice coefficients of  $0.87 \pm 0.06$  (tumor),  $0.83 \pm 0.09$  (contrast-enhancing component) and  $0.87 \pm 0.05$  (tumor and edema). Automated analysis took about 5 minutes for image preprocessing and less than 2 minutes for detection and segmentation with the 2D and 3D model.

### Conclusion

The modified nnU-Net approach, specifically adapted for metastases detection and segmentation, showed very good to excellent Dice coefficients, providing promising results on automatic lesion detection and segmentation, allowing for further investigations in image-based characterization of brain metastases.

### P034

Entwicklung eines KI-basierten Prädiktionsmodell-Protokolles für postoperative neurologische Defizite bei Patienten mit primären Hirntumoren oder Metastasen Development of an AI-based predictor model research protocol for postoperative neurological deficits in patients with primary brain tumor or metastasis

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### Objective

In patients with primary brain tumors or metastases, both maximum extent of resection and preserved postoperative neurological function are crucial for patient outcomes. The aim of this project is to develop an artificial intelligence (AI)-based algorithm that evaluates a novel biomarker, the Tract-Proximal Lesion Volume (TPLV), which quantifies tumor volume within a defined threshold distance from the pyramidal tract from preoperative MRI data to predict postoperative motor deficits.

#### Methods

The analysis will proceed in two phases: First, quantitative determination of lesion-to-tract distance (LTD) through segmentation, followed by ROC analysis with Area Under the Curve (AUC) determination to evaluate LTD's predictive quality and determine optimal threshold values using the Youden index. Second, quantification of TPLV within defined proximity zones to the CST, based on the optimal LTD threshold and its variations (±25%, ±50%, and ±100%). The diagnostic quality of TPLV will be evaluated through ROC analysis and compared against LTD's predictive capabilities.

#### Results

The study is currently in its protocol phase with ongoing data collection and analysis. A web-based cloud model has been developed that enables the assessment of uploaded pseudonymized and annotated MRI datasets (T1 MPRAGE with and without contrast agent, diffusion tensor imaging (DTI) sequences). Further data analysis will be done on the same model.

### Conclusion

This research protocol presents a novel approach to predicting postoperative motor deficits in patients with brain tumors or metastases. The successful validation of TPLV as a predictive biomarker could represent a substantial advancement in risk stratification for neurosurgical procedures affecting the pyramidal tract.

### P035

Der Vergleich von paralleler Bildgebung und der partieller Fourier-Technik für die EPI-Sequenz: Somatotope Abbildung der Finger im primären somatosensorischen Kortex des Menschen bei 3T *Comparing Parallel Imaging and Partial Fourier Techniques for the EPI Sequence: Finger Representations in the Human Primary Somatosensory Cortex at 3T* 

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### Objective

Parallel imaging and partial Fourier are well-established techniques to shorten the echo train in echo planar imaging (EPI) sequences used for fMRI. There exists yet no systematic comparison between both techniques. The aim of our study was to compare both acceleration techniques for fMRI of the somatosensory cortex which requires very high spatial resolution.

### Methods

fMRI, performed at 3T, was based on a single-shot gradient echo-EPI sequence with a measured voxel size of (1.5mm)3 and an on-off block design with a paradigm length of 12s and 300 measurements. fMRI was acquired in two separate sessions, one with parallel acquisition technique (PAT2, acceleration factor 2) and one with partial Fourier (pFOU). fMRI slices were positioned covering the primary motor and somatosensory cortices.To map the somatotopic representation of each finger, 5 healthy volunteers were recruited. Independent tactile stimulation of each fingertip of the dominant hand (right hand in all volunteers) was performed with a brush. During fMRI individual fingers were stimulated in a fixed order in separate runs for each finger, starting with the thumb (D1), followed by the middle (D3), small (D5), index (D2), and ring finger (D4).fMRI data were realigned and registered, then coregistered to a 3D data set and smoothed with a 3mm FWHM. To assess statistical effects a whole brain analysis was performed using a general linear model approach on individual subject level in a single statistical model including all 10 runs (5 fingers, 2 techniques).Finally, results of different fMRI techniques were compared according to signal intensity of the maximum T-values and the Euclidean distance of the activation maxima points.

### Results

fMRI yielded significant (p<0.001) activation in somatosensory cortex corresponding to individual fingers in each subject. In most cases, the position of the voxel with the maximum T-value was similar using different techniques. The mean Euclidean distance between PAT2 and pFOU was 4.05mm. Mean maximum T-values were 9.29 for PAT2 and 9.98 for pFOU.

### Conclusion

The localization of the activation as well as the maximum T-values were comparable with both acceleration techniques. Therefore, both sequences, parallel imaging and partial Fourier, may be comparable valuable methods especially in cases where very high spatial image resolution is required in functional imaging as single finger representation in the somatosensory cortex.

### P036

Fine-scale mapping der somatotopischen Fingerrepräsentation im primären somatosensorischen Kortex bei gesunden Probanden und Patienten nach sensorischer peripherer Nervenverletzung mittels fMRT: Eine Machbarkeits-Studie

Fine-scale mapping of the somatotopic finger representation in the primary somatosensory cortex in healthy subjects and patients with sensory peripheral nerve injury using fMRI: A feasibility study

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#### Objective

Somatotopic finger mapping in the primary sensory cortex using fMRI is challenging due to the necessity of very high spatial resolution. The aim of this feasibility study was to develop a fMRI protocol for the assessment of the individual cortical somatosensory finger representation in healthy subjects to subsequently investigate the fine-scale functional reorganization of the somatosensory cortex in patients with traumatic sensory peripheral nerve injury.

#### Methods

5 healthy volunteers (mean age 36±6 years) were recruited as well as one 40-year-old male patient suffering from complete sensory loss in the right thumb (d1), but no motor deficits following severe digital nerve trauma. fMRI was performed at a 3T scanner (Siemens Magnetom Skyra). 23 slices with a voxel size of 1.5mm3 were acquired covering the primary motor and somatosensory cortices. During fMRI sessions, independent tactile stimulation of each fingertip of the dominant hand was performed with a brush using a 12s on/off block design. In healthy subjects, individual fingers were stimulated in a fixed order in separate runs for each finger (d1, d3, d5, d2, d4). In the patient with digital nerve injury, fMRI was acquired 6 weeks after reconstructive surgery and contained stimulation of d1 and the neighboring finger d2. At this time point, sensibility of the affected d1 was still lacking. Analysis of fMRI data was performed using SPM12 with a level of significance of p=0.05 (FEW-corrected) on voxel and cluster level.

### Results

Depiction of the cortical representation of the single fingers was reliably possible in healthy subjects. fMRI data demonstrated a highly significant activation of the somatosensory cortex corresponding to individual fingers when compared to the other fingers in each subject with a somatotopic organization from ventral (d1) to dorsal (d5). In the clinical case, significant cortical activation was found for stimulation of the unaffected finger d2, but not for the affected d1 lacking sensory sensitivity.

### Conclusion

The individual somatotopic finger representation could be reliably depicted in all healthy subjects at a 3T-scanner using the suggested fMRI protocol. This method might help to monitor neuroplastic changes in the primary sensorimotor cortex in patients following peripheral nerve injury and to monitor these changes in the long term after reconstructive nerve surgery.

# Funktionelle Neurochirurgie | Functional neurosurgery

### P037

Strukturelle Konnektivität der Basalganglien von patientenindividueller Traktographie zur Vorhersage der therapeutischen Wirkung der tiefen Hirnstimulation bei Parkinson Patienten Structural connectivity of the basal ganglia from patient-individual tractography for predicting therapeutic effects of deep brain stimulation in Parkinson"s Disease

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### Objective

Therapeutic approaches for Parkinson''s disease (PD) patients include deep brain stimulation (DBS) of the subthalamic nucleus (STN). However, the mechanisms underlying the therapeutic effects of STN-DBS are not completely understood. In this work, we investigate the patient-specific structural connectivity associated with DBS and its links to therapeutic effects.

### Methods

We applied tractography to reconstruct the white matter pathways of the brain in each individual patient. Imaging data were acquired from PD patients scheduled for STN-DBS at our centre (N = 69). Clinical assessments like the UPDRS questionnaire were acquired before and after DBS surgery (median time to follow up 9.0 months [2.6 - 20.2]), under medication. Tractography based on patient-individual diffusion-weighted MRI was used to both identify the cortical projections of the volumes of tissue activated (VTAs) as well as the fibre tracts connecting the STN with the basal ganglia and cortex and their proportion targeted by STN-DBS.

### Results

VTA connectivity to the cortex revealed that VTAs primarily connect to the supplementary motor area (SMA). Around 30-40% of the fibres tracked from the STN were targeted by DBS. This proportion was positively and significantly correlated (p<0.05) with improvement of the overall UPDRS-III score, and of the tremor and rigidity subscores, not only for the connections between the STN and cortex (SMA and pre-motor cortex), but also the STN and the basal ganglia (internal and external globus pallidus).

### Conclusion

Patient-individual tractography reveals that, in PD, most of the cortical fibres that are connected with the VTA or that are affected by STN-DBS belong to the hyperdirect pathway which such presents a major target for modulation. In addition, clinical efficacy is related to the proportion of DBS-affected fibres connecting the STN with the nodes of the indirect or direct pathway. Such, patient-specific tractography could be used in a clinical context as a tool to guide therapy.



# Funktionelle Neurochirurgie | Functional neurosurgery

### P038

Phänotypisierung von Parkinson Patienten unter tiefer Hirnstimulation des Nucleus Subthalamicus Immunometabolic phenotyping in Parkinson patients with and without adjunctive deep brain stimulation of the subthalamic nucleus Immunometabolische

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### Objective

Adipocytes are a source of many pro- and anti-inflammatory cytokines, including TNF- $\alpha$  and members of the interleukin family, such as IL-1 $\beta$  and IL-6. While cytokines are predominantly secreted by immune cells and a variety of additional cell types, adipose tissue is the main source of adipocytokines, providing the basis for the so-called "adipose-brain-axis" with leptin as the classical adipocytokine. More recently, multiple lines of evidence have linked aberrant leptin signaling to neurodegenerative disorders. A protective role of leptin signaling has also been shown in models of PD. Leptin and other adipocytokines have additionally gained increasing attention due to their implication in chronic inflammation, including neuroinflammation (Figure 1).

#### Methods

This in-human re-visited current knowledge on the crossroads of PD and leptin signaling with the aim to determine if serum concentrations of circulating leptin do have an effect across different PD subtypes and PD patients with STN-DBS compared to an age- / gender matched healthy control cohort using leptin multiplex immunoassays. In addition, STN-DBS parameters, clinical scores and adverse events were recorded.

#### Results

Participants were 35 early-onset PD type (14 female/21 male), 35 controls (14 female/21 male), 20 PD-DBS (4 female/16 male), 20 PD standard care (4 female/16 male) at the age of 60.8±9.1 years). No SAE occurred with STN-DBS operating at130 Hz, 60 ms, bipolar, 0.9-3.4 mA. Although not significant, we found a trend in leptin (ng/ml) being increased after STN-DBS (Fig.1), while no differences were found comparing early-onset PD with healthy controls (Fig. 2).

#### Conclusion

Our results in are line with previous studies in PD patients with standard of care. However, to what extend deep brain stimulation may interfere with immunometabolic signaling of leptin remains unclear yet. Further experimental as well as clinical trials are needed to elucidate the mechanisms of action and the value of molecular characterization of circulating mediators of the adipose-immune-metabolism to validate the differential roles of different adipokines as potential diagnostic and therapeutic target in PD patients.
Abb. 1





Figure 2. Circulating levels of leptin in serum.



# P039

Die intraoperative venöse Luftembolie bei funktionellen neurochirurgischen Eingriffen in halbsitzender Position Intraoperative venous air embolism in functional neurosurgery

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# Objective

Precise electrode placement is crucial in deep brain stimulation (DBS). This may be compromised by brain shift caused by cerebrospinal fluid leaking or pneumocephalus. Therefore, it is an option to elevate the head. This, however, carries an increased risk of venous air embolism. Here we analyze the occurrence and management of this complication in a large consecutive series of patients.

# Methods

We performed a retrospective analysis in a series of 634 functional stereotactic operations head elevated. Surgery was performed while the patients were awake in 567 instances. Any clinical signs for air embolism such as increased throat clearing, coughing and circulatory problems were scrutinized.

#### Results

A total of 263 women and 371 men with a median age of 55 years were operated. The majority of patients underwent DBS (614), while a subset had radiofrequency lesioning procedures (20). Increased throat clearing and slight coughing occurred in about 5 % of procedures, which stopped after sealing the burrhole with wax. Three patients (0.47%) had clinically relevant intraoperative venous air embolism: a 76-year-old man with PD, a 54-year-old man with tremor, and a 50-year-old woman with cervical dystonia. All three patients were cardiovascular stable and the surgery could be finished without further complications after sealing the burrhole, flushing the site with fluid, and tilting the upper part of the operation table backwards.

# Conclusion

Stereotactic functional surgery with elevation of the head is a generally safe procedure with a low risk for intraoperative venous air embolism. Immediate reaction to the signs of venous air embolism allows the procedure to be completed.

# P040

Eine Alternative zur Entfernung infizierter DBS Systeme mithilfe von stereotaktischem Röntgen. Ein dreischrittiges Vorgehen mit Nutzung der vorhandenen Trajekte. An alternative to remove infected DBS systems using stereotactic x-ray. A three step procedure using the excisiting trajectories.

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# Objective

Infections in deep brain stimulation (DBS) hardware, while an undesired complication of DBS surgeries, can be effectively addressed. Minor infections are typically treated with wound revision and IV antibiotics. However, when visible hardware infection occurs, most centers opt for complete removal, leaving the patient in a preoperative state and necessitating post-removal care. To avoid the need for such care, a novel technique was developed.

# Methods

The electrodes are placed at the exact same spot and then led to the contralateral side. new extensions and a new generator contralateral to the infection as well. Subsequently, the infected system is removed. This case series includes six patients.

# Results

The average duration of DBS system implantation before the second surgery was 272 days. Only one system had to be removed after 18 months due to reoccurring infection; the others remained unaffected. Laboratory alterations and pathogens were identified in only half of the patients.

# Conclusion

The described surgical technique proves to be safe, well tolerated, and serves as a viable alternative to complete system removal. Importantly, it effectively prevents the need of post-removal care for patients.







# P041

Langzeitergebnisse der peripheren Nervenfeldstimulation bei Patienten mit refraktärer Trigeminusneuralgie Long-term outcomes of peripheral nerve field stimulation in patients with refractory trigeminal neuralgia

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# Objective

Peripheral nerve field stimulation is a neuromodulatory surgical treatment that has been employed to treat severe refractory trigeminal neuralgia. However, most studies had comparatively short follow-up periods. We performed a long-term analysis of patients who had received peripheral nerve field stimulation for trigeminal neuralgia.

# Methods

We searched our database for patients who had received peripheral nerve field stimulation. Only patients with trigeminal neuralgia who received a permanent implant were included. The electronic records were reviewed, and the patients were contacted for outpatient appointments or telephone interviews. Perceived treatment effectiveness was the primary outcome parameter. We further evaluated revision surgeries, other invasive treatments after the implantation for peripheral nerve field stimulation, system explants, and the painDETECT score at the latest follow-up.

# Results

15 patients were included in the final analysis: six men and nine women. Seven patients suffered from classical trigeminal neuralgia and eight from secondary trigeminal neuralgia (seven due to multiple sclerosis, one due to inoperable meningioma). The median patient age was 70 years (range 45 - 87), and the median symptom duration was 11.5 years (range 2.5 - 17). The median follow-up time was 93 months (range 30 - 126, interquartile range 66.5 - 107). Only three patients still perceived treatment effectiveness, all of them men. Kaplan-Meier analysis with log-rank test revealed a median time to failure of two years with a median of 5.1 years in men and 1.5 years in women (p = 0.003). The median patients underwent additional procedures after the implantation.

# Conclusion

Peripheral nerve field stimulation in trigeminal neuralgia is associated with a high rate of treatment failure in the long term with women possibly experiencing worse results than men.







# P043

Gezielte nicht-invasive Neuromodulation der striatokortikalen Projektionen zur Verbesserung taktiler Funktion und Aufmerksamkeit in einer Patientin mit strategischer postoperativer Mikroläsion des Caudatus-Kopfes Targeted non-invasive neuromodulation of striatocortical projections to improve tactile function and attention in a patient with strategic postoperative microlesion of the caudate head

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# Objective

We report on the technique and effects of personalised, non-invasive cortical neuromodulation designed to improve the complex pattern of complex sensorimotor and attentional deficits of a 39-year-old female patient with a small postoperative lesion in the dorsolateral caudate head and adjacent fibres of the mid-anterior limb of the internal capsule.

# Methods

After resection of the left-sided intraventricular neurocytoma WHO grade 2, the patient suffered from (I) episodes of incapacity to execute untrained movements, (II) slight right-sided, hand-accentuated hypo- and dysesthesia, and (III) concentration deficits and fast cognitive exhaustion. As part of an individualised treatment trial, we targeted the mirrored contralateral cortical termination of striatocortical projections, originating from the surroundings of the lesion. We applied inhibitory low-frequency repetitive transcranial magnetic stimulation (rTMS; 1Hz, subthreshold, 1200 pulses once daily during 5 consecutive days) to enhance recovery by reducing interhemispheric inhibition. Using tractography based on diffusion-weighted imaging combined with resting-state and task-related somatosensory functional magnetic resonance imaging, we identified two potential targets, (a) in the pre-supplementary motor area (pre-SMA) and (b) in the primary somatosensory cortex and stimulated these sites at intervals of three to five months.

# Results

During the first and in subsequent rTMS blocks, we applied a reduced stimulation intensity of 70% (instead of initially 90%) of the resting motor threshold (RMT) to resolve side effects (i.e. headache, vertigo; cave previous history of migraine). After the first rTMS block (a), the episodes of transient movement planning inability subsided. However, there was no major effect on touch sensation. In contrast, rTMS of the somatosensory target (b) during the second block, the patient showed a strong immediate and slowly fading prolonged improvement of the right hand's tactile and fine motor skills, enabling here to regain the ability to recognise surface textures. Unexpectedly, she also experienced a major improvement of attention and concentration, motivating the third stimulation block in which we could replicate the aforementioned effects.

# Conclusion

Personalised rTMS targeting interhemispheric connections can effectively modulate even complex sensorimotor and cognitive functions, opening up the field of potential indications to enhance post-lesional recovery.

# P044

Neuronale oszillatorische Dynamik bei Parkinson und Dystonie: Einblicke aus der EEG-Analyse Neural oscillatory dynamics in Parkinson disease and dystonia: insights from EEG analysis

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# Objective

Parkinson disease (PD) and dystonia (DYS) are associated with changes in neural oscillations across different frequency bands. Changes in total power and entropy across the raw data may allow the identification of comprehensive shifts in neural dynamics that may align with clinical symptoms, thus serving as markers for possible adaptive deep brain stimulation therapy.

# Methods

Nine patients with PD (age at onset: 28–58 years; eight men, one woman) and six patients with DYS (age at onset: 33–51 years; four men, two woman) participated in the study. We used EEG recordings from the motor cortex to investigate how the spontaneous power of cortical frequency bands and total power across broad bands manifest in PD patients compared to those with DYS. We also analyzed the approximate entropy (ApEn) of oscillatory activity across different frequency bands and across broad bands in the motor cortex.

# Results

In DYS enhanced theta (4-8 Hz) and gamma (30- 100 Hz) frequency bands were accompanied by lower values in theta entropy (p<0.01), whereas in PD patients enhanced beta frequency band (12-30 Hz) was accompanied by lower values in beta entropy (p<0.01). Overall, total ApEn was higher in motor cortical areas of DYS patients compared to PD patients.

# Conclusion

In DYS patients lower ApEn values in the theta band indicate higher energy availability in the lower frequency band, whereas higher ApEn values in the beta and gamma bands indicate lower energy availability compared to those with PD. Entropy-based values may be used as biomarkers to evaluate the effectiveness of treatments and neuromodulation strategies in both PD and DYS.

# P045

Komplikationsrate und Sicherheit der Vagusnervstimulation: 10 Jahre Erfahrung an einem einzelnen Zentrum Complication rate and safety of vagus nerve stimulation: 10 years of experience at a single center

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# Objective

Vagus nerve stimulation (VNS) is a rarely used treatment option for patients with refractory depression undergoing electroconvulsive therapy or treatment refractory epilepsy. The aim of this study was analyze our case series of patients treated with VNS in relation to peri- and postoperative complications.

#### Methods

We assessed 42 patients with 53 VNS surgeries out of which 31 were completely new implantations including the electrodes. The surgeries were performed in a tertiary hospital between June 2015 and November 2024. We retrospectively analyzed intraoperative complications and postoperative morbidity.

#### Results

Of the 42 patients treated, 64.29% were women. Eight patients underwent two or more surgeries during the study period, including several stimulator changes due to depleted batteries. The mean age at the time of surgery was 37.39 years, ranged from 2 to 75 years and included three minors. The median time between the last follow-up and surgery was 25 months. Depression was the most common indication with a total number of 29 implantations compared to 24 procedures in epilepsy patients. The most common intraoperative issue was high impedance measurement, which resulted in the surgeons cleaning the electrodes and readjusting the connection, which was successful in all procedures. Immediate postoperative complications occurred in 5 surgeries (9.4%; hoarseness n=3, unusual pain n=2) that later resolved. Until last follow-up, overall complications have occured after 8 procedures (15.1%). The most common complications were infections, which occurred in three cases (7.1%). Two of these patients required explantation of the system. More specific complications such as swallowing difficulties or an increase in seizure frequency have been observed in two patients each. There were no explantations performed in any of them. In addition there were four patients (9.5%) with unsatisfactory stimulation results.

# Conclusion

In conclusion VNS is a rare but a generally safe procedure with good success rates. Therapy success requires interdisciplinary communication between neurosurgeons, neurologists, psychiatrists and pediatricians.



Abb. 2



# P046

Anwendung der Vagusnervstimulation bei therapieresistenter Depression: Erkenntnisse aus einem vierjährigen nationalen Datensatz

Trends in Vagus Nerve Stimulation for Treatment-Resistant Depression: Insights from a Four-Year National Dataset

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# Objective

Vagus nerve stimulation (VNS) is a surgical option for treatment-resistant depression (TRD) that has not responded to conventional therapies. This study analyses procedure trends and their association with TRD-related diagnoses across German institutions from 2019 to 2022.

# Methods

Using data delivered under § 21 Absatz 3b KHEntgG, procedures were categorized into primary implantation (5-059.c8), electrode replacement (5-059.84), stimulator replacement (5-059.d8), and electrode removal (5-059.a2). Overall procedure volumes and diagnosis-specific trends were evaluated, with a focus on recurrent depressive disorders and severe depressive episodes.

# Results

A total of 519 procedures for depression-related indications were performed over four years. Primary implantations (5-059.c8) contributed 52%-65% of cases annually, declining from 70 in 2019 to 54 in 2022. Revision procedures, including electrode replacements (5-059.84, 28 cases in 2019 to 25 in 2022) and stimulator replacements (5-059.d8, 15 cases in 2019 to 13 in 2022), constituted 35%-40% of the total. Recurrent depressive disorder (F33.2) was the predominant diagnosis, peaking at 60 cases in 2022, followed by severe depressive episodes (F32.2, 6-12 cases annually).

# Conclusion

VNS for TRD demonstrates stable but relatively low utilization compared to its application for epilepsy. Primary implantations constitute the majority of cases, with recurrent depressive disorder as the predominant diagnosis. These findings suggest the need for further investigation into the factors limiting broader adoption of VNS for TRD, including patient access and clinical decision-making processes.

# P047

Verlust an Hirnvolumen in distinkten Arealen entfernt von selektiver Amygdalohippokampektomie durch stereotaktischer Laser- Thermoablation? Distinct brain volume loss in regions distant to selective amygdalohippocampectomy (sAHE) after stereotactical Laser – Thermoablation (sL-TA)?

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# Objective

sL-TA for sAHE has become a minimally invasive alternative to microsurgical sAHE or temporal lobe resection for the treatment of mesial temporal lobe epilepsy (mTLE). Structural long term anatomic network effects have not yet been described.

# Methods

One year after sAHE with sL-TA brain volume of eleven patients was analysed with FastSurfer segmenting T1-weighted data. Additionally, we performed visual ratings and measurements, and analyzed associations with clinical data / outcome.

# Results

The mean postoperative defect size was 1427 ( $\pm$ 517) mm3. Volumetry as well as visual ratings found tendencies for a progressive volume loss after surgery on the language dominant hemisphere in the cingulate cortex ipsilaterally and hippocampus, fusiform and entorhinal cortex, contralaterally. These changes could not be detected for surgery in the non-dominant hemisphere.

# Conclusion

A (partial) ablation of the dominant amygdalohippocampal complex might exert long- term effects on the contralateral hippocampus and temporal cortices. However, we could not observe this effect in the reverse direction. Therefore, the effect might be related to hemispheric dominance. Sequential volumetric studies of larger cohorts should be conducted to investigate these findings and putatively compared to data of age, sex and dominance matched patients after microsurgical sAHE and anterior lobectomy.

# P048

Wechsel von tiefer Hirnstimulation zu Hirnläsionen, drei Jahr Erfahrung nach dem Umzug von Industrie- in Entwicklungsländer.

Shifting from deep brain stimulation to Brain lesioning, 3 years experience after relocation from developed to developing countries.

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# Objective

Brain lesioning though used since the 1950s, had been replaced by DBS in the 1990s. The Author had an experience doing as Assistant and first surgeon more than 300 deep brain stimulation operations in Hannover/ Germany and London Ontario/ Canada from 2009 to 2019. In 2019 the Author relocated to his Homeland Jordan to transfer the functional neurosurgery experience to his country.

# Methods

Due to the financial situation of the public insurance system, the Author shifted from deep brain stimulation operations to the brain lesioning operation using Radiofrequency and Gamma Knife. On 21.07.2022 he performed the first Radiofrequency lesioning. Since then, 62 Radiofrequency Brain lesioning operations have been performed (52 unilateral and 2 bilateral pallidotomy for Parkinson as well as 4 unilateral pallidotomy and 2 bilateral pallidotomy for Dystonia). Brain lesioning using the Gamma Knife Icon have been also performed, 4 unilateral subthalamotomy for Parkinson patient, 1 Thalamotomy for essential tremor, 1 cingulotomy for anxiety disorder and 4 internal capsulotomy for medical intractable obsessive-compulsive disorder (OCD)

# Results

the median Improvement in Radiofrequency and GammaKnife of the Unified Parkinson's Disease Rating Scale (UPDRS) III was 30.1%, significant improvement of the essential tremor patient, 2 patients improved from severe to mild OCD and 2 OCD patients had no improvement. Moderate improvement of dystonia patients, an overall mean improvement of 35% in the BFMDRS-M score was achieved.

# Conclusion

Brain lesioning can be considered as a good treatment option in the developing countries, where deep brain stimulation is not often financially affordable.

# P049

Die Tumor-Nutrophilen-Interaktionen in der Mikroumgebung von Hirnmetastasen verschiedener Primärtumoren The tumor-neutrophil interactions in the microenvironment of brain metastases with different primary sites

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# Objective

Brain metastases (BrMs) are the most common malignancies of the central nervous system. BrMs from lung and breast cancers recruit and prime neutrophils to acquire a tumor-promoting phenotype, but it is unclear if this occurs in BrM with other primary sites. This study investigated the effect of tumor cells isolated from melanoma, lung and gastrointestinal (GI) BrMs on neutrophil biology and function.

# Methods

Tumor cells were isolated from six BrM patients (two melanoma, two lung cancer and two GI cancer BrM). FFPE tumor tissues from 93 BrM patients (24 melanoma, 28 lung cancer and 41 GI cancer BrM) were analyzed by immunohistochemistry and multiplex immunofluorescence to determine the Ki67 proliferation index and the neutrophil infiltration (number of CD66b positive cells) *in situ*. Peripheral blood neutrophils were isolated from healthy donors. Neutrophil chemotaxis was assessed using transwell inserts. Survival assay was performed by flow cytometry using the FITC Annexin V apoptosis detection kit with PI. MMP9 release was measured by gelatin zymography. CXCL8/IL-8, CCL4/MIP-1 $\beta$ , and TNF $\alpha$  levels were determined by ELISA. RNA levels of CXCL8, TNF $\alpha$ , and ceruloplasmin in melanoma, lung, and colorectal primary tumors were analyzed with the "RNA TCGA cancer gene" database.

# Results

Lung and GI cancer BrM SN had a strong chemotactic effect on neutrophils, unlike melanoma-derived SN. Lung and GI cancer cells released much higher levels of CXCL8 compared to melanoma BrM cells. Consistently, BrM tissues from lung and GI cancers had significantly higher numbers of tumor-infiltrating neutrophils than melanoma BrM. Lung and GI cancer SN also prolonged neutrophil survival, and induced higher MMP9 and CCL4 release from neutrophils, unlike melanoma SN. *In situ*, lung and GI cancer BrM showed a higher Ki67 proliferation index compared to melanoma BrM. The Ki67 index significantly correlated with the levels of neutrophil infiltration, which suggests a link between these two biological processes.

# Conclusion

Our study demonstrates that BrM tumor cells recruit neutrophils and stimulate them to acquire tumorpromoting functions. Notably, this phenomenon does not occur in all types of BrM, but seems to be dependent on their histologic origin. Thus, our findings identify variabilities in the immune microenvironment of BrM with different primary sites, which may ultimately affect their pathophysiology and progression.





# P050

Lungenkrebs-Hirnmetastasen und die Rolle von Gamma-Aminobuttersäure (GABA) im Tumormikromilieu Lung Cancer Brain Metastases and the Role of Gamma-aminobutyric acid (GABA) in the Tumor Microenvironment

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<sup>1</sup>Philipps Universität Marburg, Marburg, Deutschland

# Objective

Brain metastases are the most common malignant brain tumors in adults, with lung cancer as a leading cause. Gamma-aminobutyric acid (GABA), originally defined as a neurotransmitter, is emerging as an essential factor with additional functions in tumor biology and the immune system. This study investigates the GABAergic system in lung cancer brain metastases, focusing on its expression in metastatic tissues and cell lines (A549 and H1299) and the effects of GABA on cellular behavior.

# Methods

qPCR and Western Blot assessed the expression of GABA-A and GABA-B receptors, GABA transporters (GAT1, GAT3), and metabolites (GAD1, GPT2) and ß-Catenin in brain metastasis tissue samples from 20 lung cancer patients. A549 and H1299 cells were cultured with GABA (0–2 mM), and GABAergic and tumor progression markers and invasion, proliferation, and migration were analyzed.

#### Results

qPCR and Western Blot analysis showed low, similar GABA-B receptor expression in A549 and H1299 cells, but their responses to GABA differed. In A549 cells, GABA treatment upregulated  $\beta$ -catenin, correlating with significant (p < 0.05) increases in proliferation (up to 93 %) and migration (up to 200 %). In contrast, H1299 cells showed stable  $\beta$ -catenin levels and significantly (p < 0.05) reduced proliferation (up to 160 %) and migration (up to 140 %) upon GABA exposure. Brain metastasis tissues express GABA-B receptors, unlike A549 and H1299 cells, suggesting that metastatic cells can adapt to the GABA-rich brain microenvironment. Additionally, A549 cells responded to GABA even without GABA receptors or transporters, indicating alternative pathways for GABA effects. The elevated GABA-B receptor expression in brain metastases likely reflects an adaptation favoring survival within the brain environment.

# Conclusion

This study supports the idea that GABA-B receptor expression drives cell growth. Despite low or undetectable GABA-B levels in A549 and H1299 cells, their responses to GABA differ, suggesting that GABA-B upregulation is a late-stage adaptation. Brain metastasis tissues, however, express both GABA-B receptors and transporters, indicating adaptation to the GABA-rich brain environment. These findings call for further research to explore why cells develop GABA-B receptors in the brain adaptation of metastatic cells and how this affects cell behavior.

# P051

Resektion eloquenter Gehirnmetastasen mit intraoperativer Radiotherapie versus adjuvanter Radiotherapie: Eine Bewertung der Durchführbarkeit und Sicherheit. Surgical Resection with Intraoperative Radiotherapy versus Adjuvant Radiotherapy for the Treatment of Eloquent Brain Metastases: An Assessment of Feasibility and Safety.

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<sup>1</sup>Universitätsklinikum Augsburg, Neurochirurgie, Augsburg, Deutschland <sup>2</sup>Universitätsklinikum Augsburg, Strahlentherapie, Augsburg, Deutschland <sup>3</sup>Medizinische Universität Lausitz - Carl Thiem, Neurochirurgie, Cottbus, Deutschland

# Objective

The management of motor eloquent brain metastases (BMs) presents the risk of neurological deficits due to potential damage to the motor cortex and tracts. Maintaining optimal functional and neurological status is essential for enabling comprehensive oncological treatment. Emerging evidence suggests that intraoperative radiotherapy (IORT) utilizing low-voltage X-rays may serve as an alternative to adjuvant external beam radiotherapy (EBRT). The aim of this study was to assess the safety and feasibility of combining surgery with IORT in motor eloquent regions, as compared to adjuvant radiotherapy (RT).

# Methods

We conducted a retrospective chart review of patients who underwent surgery for motor eloquent BMs at our institution, receiving either IORT or adjuvant RT. All surgeries were performed under intraoperative neuromonitoring (IONM). We compared patient demographics, rates of neurological deficits, IONM parameters, functional status (Karnofsky Performance Status, KPS), and adverse events (AEs) between the two groups.

# Results

A total of 33 patients were included in the analysis, with 25 undergoing IORT and 8 receiving adjuvant EBRT for motor eloquent BMs. New motor deficits developed in 7 of 33 patients, with no significant difference between the two groups at 30 days post-surgery (IORT: 4/25 vs. adjuvant RT: 3/8; Chi-square test: p = 0.19). The KPS following surgery did not differ significantly between the groups (IORT: 90% [72.5–90] vs. adjuvant RT: 80% [70–90]; Mann-Whitney U-test: p = 0.31). No patient experienced local tumor recurrence or radionecrosis. Nine patients (9/33) experienced postoperative AEs within the 30-day follow-up, with no significant differences between the two groups (IORT: 5/25 vs. adjuvant RT: 4/8; Chi-square test: p = 0.09).

# Conclusion

50 kV photon IORT is a safe treatment option for motor eloquent BMs and does not appear to provoke symptomatic brain irritation.

# P053

# Single Center Analyse bei Lungenkrebs Hirnmetastasen Single-center analysis of brain metastasis in lung cancer

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<sup>1</sup>Universitätsklinikum Marburg, Klinik für Neurochirurgie, Marburg, Deutschland

# Objective

Bronchial carcinomas are the most common type of cancer and cause of death worldwide. Brain metastases frequently occur in advanced bronchial carcinoma and often cause the first symptoms of the tumor. Therefore, this study aims to analyze the clinical features, treatment strategies, and prognostic factors associated with the overall survival of the selected patient cohort and to identify factors that influence the respective outcomes of the patients.

#### Methods

We retrospectively analyzed ninety-four consecutive patients with brain metastasis caused by lung cancer who received surgery for brain metastasis. Comprehensive clinical, demographic, and pathological features were extracted from the patient"s records.

#### Results

Forty-seven (50%) of the patients analyzed were female. Median age at surgery was 61.02 years (IQR 13.41). Eighty-four (89.36%) were diagnosed with non-small-cell lung cancer, and ten patients (10.64%) had small-cell lung cancer. Fifty-three (51.96%) are diagnosed synchronous to lung cancer. The median overall survival after the primary diagnosis was 513 days (IQR 1437), while the median overall survival after the resection of the brain metastasis was 236 days (IQR 504). Kaplan-Meier"s survival estimations revealed a significant difference between synchronous and metachronous diagnosis (p = 0.009). Poor (<80) preoperative Karnofsky Performance Index (p<0.001), infratentorial tumor localization (p=0.006), and extracerebral metastasis (p=0.004) had a significant impact on postoperative survival. Meanwhile, postoperative targeted therapy (Tyrosine kinase inhibitors p=0.807 and immunotherapy p=0.98) and radiotherapy (p =0.079) did not significantly influence the overall survival in this cohort.

#### Conclusion

Time of diagnosis, clinical condition, extracerebral metastasis, and tumor localization are crucial for survival. Targeted therapy and radiotherapy after resection of brain metastases slightly missed significance in our cohort. We were also able to prove the significant impact of extracerebral metastasis on survival occurring at the time of brain surgery. These findings suggest that a delayed initial diagnosis of lung cancer is associated with poor overall survival, irrespective of whether postoperative treatment was administered following brain metastasis surgery.

# P054

Bedeutung des Hormonrezeptor- und Menopausenstatus bei Patientinnen mit Hirnmetastasen bei Mammakarzinom

Relevance of hormonal receptor and menopausal status in patients with breast cancer brain metastases

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# Objective

Brain metastasis (BM) is a frequent complication of breast cancer (BC), often requiring neurosurgical intervention for symptom relief and disease control. Hormonal receptor status can significantly influence the clinical course and outcomes of these patients, particularly when considered alongside menopausal status. This study aimed to evaluate differences in treatment-relevant clinical characteristics and surgical outcomes between premenopausal and postmenopausal BC patients with BM who underwent neurosurgical treatment.

# Methods

This retrospective cohort study included patients with histologically confirmed breast cancer brain metastases (BCBM) who underwent surgical treatment at a single neurosurgical center. According to the age at BC diagnosis, patients were categorized into premenopausal (<50 years) and postmenopausal (≥50 years) groups. Clinical data, systemic disease characteristics, and postoperative outcomes were collected and analyzed. Kaplan-Meier survival analysis and Cox proportional hazards models were employed to identify factors associated with overall survival.

# Results

A total of 93 patients were included in the study, comprising 38 premenopausal and 55 postmenopausal individuals. Premenopausal patients were younger at the time of BM diagnosis (median age: 51 vs. 67 years, p<0.001). Time intervals between BC and BM diagnoses were 53 and 40 months in premenopausal and postmenopausal groups, respectively (p=0.246). The median overall survival following BCBM surgery was 24 months in premenopausal patients compared to 14 months in postmenopausal patients (p=0.124). Multivariate analysis revealed that a Karnofsky Performance Status  $\geq$ 80% (p=0.019, adjusted hazard ratio [aHR] 8.53, 95% CI 1.43–50.82) and receptor conversion in BM (p=0.031, aHR 3.13, 95% CI 1.11–8.79) were independent predictors of survival in premenopausal patients. Conversely, in postmenopausal patients, Trastuzumab treatment (p=0.050, aHR 2.39, 95% CI 1.00–5.70) and consistent HER2 receptor status (p=0.003, aHR 7.24, 95% CI 1.99–26.36) emerged as significant prognostic factors.

# Conclusion

Hormonal receptor status and menopausal status are pivotal in determining outcome-relevant clinical characteristics and significantly influence the prognosis of BCBM patients following neurosurgical intervention. These findings highlight the need for further research in larger pooled patient samples to develop personalized therapeutic strategies tailored to these variables.

# P055

Die Rolle der Neurochirurgie bei Patienten mit multiplen- und einzelnen Hirnmetastasen: eine retrospektive Analyse von 140 Fällen.

The role of neurosurgery in patients with multiple and single brain metastasis: a retrospective analysis of 140 cases.

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# Objective

Since cancer therapies improve outcomes, patients live longer, and the incidence of brain metastases (BM) increases. The role of neurosurgery remains controversial, particularly in the case of multiple metastases. This study evaluates the survival of patients with single (SBM) and multiple (MBM) brain metastasis.

# Methods

140 patients suffering from BM treated with surgery and radiotherapy between 2006-2017 were retrospectively analyzed. 26 patients could not be followed. Indications for surgery in the remaining 114 patients were tissue diagnosis, neurological deficit, edema, CSF obstruction, and intratumoral hemorrhage. Survival times of patients with SBM (n=70) and MBM (n=44), improvement of neurological deficit, morbidity and mortality were evaluated.

# Results

There was no significant difference between the median survival times (MST) of SBM (8,5 months) vs. MBM (8 months). Lung cancer patients had a longer MST than breast cancer Patients (p = 0,049). MBM patients with lung cancer lived longer than breast cancer (p=0.026). Melanoma caused more MBM (p=0.025). We observed an improvement in neurological deficit in SBM group of 97%, and MBM group in 87% of the cases. The mortality rate was 1,7 % (n=2) and the morbidity rate was 11 % (n=13).

# Conclusion

Neurosurgery can increase survival times and improve quality of life, not only in patients with SBM, but also can be considered in MBM.

#### The role of neurosurgery in patients with multiple and single brain metastasis: a retrospective analysis of 140 cases

#### Objective

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#### Conclusion

Neurosurgery can increase survival times and improve quality of life, not only in patients with SBM, but also can be considered in MBM.

# P056

Auswirkungen des Resektionsausmaßes auf lokale Rezidive bei Hirnmetastasen: Ergebnisse einer prospektiven Studie

#### Impact of Extent of Resection on Local Recurrence in Brain Metastasis: Findings from a Prospective Study

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#### Objective

Recent retrospective studies have examined the impact of the extent of resection (EOR) in brain metastasis surgeries on patient survival. Subtotal resections may pose a risk for local recurrence despite adjuvant radiotherapy, but there is a lack of prospective data supporting the benefits of extensive resections. This prospective observational study aimed to identify risk factors and timing of local recurrence (LR), and determine the optimal duration and frequency of follow-up, while considering the practical implications of follow-up protocols on healthcare resources.

#### Methods

We conducted a prospective observational study involving 150 patients who underwent resection of brain metastases between November 2020 and November 2021. Over three years, patients received follow-up assessments every three months, which included MRI scans, physical examinations, and therapeutic monitoring, with data collected on LR, disease progression and treatment interventions for local recurrences (LR). Multivariate analysis and Kaplan-Meier analyses were utilized to investigate the impact of EOR on the incidence of LR.

# Results

A total of 149 patients(74 women;mean age 61 years)were included(1 lost to follow-up).Gross total resection was achieved in 80.6% of cases. The most common entities were bronchial carcinoma(61;41%),breast carcinoma(27;18%)and malignant melanoma(19;13%).Ninety-five(63%)had singular metastasis,40(27%)oligometastasis(2-4 metastases),and 15(10%)multiple metastases(>4).The overall LR incidence was 18.9%(28),occurring less frequently in GTR(16%)than STR(28%)(Log-rank p=0.004).In total,95(63.5%)received postoperative radiation,10(7%)pre-/intraoperative radiation,and 44(29.5%)were not irradiated(mostly due to death or poor condition).Median time to LR was 12 months[CI 95% 8.2-15.6],15 months[CI 95% 10.8-19.2]for GTR,6 months[CI 95% 3.2-8.8]for STR.Within six months post-surgery,47(31.5%)had died,and of the remaining 102,23(22.5%)developed LR.Besides EOR,only preoperative tumor volume(OR 1.38 per 10ml,p=0.036)and melanoma histology(OR 0.00,p=0.009)were risk factors for LR.Of those with LR,86%received interventions:new systemic therapy(12;44.4%),radiation(RT)(10;37%),and re-resection(7;25.9%).

# Conclusion

Patients with brain metastases who underwent GTR had a significantly lower risk of LR compared to those with STR. Postoperative MRI is essential for early disease progression detection. We recommend MRI follow-up every three months for at least 15 months to ensure timely LR identification.

# P057

# Chirurgische Tumorvolumenreduktion bei Patienten mit Hirnmetastasen: eine systematische Review und Meta-Analyse

#### Surgical tumor volume reduction in patients with brain metastases: a systematic review and meta-analysis

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#### Objective

Microsurgical resection of brain metastases (BM) has traditionally been a mainstay of local control for large or symptomatic lesions. Maximal tumor burden reduction remains controversial in the multidisciplinary management of BM patients and needs to be re-evaluated in view of new systemic treatment options. We conducted a systematic review and meta-analysis to evaluate the role of extent of resection (EOR)/residual volume (RV) for progression-free (PFS) and overall survival (OS) in patients with BM.

#### Methods

A systematic review was performed according to PRISMA guidelines and quality of included studies was assessed with GRADE tool. Study characteristics were tabulated and critically reviewed. Results from Cox -regression models and log-rank tests for the association of gross total resection (GTR) versus subtotal resection (STR) with PFS and OS were extracted to perform separate random-effects meta-analyses.

# Results

Thirty-nine articles were included. All included studies were retrospective and all but 3 monocentric. Most studies included BM from heterogenous primary tumors, with 9 focusing on BM from a single primary. Systemic therapies were variably reported and only two studies reported on the use of steroids. Twenty-one studies showed a significant association of EOR/RV with improved OS. Meta-analysis of studies reporting multivariable Cox regression models (n=11) showed a significant association of GTR with longer OS (HR 0.67, 95% CI 0.56-0.81, p<0.001). Separate meta-analyses run for univariable cox regression and log-rank tests were also significant (Figure 1). Of the 12 studies reporting an association of EOR on PFS, only 6 could be pooled and included for quantitative analysis. 3 studies performed multivariable and 3 studies reported univariable Cox regression and were thus pooled in separate meta-analyses. Only the former found a significant association of GTR with PFS (HR 0.21, 95% CI 0.12-0.37, p<0.001, Figure 2).

# Conclusion

Although in several studies higher EOR/lower RV was associated with improved OS and PFS, evidence consists of heterogeneous cohorts and rarely includes primary tumor-specific systemic therapies or relevant confounding covariates. New studies are needed to elucidate the role of microsurgical tumor burden reduction in BM patients in the era of targeted or immune modulatory therapies.

А							
	Study	logHR	SE(logHR)	Random Effects Model	HR	95%-CI	Weight
	Baumgart 2023	-0.6408	0.2502	— <u> </u>	0.53	[0.32; 0.86]	7.4%
	Lin et al 2023	-0.4642	0.2055		0.63	[0.42; 0.94]	8.9%
	Grossenbacher 2023	-0.4700	0.1882		0.62	[0.43; 0.90]	9.6%
	Aftahy 2022	-0.0178	0.0061		0.98	[0.97; 0.99]	15.8%
	Winther 2022	-0.4155	0.1362		0.66	[0.51; 0.86]	11.8%
	Prabhu 2021	-0.8440	0.3082 -		0.43	[0.24; 0.79]	5.8%
	Eitz 2020	-0.1740	0.1480	+ =+	0.84	[0.63; 1.12]	11.3%
	Calluaud 2019	-0.8074	0.2433		0.45	[0.28; 0.72]	7.6%
	Lee 2013	-0.5158	0.2364		0.60	[0.38; 0.95]	7.8%
	Hong 2013	0.4187	0.4008		1.52	[0.69; 3.33]	4.0%
	Rades 2007	-0.5878	0.1798		0.56	[0.39; 0.79]	9.9%
	Random effects mode	I		·	0.67	[0.56; 0.81]	100.0%
				0.5 1 2			
	Heterogeneity: $I^2 = 83\%$ , 1	$t^2 = 0.0550$	p < 0.01	Log Hazard Ratio			
			, <b>p</b> = = = = =				
В	Study	logHR	SE(logHR)	Random Effects Model	HR	95%-CI	Weight
	Sauvageot 2024	-0.8502	0.2185 -	— <b>—</b> :	0.43	[0.28; 0.66]	13.0%
	Baumgart 2023	-0.0247	0.0112		0.98	[0.95; 1.00]	24.1%
	Sander 2022	-0.0296	0.4712		0.97	[0.39; 2.44]	4.8%
	Winther 2022	-0.4005	0.1205		0.67	[0.53; 0.85]	19.1%
	Shah 2021	-0.4955	0.3908 -		0.61	[0.28; 1.31]	6.4%
	Koo 2021	0.0000	0.3728		1.00	[0.48; 2.08]	6.9%
	Eitz 2020	-0.3577	0.1303		0.70	[0.54; 0.90]	18.5%
	Hong 2013	0.0198	0.3624		1.02	[0.50; 2.08]	7.2%
	Random effects model				0.75	[0.60: 0.94]	100.0%
	Kandom enects model						
				0.5 1 2			
	Heterogeneity: $I^2$ = 78%, $\tau^2$ = 0.0553, $p$ < 0.01			Log Hazard Ratio			
С	Study	logHR	SE(logHR)	Random Effects Model	HR	95%-CI	Weight
	McHugh 2020	-0.6607	0 2530	<u> </u>	0.52	[0.31.0.85]	7 5%
	Olesrud 2019	-0 7621	0.0493		0.02	[0.01, 0.00]	18.2%
	She 2019	-0.3704	0 1847		0.69	[0.48: 0.99]	10.5%
	Rava 2016	-0.2877	0.2210		0.75	[0.49: 1.16]	8.8%
	Gazzeri 2014	-1.0296	0.2756 -		0.36	[0.21; 0.61]	6.8%
	Lee 2013	-0.3008	0.1863		0.74	[0.51: 1.07]	10.4%
	Shackert 2013	-0.6030	0.2199		0.55	[0.36; 0.84]	8.9%
	Shackert 2013	-0.8383	0.2477		0.43	[0.27; 0.70]	7.7%
	Limbrick 2009	-0.2231	0.6455	*	0.80	[0.23; 2.83]	1.7%
	Tendulkar 2006	-0.1975	0.1510		0.82	[0.61; 1.10]	12.4%
	Bindal 1993	-0.8473	0.2679		0.43	[0.25; 0.72]	7.0%
	Random effects mode	I		÷	0.57	[0.48; 0.68]	100.0%
			0.5 1 2				
	Heterogeneity: $I^2 = 62\%$ , a	$t^2 = 0.0410$	p < 0.01	Log Hazard Ratio			

A	Study	logHR SI	E(logHR)	Random Effects Model	HR	95%-CI	Weight
	Koo 2021	-1.2379	0.4997		0.29	[0.11; 0.77]	22.9%
	Prabhu 2011	-2.2073	0.4302 -		0.11	[0.05; 0.26]	28.1%
	Rades 2007	-1.3324	0.2494		0.26	[0.16; 0.43]	49.0%
	Random effects mo	del		, <b>↓</b> , , , , , , , , , , , , , , , , , , ,	0.21	[0.12; 0.37]	100.0%
	Heterogeneity: $I^2 = 42$	%, τ <sup>2</sup> = 0.1027, <i>p</i>	= 0.18	0.1 0.5 1 2 10 Log Hazard Ratio			
в	Study	logHR SI	E(logHR)	Random Effects Model	HR	95%-CI	Weight
	Sauvageot 2024	-0.0677	0.1937	<del>; , , , , , , , , , , , , , , , , , , ,</del>	0.93	[0.64; 1.37]	43.9%
	Eitz 2020	-0.4121	0.2354		0.66	[0.42; 1.05]	39.1%
	Koo 2021	-1.2040	0.5155 -		0.30	[0.11; 0.82]	17.0%
	Random effects mo	del			0.67	[0.41; 1.10]	100.0%
	Heterogeneity: $l^2 = 58^{\circ}$	$(5 + 7^2 = 0.1071)$ n	= 0.09	0.2 0.5 1 2 5			
	rictorogeneity. 7 = 50	(1, 1, 2) = 0.1071, p	0.00	Log Hazara Kado			

# P058

# Thrombozytenhemmung verzögert zerebrale Metastasierung bei nicht-kleinzelligem Lungenkrebs Platelet inhibition delays cerebral metastasis in non-small cell lung cancer

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# Objective

An inverse association between the use of platelet inhibitors and the risk of cancer has been reported by numerous epidemiological studies in the past. The effects of antiplatelet agents on the cerebral metastasis formation of non-small cell lung cancer (NSCLC) are largely unknown. We therefore, investigated the effect of platelet inhibition in NSCLC patients at the time of the first diagnosis of cerebral metastases.

# Methods

We investigated the clinical course of 417 NSCLC patients with cerebral metastases who underwent craniotomy for metastasis resection during the course of their disease. The presence of platelet inhibition prior to cerebral metastases diagnosis was used to dichotomize the cohort. Relevant clinical parameters, including time to cerebral metastasis formation, overall survival, and the incidence of intracranial hemorrhage or hemorrhagic transformation of metastases, were compared between the two groups

# Results

The presence of platelet inhibitor intake significantly prolonged time to cerebral metastasis in non-small cell lung cancer 63 vs. 47 months; (p = 0.001). Furthermore, platelet inhibitor intake was also associated with an increased overall survival of 12 vs. 11 months (p=0.02). Statistically, no increased risk of hemorrhagic transformation of the metastasis or intracranial hemorrhage was found (p=0.635 and p=1.000), respectively.

# Conclusion

While the use of platelet inhibitors did not show an increased risk of intracranial hemorrhage, the use of platelet inhibitors resulted in delayed cerebral metastasis and better survival in NSCLC patients.



# P059

Untersuchung der TIGIT/CD226 Achse in Melanom Hirnmetastasen Exploring the TIGIT/CD226 axis in melanoma brain metastasis

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# Objective

TIGIT and CD226, immune checkpoints, are expressed on T/ NK cells, and modulate the T-cell functional activity. TIGIT functions as an inhibitory receptor, while CD226 acts as an activating receptor(Samanta et al., 2015, Chiang et al., 2022). Study"s show that TIGIT is overexpressed and CD226 is downregulated in metastatic melanoma (Chauvin et al., 2015). Below, we analyze TIGIT and CD226 expression in brain melanoma metastasis patients based on their therapy.

# Methods

Patient samples were collected during surgery and frozen with liquid nitrogen. They were divided based on their treatment: no therapy, gene therapy, interferon and immunotherapy. Quantitative real-time PCR was used to determine the expression of TIGIT, CD226. All genes expressions were levelled with  $\beta$ -Actin. Statistical analysis was performed using GraphPad Prism.

# Results

Figure 1 shows higher CD226 expression in patients who received gene therapy compared to those who did not (3.155 vs 0.584, p=0.0382). The expression of TIGIT is comparable to that of CD226, but is not significant. In a summary plot both checkpoint markers CD226 (1.511 vs 0.584, p=0.0301) and TIGIT (4.509 vs 1.799, p=0.0161) show a significant higher expression in patients who received therapy compared to those who did not (Figure 2).

# Conclusion

Both TIGIT and CD226 show an increased expression in patients who were treated throughout the disease compared to those who have not. Especially those who were treated with gene therapy see a higher expression trend.



Figure 1: mRNA expression levels of TIGIT and CD226 in melanoma metastasis according to their received treatment. The columns determine the mean value and standard error of the mean. Significance is not received with asterisks for the following P value: \* p < 0.05.



Figure 2: mRNA expression levels of TIGIT and CD226 in melanoma metastasis according to their received treatment. The columns determine the mean value and standard error of the mean. Significance is portraved with asterisks for the following P value: \* p<0.05.

# P060

# Auswirkungen anderer Krebsarten bei Patienten mit neu diagnostiziertem Glioblastom Impact of other cancers in patients with newly diagnosed glioblastoma

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#### Objective

Patients afflicted with various forms of cancer in different organs have a poor prognosis and a limited survival time. However, the consequences of the presence of other cancers in patients with glioblastoma (GBM) are not well understood. The aim of this study was to investigate the impact of other cancers in patients with newly diagnosed GBM.

#### Methods

A total of 190 adult patients with newly diagnosed GBM who were treated at our university hospital over the past decade were included in the study. Among these patients, 19 (12 men and 7 women) also had cancer in other organs. The clinical characteristics, disease progression, and treatment outcomes of these patients were evaluated and compared with those of GBM patients without other cancers.

# Results

Cancer of another organ was diagnosed and treated in 16 patients between 4 months and 27 years before GBM diagnosis, and in 3 patients between 3 months and 3 years after GBM diagnosis. The origin of the cancer was gastrointestinal tract (n = 4), genitourinary tract (n = 5), breast (n = 4), skin (n = 5) and hematopoietic system (n = 1). Patients with both GBM and other cancers were older (mean age 72 vs. 65 years) and had a longer progression-free interval after the first surgical resection (14 months vs. 9 months) compared to patients with GBM alone. Overall survival was higher in patients with other cancers (21 months vs. 12 months). The 2-year survival rate was 15.8% for patients with other cancers, while the 5-year rate was 10.5%. In contrast, only 8.2% of patients with GBM only achieved a 2-year survival rate, and only 0.6% achieved a 5-year survival rate. At the last follow-up, 2 GBM patients with other cancers and 7 GBM-only patients were still alive.

#### Conclusion

Notwithstanding their advanced age and presumably less favorable prognosis, patients with both GBM and other cancer have surprisingly better survival rates compared to patients with only GBM.

# Wirbelsäule 1 | Spine 1

# P061

Chirurgische Versorgungs-Standards von Wirbelsäulenläsionen bei Multiplem Myelom – Ergebnisse einer internationalen Umfrage aus dem AO Spine Knowledge Forum Tumor. Surgical management of Multiple Myeloma vertebral column lesions – Results from an international survey distributed to the AO Spine Knowledge Forum Tumor.

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# Objective

Vertebral fractures and epidural infiltration are common complications in Multiple Myeloma (MM), causing vertebral pain and neurological deficits. Non-surgical management is universally preferred due to poor bone quality and fear of surgical complications in immunocompromised patients, while internationally accepted guidelines are lacking. The aim of this study was to assess the current international treatment standards and clinical conditions guiding surgical decision-making in MM vertebral lesions.

# Methods

A survey was distributed to the members of the AO Spine Knowledge Forum Tumor, an international, interdisciplinary expert forum specialized on the treatment of oncologic spine disease. The survey consisted of 25 questions, of which 15 assessed the participant's background, clinical expertise, and experienced treatment standards regarding MM vertebral lesions, followed by ten case examples with seven possible treatment scenarios each. The survey distribution was supported by AO Spine, and facilitated via a REDCap® database.

# Results

51 international experts, originating from 14 countries and five continents completed the survey, with 51% being of orthopedic, and 44% of neurosurgical background, while 6% were radio-oncologists. 87% of the participants were university-associated, and 96% part of interdisciplinary cancer centers. 84% of the participants stated that they "see vertebral lesions in MM in general as a non-surgical disease". As strongest indicators to nonetheless perform surgery, neurological deficits (74%), and potentially unstable lesions (20%) were chosen. As surgical scores, the SINS (85%), and Bilsky (70%) scores were most frequently named. Clinical and radiolocal follow-up is performed by 83%, mostly by MRI (62%), however only in 46% at defined intervals. Universally, 89% would chose "less invasive" surgical strategies in MM than in similar lesions related to metastatic spine disease.

# Conclusion

The results of this international survey display the current international treatment standards for MM vertebral column lesions. While the participating experts agreed towards a more restrained and less invasive management of MM patients, the applicability of surgical scores, standards for clinical and radiological follow-up, and indications as well as surgical strategies for MM vertebral lesions varied widely, illustrating the need for international guidelines standardizing treatment.

# Wirbelsäule 1 | Spine 1

# P062

Knochenmineraldichte als potenzieller individueller prognostischer Biomarker bei Patienten mit chirurgisch behandelten Wirbelsäulenmetastasen

Bone mineral density as potential individual prognostic biomarker in patients with surgically treated spinal metastasis

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#### Objective

Bone mineral density (BMD) plays a crucial role in diagnosing and treating various systemic chronic diseases. Patients with spinal metastasis (SM) are typically in advanced stages of systemic cancer, often leading to significant alterations in BMD. The present study investigated the prognostic value of perioperative Hounsfield units (HU) as a surrogate marker for estimated BMD in patients with SM after surgical treatment (ST).

#### Methods

HU values, serving as a surrogate for estimated BMD, were measured from circular regions of interest (ROIs) in the first lumbar vertebra (L1) from routine preoperative staging computed tomography (CT) scans in 187 patients after ST. The estimated BMD was stratified into pathologic and physiologic values and correlated with survival parameters in our cohorts.

#### Results

Median L1 BMD of 92 patients (49%) with pathologic BMD was 79.5 Hounsfield units (HU) (IQR 67.25-93.5) compared to 145 (IQR 123-166) for 95 patients (51%) with physiologic BMD ( $p\leq0.001$ ). Patients with pathological BMD exhibited a median overall survival of 8 months compared to 12.2 months in patients with physiologic BMD (p=0.006). Multivariable analysis revealed pathologic BMD as an independent prognostic predictor for increased 1 year mortality (AUC: 0.637, 95% CI: 0.556–0.718; p=0.001).

# Conclusion

The present study demonstrates that decreased perioperative BMD values, as derived from HU measurements, may represent a previously unrecognized negative prognostic factor in patients of SM after ST. The estimated perioperative BMD could emerge as a highly individualized, readily available potential biomarker for prognostic assessment, treatment guidance, and discussion of affected patients with SM.







# Wirbelsäule 1 | Spine 1

# P064

3D-VR-Modelle können bei der Planung der chirurgischen Strategie und der Bewertung der postoperativen Ergebnisse bei monosegmentaler unilateraler zervikaler Foramenstenose hilfreich sein 3D VR models can be helpful in the planning of surgical strategy and the evaluation of postoperative results for monosegmental unilateral cervical foraminal stenosis

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# Objective

Foraminal cervical nerve root compression can be caused by lateral disk herniation or osteophyte formation of the vertebrae. Improved diagnosis and evaluation can be achieved using different imaging techniques: radiographs, computed tomography (CT), and magnetic resonance imaging. We retrospectively evaluated the potential influence of a virtual reality (VR) visualization technique on surgery planning and evaluation of postoperative results in patients with monosegmental, unilateral osseous cervical neuroforaminal stenosis.

# Methods

Seventy-three patients were included. Ventral decompression of the neuroforamen was performed in 41 patients, dorsal decompression in 32 patients. Patients" files were evaluated. CT scans were visualized via VR software to measure the smallest cross-sectional area of the intervertebral neuroforamen in the lateral resection region. A questionnaire evaluated the influence of VR technique on surgical planning and strategy.

# Results

The VR-technique had a moderate influence on the choice of the approach (ventral or dorsal), a significant influence on the ventral approach strategy, and no influence on the positioning of the patient or the dorsal approach strategy. A significant difference was found in the size of the smallest cross-sectional area of the intervertebral neuroforamen in the lateral resection region between ventral and dorsal approaches, with no correlation to the clinical outcome.

# Conclusion

Reconstruction of pre- and postoperative 2D-CT images of the cervical spine into 3D images, and the spatial and anatomical reconstructions in VR models, can be helpful in planning surgical approaches and treatment strategies for patients with cervical foraminal stenoses, and for evaluation of their postoperative results.



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### P065

Bewertung von Adipositas als Risikofaktor bei lumbalen Bandscheibenoperationen anhand von Simulationen auf 3D-gedruckten Modellen Assessment of Obesity as a Risk Factor in Lumbar Disc Surgery Through Simulations on 3D-Printed Models

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### Objective

Obesity is often seen as a risk factor for surgery, affecting both the procedure and postoperative recovery. Given the rising prevalence of obesity and the high frequency of lumbar disc surgeries, accurately evaluating these risks is crucial. A prolonged operation time is frequently identified as a potential risk factor.

### Methods

To investigate the relationship between obesity and surgical duration in lumbar disc prolapse surgery, a retrospective analysis was conducted. The body mass index (BMI) of patients with monosegmental disc herniation was correlated with operation times. Postoperative complications, including bleeding, wound healing disorders, and length of hospital stay, were recorded. Additionally, simulated surgeries on 3D-printed anatomical models with varying degrees of obesity were performed to assess operation times and the suitability of surgical instruments in geometrically challenging conditions.

#### Results

Of 598 patients meeting inclusion criteria, 438 had a BMI < 30, and 160 had a BMI  $\ge$  30. Complication rates did not differ significantly between these groups. Linear regression analysis revealed no clear dependency of operation time on BMI in either group (R<sup>2</sup> = 0.039 for BMI < 30; R<sup>2</sup> = 0.059 for BMI  $\ge$  30). However, in simulated surgeries, operation times increased significantly with higher obesity levels. This increase was attributed to geometric challenges posed by standard surgical instruments, which were less effective in models representing higher BMIs.

### Conclusion

In clinical settings, factors beyond obesity, such as the operated spinal segment, orientation of the disc herniation, and surgeon performance, obscure a direct link between BMI and surgical duration. Nevertheless, in controlled simulations with reduced variables, obesity's impact, particularly due to limitations of standard instruments, became evident. These findings underscore the need for optimized surgical tools tailored for obese patients to improve outcomes and efficiency in lumbar disc surgeries.

Abb. 1



### P066

### Der Einfluss des Mikroorganismus auf das Ausmaß struktureller Schäden bei pyogenen Wirbelsäuleninfektionen The impact of pathogen species on the extent of structural damage in pyogenic spinal infections

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#### Objective

The progression of structural and deformity-related complications in pyogenic spinal infections remains a critical challenge. Understanding the impact of specific pathogens on vertebral destruction, deformity progression, and clinical outcomes is essential for optimizing management strategies.

### Methods

This retrospective study evaluated the associations between specific pathogens and structural compromise, assessed using MRI at baseline and follow-up. Data were extracted from a cohort of conservatively treated patients with either microbiologically or histologically confirmed pyogenic spinal infections. Correlation analyses and univariate regression models were performed to identify significant predictors.

### Results

Pathogens were identified in 45 cases (76.3%), while no pathogen was identified in 14 cases (23.7%). Among the pathogen-positive cases, the most common pathogens were Methicillin-sensitive Staphylococcus aureus (MSSA) in 17 cases (28.8%), Streptococcus spp. in 13 cases (22.0%), enteric bacteria in 7 cases (11.9%), and skin commensals in 4 cases (6.8%). Bony erosion was observed in 81.4% of cases, and vertebral body edema exceeding 50% was noted in 88.1%. Vertebral body destruction affected 20.3% of patients with less than 50% involvement and 30.5% with more than 50% destruction. Epidural abscesses were present in 54.2% of patients. Regression analyses revealed that MSSA was significantly associated with a higher likelihood of vertebral body destruction exceeding 50% at baseline (OR 4.13, 95% CI 1.24–13.75, p = 0.021) and vertebral fractures at follow-up (OR 7.09, 95% CI 1.52–33.04, p = 0.013). Enteric bacteria were strongly associated with progressive segmental kyphosis exceeding 20 degrees at follow-up (OR 12.35, 95% CI 1.38–110.92, p = 0.025).

### Conclusion

MSSA and enteric bacteria were identified as key contributors to significant structural damage in affected spinal segments, both at baseline and throughout the disease course. Further studies in larger cohorts, incorporating diverse management strategies, are needed to determine the necessity and potential benefits of pathogen-specific tailored treatment approaches.

### P067

Primäre spinale Tumoren: Identifikation von Risikofaktoren für schlechtere Outcomes und Umdenken agressiver Therapie-Strategien Primary Spine Tumors: Identifying Risk Factors for Poor Outcomes and Rethinking Aggressive Treatment Strategies

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### Objective

Primary bone tumors of the spine (PBTs)represent a diverse group of pathologies with varying prognoses. While aggressive surgical and oncological treatments have historically been favored, increasing evidence highlights their potential for significant morbidity, especially in patients with poor prognostic factors. This has led to growing criticism of overly aggressive treatment strategies in certain cases. This study aims to identify clinical, pathological, and treatment-related factors associated with poor outcomes in patients with primary spine tumors.

### Methods

We conducted a retrospective analysis of patients diagnosed with primary spine tumors, evaluating variables such as tumor histology, extent of disease, functional status, and treatment modalities. Outcome measures included overall survival, functional recovery, and treatment-related complications. We included 145 patients receiving surgery for PBTs between 2007 and 2024.

### Results

We included 145 patients receiving surgery for PBTs between 2007 and 2024. The mean age at operation was 45 years, 34.9 % of the patients were female. Most frequently operated tumors were chordomas (17.9%), hemangiomas (17.9%), osteoidosteomas (12.4%), aneurysmatic bone cysts (6.8%) and osteosarkomas (6.8%).

Reason for the imaging was mostly pain which occurred in 101 cases. Most cases could be operated without new neurological deficits (95%).

Several factors were significantly associated with worse outcomes, including advanced tumor stage, poor baseline functional status, and comorbidities. Patients undergoing aggressive surgical interventions demonstrated higher complication rates, prolonged recovery times, and no significant improvement in survival or quality of life when compared to those treated with less invasive approaches.

### Conclusion

The findings underline the importance of identifying patients who may benefit from less invasive and more targeted treatment strategies. As the criticism of overly aggressive interventions continues to grow, a patient-centered, risk-adapted approach should be adopted. Future treatment protocols must integrate prognostic factors to balance the potential benefits of aggressive treatment against its risks, ensuring optimal outcomes while minimizing unnecessary harm.

### P068

Einflussfaktoren auf die Lebensqualität bei Patienten mit posttraumatischer Rückenmarksverletzung: Eine prospektive Kohortenstudie Impacting Factors on Quality of Life in Post-Traumatic Spinal Cord Injury Patients: A Prospective Cohort Study

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### Objective

Spinal cord injury (SCI) is a severe and often irreversible phenomenon that causes significant disruptions in the quality of life of affected patients. Thus, understanding the main factors that impact quality of life is essential in seeking the best rehabilitation alternatives.

### Methods

This was a prospective cohort study. The survey was applied to patients with post-traumatic SCI who underwent spinal surgery and attended spine clinics from April 2020 to December 2023. Inclusion criteria were traumatic SCI patients who had at least one outpatient visit and consented to participate. Exclusion criteria included those receiving only conservative treatment or not returning to the hospital within the study period. Demographic data, injury-related data, and quality of life questionnaires (Visual Analog Scale and Short Form-36) were collected. The data were compared using ANOVA, and p-values less than 0.05 were considered significant.

### Results

Of the 100 patients analyzed, 70 were included in the study, with 54 males and 16 females. The average age of the patients was 40 years. Most injuries were cervical (40%), thoracic (31%), or lumbar (29%). Frankel scale results showed 63% of patients at grade D. Post-operative QoL scores were poor, with an average VAS pain score of 5.2 and an SF-36 functional capacity score of 32.7 points. Severe injuries (Frankel A-C) resulted in lower functional capacity scores compared to Frankel D. Statistically, men had worse QoL in functional and vitality aspects. Income had a statistical impact on QoL in the mental health aspect. Sexual activity statistically impacted QoL in the functional aspect. Patients with more severe injuries on the Frankel scale or with injuries in the cervical or thoracic regions had lower values in the physical conditions subdomain. Those with sphincter dysfunction had statistically worse QoL in the functional and vitality aspects. Only 5% had access to rehabilitation centers and multidisciplinary teams.

### Conclusion

The present study demonstrated that male patients, those with more severe injuries on the Frankel scale, injuries in the thoracic or cervical regions, those not sexually active, or with sphincter dysfunction, show worse quality-of-life outcomes.

### P069

Wahrscheinlichkeit Intraoperativer venöser Luftembolien bei Elektiv- und Notfalleingriffen an der Halswirbelsäule in halbsitzender Position ohne Präoperative Transösöphageale Echokardiographie Probability of Intraoperative Venous Air Embolism due to Elective and Emergency Surgery of the Cervical Spine in Semi-Seated Position without Preoperative Transesophageal Echocardiography

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### Objective

The most common patient positioning in elective and trauma surgery of the dorsal cervical spine is prone position. Advantages of the sitting position in comparism to prone positioning are a dry surgical field, easier evaluation of spinal alignment prior to instrumentation and improved intraoperative x-ray resolution in patients with large necks or body habitus and can be used in patients who require microsurgical or endoscopic decompression, sequeterectomy or posterior fusion. Despite these benefits preoperative transesophageal echocardiography is common to exclude a PFO due to concern that the sitting position increases the risk for venous air embolism. We utilized this patient positioning in trauma and elective surgeries of the cervical spine due to the several advantages even without preoperative transesophageal echocardiography in elective cases.

### Methods

All patients with elective and trauma surgeries of the dorsal cervical spine who had a surgical treatment with a dorsal approach in semi-seated positioning between 2008 and 2022 were evaluated retrospectively. All patients underwent the surgery without preoperative transesophageal echocardiography. We examined these patients due to outcomes of postoperative air embolism events occurred within a 30-day postoperative time window. All patients underwent the surgery with arterial lines, central venous catheters but without preoperative transesophageal echocardiography.

### Results

699 patients had undergone microsurgical surgery, endoscopic surgery, dorsal instrumentation or a combination between 2008 and 2022. 436 emergency cases and 263 elective cases were identified. All operations were conducted in a semi sitting position without preoperative transesophageal echocardiography. In the follow-up 73% had excellent outcome scales due to Odom criteria. Due to Patient Satisfaction Index (PSI) 65% of the patients were very satisfied postoperatively, 17% were dissatisfied and 0% very dissatisfied. No patient had VAE complications within 30 day of the surgery.

### Conclusion

Elective and Trauma surgery of the cervical spine via dorsal approach in a semi-seated positioning is a safe and effective treatment option. This method can be applied without preoperative transesophageal echocardiography in a safe manner without a higher risk for VAE complications. In relation to the patient outcome criteria it holds comparable results to surgery in the prone position with additional advantages of the sitting positioning for the surgeon

Abb. 1



Abb. 2



## P070

Auswirkung von Müdigkeit auf die technische Leistung: Eine Simulationsstudie zur mikroneurochirurgischen Leistung vor und nach einer 24-stündigen Schicht Impact of Surgeon Fatigue on Technical Performance: A Simulation Study of Microneurosurgical Performance Before and After a 24-Hour Shift

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### Objective

Fatigue from prolonged work hours is a critical factor affecting surgical performance and patient safety. This study evaluates the impact of a 24-hour shift on neurosurgical residents" technical performance during microsurgical clipping of middle cerebral artery (MCA) aneurysms via a pterional craniotomy.

### Methods

Five neurosurgical residents (PGY 3–5) performed microsurgical clipping of a standardized MCA aneurysm model twice: once while rested (baseline) and once immediately following a 24-hour clinical shift. Performance was assessed using the Objective Structured Assessment of Neurosurgical Skills (OSANS) and procedure-specific metrics, including: 1. Craniotomy precision: Deviation in planned dimensions (mm). 2. Microsurgical dissection accuracy: Number of vessel or nerve injuries. 3. Clip placement success: Proper clipping without residual aneurysm or vessel occlusion. 4. Operative time: Total time to complete the procedure (minutes). 5. Tissue handling quality: Evaluated by independent neurosurgeons on a 5-point scale.

### Results

While fatigue had minimal impact on clip placement success and dissection accuracy, it significantly affected operative efficiency and tissue handling quality. Interestingly, the microsurgical dissection accuracy (2) did not differ between the two groups, while craniotomy precision (1), clip placement success (3), operative time (4) and tissue handling quality (5) showed lower values in OSANS metrics.

### Conclusion

Fatigue following a 24-hour clinical shift primarily impacts operative efficiency and the quality of tissue handling, while clip placement and dissection accuracy remain relatively stable. These findings emphasize the need for fatigue management strategies to enhance procedural efficiency and ensure optimal surgical outcomes. Simulation-based assessments provide valuable insights into the effects of fatigue and serve as a platform for improving training and preparedness in neurosurgery.



Figure 1: Neurosurgical residents performing head positioning a fixation, cranotomy placement, dural incision, dissection of the Sylvian fissure and clipping of MCA aneurysm via a standard pterional craniotomy before and after a 24-hour clinical shift. Performances were assessed by independen neurosurgeons during and after each simulaton using live performances and recorded video material.

### P071

# Funktionelle Genomanalysen zeigen genetische Abhängigkeiten und unterschiedliche Zellzyklusprogramme in atypischen teratoid rhabdoiden Tumoren auf

# Genome-wide CRISPR-Cas9 screens identify genetic dependencies and differing cell cycle programs in atypical teratoid rhabdoid tumors

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#### Objective

Atypical teratoid rhabdoid tumors (ATRT) are incurable high-grade pediatric brain tumors. Despite intensive research efforts, the prognosis for ATRT patients under currently established treatment protocols is poor. While novel therapeutic strategies are urgently needed, the generation of molecular-driven treatment concepts is a challenge mainly due to the absence of actionable genetic alterations.

#### Methods

We here used a genome-wide CRISPR-Cas9 knockout library to screen six human ATRT cell lines in negative selection screens. Identified genetic dependencies were used to generate a library of small molecule inhibitors that was used for drug screening in ATRT and non-ATRT human cancer cell lines. Additionally, chemogenetic CRISPR-Cas9 screens were used to investigate modulators of response to CDK4/6 inhibition in ATRT cells. Protein level changes upon loss of *AMBRA1* in ATRT cells were investigated using a bead-based western blot approach (DigiWest). Interaction partners of AMBRA1 were investigated using AlphaFold2 and co-immunoprecipitations.

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### Results

We here generate a map of context-specific genetic dependencies in ATRT, validate selected hits using a functionally-instructed small molecule drug library, and observe preferential activity in ATRT cells without subgroup-specific selectivity. CDK4/6 inhibitors are among the most potent drugs and display anti-tumor efficacy due to mutual exclusive dependency on CDK4 or CDK6. Chemogenetic interactor screens reveal a broad spectrum of G1 phase cell cycle regulators that differentially enable cell cycle progression and modulate response to CDK4/6 inhibition in ATRT cells. In this regard, we find that the ubiquitin ligase substrate receptor AMBRA1 acts as a context-specific inhibitor of cell cycle progression by regulating key components of mitosis including aurora kinases.

### Conclusion

Our data provide a comprehensive resource of genetic and chemical dependencies in ATRTs, which will inform further preclinical evaluation of novel targeted therapies for this tumor entity. Furthermore, this study reveals a unique mechanism of cell cycle inhibition as the basis for tumor suppressive functions of AMBRA1.

## P072

Augmented Reality (AR) in mikrochirurgischen multimodalen, bildgeführten Epilepsiechirurgie bei Kindern: Ergebnisse einer retrospektiven Studie Augmented reality (AR) in microsurgical multimodal image guided focal pediatric epilepsy surgery: Results of a retrospective feasibility study

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### Objective

Augmented reality (AR) is increasingly being used to improve surgical planning and assist in real time surgical procedures. A retrospective investigation was conducted to study its feasibility in pediatric epilepsy surgery at a single institution.

### Methods

Functional neuronavigation using multimodal imaging data (fMRI, DTI-tractography, PET, SPECT, sEEG) were used to augment the surgical navigation by transferring MRI imaging reconstructions as AR maps into the surgical microscope overlaying the surgical field

### Results

Altogether, 43 patients (17 female, 0-18 yrs, mean 9 yrs) were operated between 10/2020 and 10/2023 and fulfilled the inclusion criteria. 26 patients (60.5%) had an extra-temporal and 17 (39.5%) a temporal seizure origin. The 3 top histological diagnoses encountered were: FCD (32.6%), ganglioglioma (23.3%) and DNET (11.6%). Preoperative MRI studies showed no epileptogenic lesion in 11 patients (25.6%, MRI negativ group), which necessitated implantation of depth electrodes before resection. There were no adverse events while using AR enhanced neuronavigation. Altogether, of 24 patients with a follow up of more than one year, 83.3% displayed a favorable ILAE grade 1 seizure outcome (75% ILAE 1a), 14 % experienced a transient hemiparesis, 4.3% a permanent quadrantanopia and one needed a subdural-peritoneal shunt.

### Conclusion

AR supported navigated microscope resection allowed targeting and removal of lesional as well as non-lesional (sEEG defined) epileptogenic zones in pediatric epilepsy surgery with low morbidity and an expected seizure outcome.

### P074

Klassifikation von intraoperativen unerwünschten Ereignissen (ClassIntra) in Bezug auf Komplikationen und neurologische Ergebnisse in der pädiatrischen Neurochirurgie Value of the Classification of Intraoperative Adverse Events (ClassIntra) With Complications and Neurological Outcome in Pediatric Neurosurgery

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### Objective

Quality monitoring and improvement in pediatric neurosurgery are essential for accurate risk assessment, which aids in targeted preparations for interventions and enhances interdisciplinary cooperation while increasing parental trust. This study investigates the applicability of the ClassIntra classification for evaluating intraoperative complications in pediatric cases and examines its reliability in recording these complications, as well as its potential for predicting postoperative outcomes, including neurological status.

### Methods

In this prospective cohort study at a tertiary care center, we evaluated outcomes of neurosurgical procedures in 47 pediatric patients scheduled for various interventions. Data were systematically collected throughout the perioperative period, focusing on preoperative characteristics, intraoperative variables, and postoperative recovery metrics. The cohort was monitored for immediate and long-term outcomes, facilitating a comprehensive analysis of factors influencing recovery and overall patient well-being in pediatric neurosurgery.

#### Results

This study analyzed 47 pediatric patients undergoing neurosurgical procedures, categorizing intraoperative adverse events using the ClassIntra grading system into three groups: CI 0 (N=24), Cl 1 (N=20), and Cl  $\geq$  2 (N=3). The mean patient age was 7.0 years, with no significant demographic differences across groups. Operative times increased with higher ClassIntra grades, averaging 126.6 minutes for Cl 0, 227.6 minutes for Cl 1, and 260.7 minutes for Cl  $\geq$  2 (P=0.01). Patients with major adverse events had higher rates of neurological deterioration (P=0.03) and significantly elevated 90-day readmission rates in the Cl  $\geq$  2 group (P < 0.01). These results indicate that increasing intraoperative complications correlate with longer operative times, worse neurological outcomes, and higher readmission rates.

### Conclusion

These findings highlight the significant impact of intraoperative adverse events on postoperative outcomes in pediatric neurosurgery. Operative times increased with higher ClassIntra grades, and neurological outcomes deteriorated, especially in the Karnofsky Performance Status. The 90-day readmission rate was notably higher for patients with major intraoperative events, with all in the highest risk group requiring readmission. These findings highlight the need for precise intraoperative management and improved monitoring to reduce complications and enhance recovery in pediatric neurosurgery.

## P075

Vermeidbare Stürze bei Kindern In British Columbia: eine retrospektive Querschnittsanalayse an 816 Kindern The impact of preventable falls in the pediatric population in British Columbia: a retrospective cross-sectional hospital-based study of 816 Children

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### Objective

In the pediatric population, falls from height are associated with significant morbidity and mortality, unintentional falls are the leading cause of non-fatal injuries. In this study, we aim to describe the demographics, mechanism of fall, degree and severity of injuries, and outcomes from the corresponding treatments received by pediatric patients in our retrospective cohort. We hypothesize that a significant proportion of unintentional falls may arise from preventable circumstances. Ultimately, we want to build awareness of the magnitude of the problem of excess injuries from falls which remains to have relevance and implications to public policy for child and adolescent health.

### Methods

Patients were identified from the BC Trauma Registry. Demographic data was assessed. Individual chart review of all children sustaining an unintentional fall and treated at BC Children's Hospital between January 1st, 2007 and December 31st, 2020 was performed. Socioeconomic data was gathered from the 2021 Census of population database for demographic data.

### Results

We identified 816 patients, mage was 6.0+/-3.8 years. Mean hospital length of stay (LOS) was 2.7+/-3.8 days. 33% (n=270) of falls happened on the playground, but falls out of a window or off a balcony/deck were also important injury mechanisms (n=153, 19%). Excluding soft tissue injuries, traumatic brain injury (TBI) was the most common injury (n=506, 62%). Compared to other fall mechanisms, window and balcony/deck falls had the highest incidence of TBI. Cranial surgery was required in only 13 children (2%). 116 patients (14%) required intensive care with a mean length of stay of 2 days. Falls from windows and balconies accounted for the longest length of stay (LOS), both in hospital and in the ICU. Overall mortality rate was low at 0.5%, with the vast majority (97%) of children being sent home.

### Conclusion

The mechanism of unintentional falls among pediatric patients in our cohort is fall from a height most commonly sustained from playgrounds, but playground safety measures largely prevent devastating injuries. Falls from windows and balconies are associated with significant morbidity and a high burden of injury, evidenced by the incidence of intracranial hemorrhage, hospital and ICU LOS. These injuries span socioeconomic boundaries

Abb. 1



Abb. 2



## P076

Die "Number needed to scan". Über die Sensitivität der MRT-Diagnostik im Zeitalter des ultraFAST Imaging bei kindlichem Hydrozephalus The "Number needed to scan". On Sensitivity in MR-Imaging in the Age of ultraFAST Scans in Pediatric Hydrocephalus

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### Objective

Pediatric hydrocephalus is one of the main objectives in pediatric neurosurgery. After sucessful surgical treatment, surveillance and care of shunted children is crucial. There is an ongoing debate on standards for routine imaging. In this retrospective, wie opposed routine and clinically caused imaging and analysed deducted therapeutical interventions.

### Methods

We searched our database for outpatient care for "hydrocephalus" for the last 5 years, starting 2020. Besides biographical data, we assessed number and cause of MR imaging, the frequence and kind of intervention and morpological and clinical data.

### Results

the search request showed 208 children being seen in the outpatient setting with primary diagnosis "hydrocephalus". Exclusion criteria were coincidental oncological disease with necessity of surveillance imaging. Singular appointments were excluded. 130 children were selected for data analysis. 490 MR-scans were conducted. Mean interval between scans was 28 months, 2.7 MR-scans per child and year were conducted. 106 scans were clinically triggered, 384 were conducted routinely. We drew 65 surgical consequences as well as 12 valve adjustments, whereas 61 indications were based on integrative clinical AND MR cirteria; 6 sugeries were undertaken only based on imaging, without clinical symptoms. For every clinically triggered intervention, 1.6 MR-scans were conducted, while 1 in 64 routine scans had consequences.

### Conclusion

The number of routine diagnostics necessary to detect treatable shunt dysfunction or dysfunctional valve setting is relatively high. We cannot state or judge the proportionality of these measures, as we did not collect primary outcome data. Surveillance intervals after shunting should be based on the probability of dysfunction in the individual case, biological, psychological and social circumstances of the child and parents' compliance. Clinical surveillance and parents education seems to be more sensitive then MR-imaging. Vice versa, whenever there is clinical suspicion for shunt dysfunction, imaging should alwas be undertaken.

### P077

Ausmaß der Dekompression bei Chiari-Malformation Typ 1: Bietet die intraoperative Ultraschalluntersuchung Klarheit oder führt sie in die Irre? Eine systematische Übersichtsarbeit Extent of Decompression in Chiari malformation type 1: Does intraoperative ultrasound provide clarity or mislead? A systematic review

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### Objective

Patients with symptomatic Chiari malformation Type 1 (CM-1) require a bone-only posterior fossa decompression (PFD) or a more invasive dural expansion surgery with or without tonsillar resection (PFD+), although the latter comes at a higher risk of complications. Intraoperative ultrasound (iUS) may be used to decide on the extent of required decompression and hence avoid the higher complication rate for those patients in whom PFD suffices. However, it remains unclear what iUS criteria exist, how they should be applied and whether the use of iUS aids in decision-making.

### Methods

We performed a systematic literature review according to the PRISMA statement. Search terms included intraoperative ultrasound/sonography and Chiari malformation, variations of these terms, and related concepts. Consolidation of published results, as well as conversions (revision rate of PFD to PFD+) and the iUS sensitivity for each study/criteria was calculated based on the published data.

### Results

Of the 202 initially retrieved articles, one prospective and eight retrospective studies were identified, describing a mixture of pediatric and adult cohorts, resulting in 844 patients and 858 surgeries. Of those surgeries, 441 were PFD and 417 PFD+. The iUS criteria were heterogeneous: most studies used qualitative iUS findings, while one applied quantitative thresholds for decision-making. The conversion rate was 5% and varied from 0–16% per study. The iUS sensitivity ranged from 0.857 to 1.000 (95% CI 0.722 to 0.933 and 0.676 to 1.000), depending on the study, follow-up time, and criteria applied, while the specificity remains unknown.

#### Conclusion

Despite its frequent use in surgery for CM-1, the accuracy of iUS in determining the necessity for decompression beyond bone-only is difficult to ascertain. There is a heterogeneity of its application and lack of standardization. Comparative studies are needed to assess whether the use of iUS translates to improved clinical outcome.

### P078

Vergleichende Studie über die Genauigkeit der Positionierung externer Ventrikeldrainagen bei Kindern und das Auftreten von Komplikationen in Abhängigkeit der neurochirurgischen Erfahrung des Operateurs und des operativen Settings

Comparative study of the accuracy of external ventricular drain positioning in children and occurrence of complications depending on neurosurgical experience and operative setting

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### Objective

The insertion of an external ventricular drain (EVD) is a standard procedure for the treatment of acute hydrocephalus. To analyze the influence of neurosurgical experience and operative setting on accuracy of drain placement and occurrence of complications, the first analysis on a pediatric population was performed.

### Methods

101 patients were included in this retrospective study (62 males, 39 females, mean age 7,1 years, range from 17,5 to 0 years). Statistical analyses were performed balancing neurosurgical experience and operative setting, i.e. operating room (OR) and intensive care unit (ICU) with the occurrence of complications like multiple insertion attempts (MIA), revisions, cerebrospinal fluid (CSF) infections, malpositions, and bleedings. We defined neurosurgical experience dividing the operating neurosurgeons in junior neurosurgeons (JN), considering residents in last years of training or specialist with <5 years" experience and senior neurosurgeons (SN), considering pediatric neurosurgeons or specialist with >5 years" experience.

### Results

73 (72.3%) EVDs were placed by SN, 28 (27.7%) by JN. 90 (89.1%) in OR, and 11 (10.9%) in ICU. 22 patients experienced revision, 13 CSF infection, 11 multiple insertion attemps (MIA), 10 malpositions, and 4 bleedings. Fisher's Exact and Pearson's Chi-squared Tests revealed that a statistically significant larger number of MIA occurred by JN compared to SN (p=0.0094). The number of revisions also presented higher in the JN group (p=0.018) and incurred significantly more frequently by placement in ICU (p=0.0017). CSF infections, malpositions and bleedings were distributed without statistically significant differences in the JN and SN groups as well as in the OP and ICU groups. Multivariable logistic regressions models obtained surgical experience (p=0.005) as significant predictor of MIA and operative setting (p=0.034) as significant predictor of revision.

### Conclusion

We could report a higher rate of MIA and revisions in the JN and ICU groups, indicating that the accuracy of EVD placement is strongly dependent on neurosurgical specialized experience and operative setting.

### Abb. 1





### Abb. 2





## P079

### Innovative synergistische Strategien für die gezielte Behandlung des MYC-positiven Medulloblastoms. Identifying innovative synergistic strategies for the targeted therapy of MYC-driven medulloblastoma leveraging advanced 3D models and multi-omics analysis.

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### Objective

MYC-driven medulloblastoma is associated with a poor prognosis, high-grade malignancy, and rapid progression. MYC plays a pivotal role in oncogenesis by regulating cell proliferation, apoptosis, differentiation, and metabolism. Its multifaceted functions also contribute to resistance against chemotherapy; for instance, MYC promotes resistance to tyrosine kinase inhibitors in ROS-driven lung cancer. Therefore, understanding the mechanisms behind MYC-mediated therapy resistance in medulloblastoma can offer a powerful strategy for controlling tumor evolution and improving the efficacy of cancer treatments.

### Methods

In our study, we utilized high-throughput screening to identify class 1 histone deacetylase (HDAC) inhibitors that specifically target MYC-driven medulloblastoma cell lines and primary cancer cells. To investigate the resistance mechanisms arising from MYC overexpression in response to class 1 HDAC inhibitors, we employed the CRISPR-based Synergistic Activation Mediator approach.

### Results

Through this investigation, we discovered that the TGFB1/Erk/MKNK1 signaling pathway plays a crucial role in how MYC-driven medulloblastoma cells respond to class 1 HDAC inhibitors. By overexpressing neural EGFL-like 2, we were able to desensitize MYC-driven cells to class 1 HDAC inhibitor treatment. Utilizing patient-derived 3D spheroids and a synergistic treatment combining EW-7197 with the Class 1 HDAC inhibitor Entinostat, we observed a significant increase in the percentage of dead cells compared to monotherapy.

### Conclusion

Our results suggest that the synergistic targeting of the TGFB1/Erk/MKNK1 signaling pathway and MYC could provide a novel therapeutic option for MYC-driven medulloblastomas.

## P080

Multimodale Behandlung eines pädiatrischen diffusen hemisphärischen hochgradigen Glioms mit H3-G34-Mutation als Beispiel für eine Verbesserung des Erstbehandlungsansatzes bei schwer zu behandelnden pädiatrischen Hirntumoren.

Multimodal treatment of a pediatric H3-G34-mutated diffuse hemispheric high-grade glioma as example to endorse a shift in the first-line treatment approach of difficult-to-treat pediatric brain tumors.

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### Objective

H3-G34-mutated diffuse hemispheric high-grade glioma (H3G34-DHG) is a rare, highly malignant brain tumor with dismal prognosis and median time to progression of 10 months with standard therapy underlining the need for novel treatment strategies. This study aimed on investigating a multimodal approach in a child combining surgery, chemotherapy, radiotherapy, Tumor Treating Fields (TTFields), WT1 dendritic cell immunotherapy, and targeted therapy STAT3-inhibition in terms of effectiveness, safety, and quality of life.

### Methods

A 13-year-old boy presented with focal myoclonic seizures and left-sided sensory sensations while remaining conscious. Seizures resolved spontaneously without neurological sequelae. MRI revealed a 5.1 cm cortical T2 hyperintense right parietal tumor. Subtotal tumor resection with a small hypermetabolic remnant was performed. Histology confirmed a high-grade diffuse glioma. Mutations in H3-3A, TP53, and ATRX were identified by immunohistochemistry and RNA sequencing. DNA methylation analysis classified the tumor as H3G34-DHG mutant (calibrated score: 0.99). The copy number profile showed chromosomal gains and losses with homozygous loss of CDKN2A/B. MGMT promoter was methylated. WT1 staining showed 93% cytoplasmic positivity.

### Results

The patient underwent standard HGG treatment, including resection, focal chemoradiation with proton therapy (up to 59.4 Gy), and temozolomide. Consolidation chemotherapy with temozolomide and lomustine (ACNS0423 protocol) was initiated. Due to poor prognosis, additional treatment was added, including TTFields, WT1 dendritic cell therapy (NCT04911621), targeted STAT3 inhibition, and complementary therapies (ketogenic diet, cannabidiol). TTFields compliance was 88% (range 40-94%). The patient tolerated combined treatment well, achieving 24 months progression-free and preserved quality of life.

### Conclusion

H3G34-DHG is a challenging tumor with poor prognosis, and inclusion in clinical trials is often restricted, limiting treatment options. Combining different therapies as first-line treatment, while considering quality of life, may delay relapse and prolong survival. In the case presented here time to progression was extended to 24 months without major impairments emphasizing that a shift in the first-line treatment may significantly improve the outcome for these patients.



#### Abb. 1

Figure 1: Treatment overview of a pediatric patient with H3G34-mutated diffuse hemispheric high-grade glioma. Overview of different treatment components. TTFields compliance was consistently high throughout the course of therapy and above the recommended level of 75%

## P082

Überexpression von Piccolo und Syntaxin-1A in pädiatrischen Medulloblastomen High expression of Piccolo and Syntaxin-1A in paediatric medulloblastoma due to both: high neuronal fraction and endogenous expression

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### Objective

Emerging evidence indicates that the "healthy" nervous system contributes to the pathogenesis of cancer. Tumor cells were found to form ultra-long protrusions with distinct synapses, mainly in the infiltrative zone, resulting in a neuron-to-brain tumor synaptic communication. Located at the presynapse, proteins of the cytomatrix of the active zone have been identified to maintain highly specialized functions in neurons. Further, the proteins were shown to be involved in progression in various tumors, but little is known about their role in brain tumors. This study examined the expression of cytomatrix assembled at the active zone proteins (CAZ) proteins in glioma and medulloblastoma.

### Methods

Tumor samples of Astrocytoma, glioblastoma, pilocytic astrocytoma and medulloblastoma were obtained during neurosurgical resection. Transcription rate of following CAZ proteins was measured via qPCR: *SNAP25, VAMP1, VAMP2, SYT1, PCLO, BSN, STX1A.* To examine amount of neuronal tissue *TUBB3* and for glial fraction *GFAP* were quantified. A medulloblastoma cell line (DAOY) was furthermore analyzed to evaluate origin of high expressed proteins.

### Results

Medulloblastoma showed high expression of *PCLO* (pilocytic astrocytoma vs. medulloblastoma p=0.0126) and *STX1A* (pilocytic astrocytoma vs. medulloblastoma p=0.0006) compared to. Likewise a high transcriptional level of *TUBB3* could be seen with significance to pilocytic astrocytoma ( $2.2 \pm 1.4 \text{ vs.} 0.2 \pm 0.17$ ; p = 0.0018), which could indicate a high amount of neuronal tissue in given medulloblastoma samples. To rule out a causal link between high proportion of neuronal tissue and high CAZ expression, a paediatric medulloblastoma cell line was analysed. High expression of *PCLO* and *STX1A* in absence of *TUBB3* was shown (3.8 and 2.01 vs. 0.059), indicating endogenous expression of CAZ proteins in medulloblastoma.

### Conclusion

Presynaptic CAZ proteins seem to play an important role in medulloblastomas.





Effect of downregulation on migration. Wound healing assay of controls and DAOY cells after treatment with *PCLO*-siRNA (A) and *IDH*-mutant U-87 cells after treatment with *STX1A*-siRNA (B) 0 h, 24 h and 48 h after infliction of wound (n = 4).

### P083

Operationen in halbsitzender Position: Eine internationale professionelle Umfrage unter Neurochirurgen *Surgery in semi-sitting position: an international professional survey among neurosurgeons* 

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### Objective

The semi-sitting position in neurosurgery remains a topic of debate. Despite its advantages, including improved accessibility and visibility of the surgical field, it is associated with risks such as venous air embolism. This study provides an overview of the current use, benefits, challenges, and future prospects of the semi-sitting position, based on insights from a sample of international neurosurgeons.

### Methods

A structured questionnaire was distributed via social media channels to neurosurgeons worldwide to gather data on demographics, frequency and indications for using the semi-sitting position, reasons for its use or non-use, feared complications, alternative positions employed, and the types of pathologies treated in this position. Responses from 141 neurosurgeons were analyzed using descriptive statistics.

### Results

The survey revealed that 81.6% of participants use the semi-sitting position, with varying frequencies: 35.5% perform fewer than 5 surgeries annually, 27.7% perform 5–20, and 18.4% perform more than 20. Major barriers to its adoption include fear of complications such as venous air embolism (22.2%), lack of trained anesthesia teams (21.5%), and insufficient equipment (15.8%). Most respondents (42.1%) used the position for infratentorial pathologies only, with tumors in the pineal region (36.4%) and cerebellopontine angle (24.7%) being the most treated pathologies. The most common perioperative monitoring tools included preoperative echocardiography (24%), capnometry (20.5%) and intra-arterial blood pressure monitoring (17.9%). Among surgeons not currently using the semi-sitting position, 44% expressed willingness to adopt it with proper support.

### Conclusion

Despite its challenges, the semi-sitting position offers significant advantages for specific neurosurgical procedures. The presence of an experienced neurosurgical and anesthesiological team is essential for successful implementation. Efforts to enhance training, improve technology, and provide adequate infrastructure could facilitate broader adoption of this position.

### P084

Anatomische Aspekte des Überganges zwischen der hinteren Siebbeinregion und der Keilbeinhöhle, fokussiert auf den Recessus sphenoethmoidalis

Anatomical considerations of the junction between the posterior ethmoidal region and the sphenoid sinus with a focus on the sphenoethmoidal recess

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### Objective

The anatomy of the sphenoethmoidal recess is of clinical importance, however, the literature focuses on the superior turbinate and the sphenoid ostium. We analysed the entire junction of the posterior ethmoidal region and the sphenoid sinus to define possible regularities.

#### Methods

We analysed 100 paranasal sinuses of 50 individuals with the Slicer 3D software to investigate the anatomy of the junction of the posterior ethmoidal region and the sphenoid sinus.

### Results

The junction between the posterior ethmoidal region and the sphenoid sinus had two components: medially the sphenoethmoidal recess, laterally the common wall between these aeriated regions. This wall was built by the basal lamella of the superior turbinate (4BL) in 92.0% which was a constant landmark structure (100.0%). The most frequent phenotype of the 4BL (44.0%) was a frontally oriented pentangular bony wall without dehiscences. In most cases the 4BL built the lateral continuation of the sphenoethmoidal recess. It had three relevant complicating factors. Firstly, if the supreme turbinate was present (43.0%), the 4BL shifted to anterior, away from the sphenoethmoidal recess. Secondly, the pneumatization of the 4BL and the superior turbinate (25.0%) was related to an incomplete, dehiscent anterior wall of the 4BL. Thirdly, the presence of sphenoethmoidal cells (36.0%) led to a bony contact of the optic canal and the 4BL (33.0%). The sphenoid ostium was mostly superior and medial from the superior turbinate's posteroinferior tip with an average direct distance of 1 cm.

#### Conclusion

The sphenoethmoidal recess should be understood together with the ethmoidal cells' anatomy. The 4BL is an important landmark at the junction of the posterior ethmoidal region and the sphenoid sinus for endoscopic sinus and skull base surgery with highly constant morphology. This study can help surgeons to predict anatomical variations during skull base procedures and improve their intraoperative orientation.

### P085

Prognose des Tumorprogresses bei nicht-funktionellen hypophysären Makroadenomen nach transnasaler transsphenoidaler Resektion: Erkenntnisse aus einer retrospektiven Studie eines Einzelzentrums Predicting Tumor Progression in Non-Functioning Pituitary Macroadenomas Following Transnasal Transsphenoidal Resection: Insights from a Single-Centre Retrospective Cohort Study

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### Objective

This retrospective, single-centre study aimed to identify predictive factors for progression in postoperative residual findings of non-functioning pituitary macroadenomas (NFPMAs). The findings are intended to support individualized decisions regarding follow-up and adjuvant therapy.

### Methods

A retrospective analysis was conducted on 212 patients treated at a tertiary referral centre between 2007 and 2023. Patients underwent MRI-guided, transnasal transsphenoidal surgery for histologically confirmed NFPMAs. Pre- and postoperative tumor volumes were assessed alongside demographic, clinical, and histopathological data. Tumor configuration was classified using Hardy and Knosp scales. Subgroups were defined based on postoperative imaging: stable residuals, progressive residuals, or recurrence after gross total resection (GTR). Statistical analyses included multivariate testing and ROC analysis to determine predictive cutoff values.

### Results

Of the 212 patients, GTR was achieved in 44.3%. Among patients with residual findings, 76 (35.8%) exhibited stable tumors after a mean of follow up of 39 months, while 42 (19.8%) showed progression, which correlated significantly with larger preoperative tumor volumes (median: 11.6 cm<sup>3</sup> vs. 5.81 cm<sup>3</sup> p < 0.001). ROC analysis identified 7.12 cm<sup>3</sup> as the optimal cutoff for distinguishing stable from progressive residual tumor volumes (AUC = 0.748). No significant differences between stable and progressive groups were observed in Hardy or Knosp classifications. Postoperative cortisol levels were significantly higher in patients with progressive residuals (14.10 µg/dL vs. 10.83 µg/dL; p = 0.022).

### Conclusion

According to our study, preoperative and postoperative tumor volumes are key predictors of progression in NFPMAs, with a critical cutoff of 7.12 cm<sup>3</sup> for stability. These findings could inform tailored follow-up strategies. Prospective studies are warranted to validate these results and further explore the impact of surgical and tumor characteristics on long-term outcomes.

## P086

Nutzen der Lumbaldrainage nach Duraverschluss während endonasaler endoskopischer Schädelbasischirurgie Use of lumbar drainage after dural repair in endonasal endoscopic skull base sugery

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### Objective

Endonasal transsphenoidal endoscopic surgery is the standard for resecting sellar region pathologies due to its effectiveness and low complication rates. However, complications like cerebrospinal fluid (CSF) leaks, meningitis, and bleeding can still occur. Proper closure of the sellar floor is essential to prevent postoperative CSF leaks, and the use of lumbar drains may help, though their effectiveness is debated. This study evaluates the outcomes of a multilayer closure technique of the sellar floor in relation to postoperative lumbar drain usage.

### Methods

The authors retrospectively reviewed 280 patients who underwent this surgery at our hospital from January 2011 to April 2020. Among them, 87 had intraoperative CSF leaks and were included in the study. We assessed postoperative complications and CSF leak occurrences, correlating them with closure materials and lumbar drainage. We also analyzed the relationship between intraoperative leak grades, underlying pathologies, and patient demographics.

### Results

Of the 87 patients, 54 were women (62%) and 33 men (38%), with a mean age of 56.3 years. The most common diagnosis was non-secreting adenoma (45%), followed by secreting adenomas (18%). Intraoperative CSF leaks were classified by Esposito"s system, with grade 3 leaks primarily treated with lumbar drains (90%) and autologous fat (87%). Only nine developed new postoperative CSF leaks, managed conservatively with lumbar drains; three discontinued this method, while six required revision surgery.

### Conclusion

The study found a lower intraoperative CSF leak rate compared to others, with a similar postoperative leak rate (3.1% vs. 3.9%). Our closure techniques, including intraoperative lumbar drainage, proved effective across various leak grades. For postoperative leaks, the benefit of lumbar drains is limited, and immediate revision surgery is recommended for definitive closure.

### P087

Hochnähen oder nicht: Einblicke von einer multinationalen Umfrage zu Durahochnähten bei pterionalen Kraniotomien

To Tent or Not to Tent: Insights from a Multinational Survey on Dural Tenting Sutures in Pterional Craniotomies

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### Objective

The routine use of dural tenting sutures in pterional craniotomies is a common practice aimed at reducing complications such as epidural hematomas. However, robust evidence supporting this practice is limited, and its impact on surgical outcomes remains unclear. This study aimed to evaluate neurosurgeons' perceptions and practices regarding dural tenting sutures to identify potential areas for future research and guideline development.

### Methods

A global survey targeting neurosurgeons was conducted, collecting demographic data, surgical experience, and opinions on the utility and complications of dural tenting sutures. The anonymized online survey was distributed in December 2024 (1st-31st) by the DGNC among DGNC members via mail and in social media addressing international neurosurgical audience. Statistical analysis compared responses based on practice settings, surgical experience, and the use or non-use of dural tenting sutures.

#### Results

The survey received 102 responses. The majority of participants (72.3%) reported routinely using dural tenting sutures, primarily to reduce the risk of epidural hematomas (63.7%). Neurosurgeons in high-income settings, referring to the World Bank country classifications by income level, were less likely to use dural tenting sutures compared to those in upper- and lower-middle-income settings (p = 0.004). Among those who did not use dural tenting sutures (27.7%), the main reasons cited were the perceived lack of necessity to reduce complications (15.7%) and concerns about prolonged surgery or potential complications. While most respondents (65.7%) supported the use of dural tenting sutures in high-risk bleeding cases, 48% expressed no significant concerns regarding associated complications. Interestingly, 86% of respondents supported the need for randomized controlled trials (RCTs) to provide evidence on the efficacy of dural tenting sutures, as the perceived level of existing evidence was predominantly Level 5 (58.5%).

### Conclusion

The survey highlights substantial variability in the use of dural tenting sutures, influenced by income setting, surgical experience, and institutional practices. While most neurosurgeons favor their routine use, the lack of high-quality evidence underlines the need for RCTs to establish evidence-based guidelines. This study provides a foundation for future investigations to standardize practices and improve patient outcomes.

### P088

# Paragangliom mit radiologischem Aspekt eines Vestibularisschwannom – Fallbericht und Literaturübersicht Paraganglioma mimicking a Vestibular Schwannoma – case report and review of the literature

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### Objective

Head and neck paragangliomas (PG) are a heterogenous group of benign neuroendocrine tumors with typical locations and characteristic growth patterns. The intracranial form (jugulo-tympanic) typically starts at the jugular bulb and extends from the jugular foramen into the posterior fossa (Fisch classification type D<sub>i</sub>). Those forms are typically large, highly vascularized and invade bone. Here, we present an atypical PG that primarily developed in the CPA and that was pre-operatively diagnosed as "vestibular schwannoma" on MRI and CT. Furthermore, we reviewed the literature and discussed relevant radiological differential diagnostic features. (1–3)

### Methods

Presentation of a clinical case of a rare CPA paraganglioma. The systematic review was based on PRISMA (2020) guidelines and a PUBMED search using the terms "*CPA Paraganglioma*", "*cerebellopontine angle paraganglioma*," and "*intracranial paraganglioma*" and related terms. Inclusion criteria were based on language, anatomical location, tumor origin and pathological entity.

### Results

A 42-year-old female presented with otalgia, fluctuating tinnitus, hypoacusis and vertigo. MRI in T1 with Gadolinium revealed a 2 cm homogenous, strongly hyperintense mass in the right CPA (**Figure 1**). Radiologically the tumor was diagnosed as vestibular schwannoma or meningioma. The tumor was resected via a retrosigmoid approach. It was highly vascularized and hemorrhagic, displaced cranial nerves and compressed the brainstem. A small portion extended to the jugular gulf. Gross total resection was achieved without neurological deficit. Pathology confirmed a PG.The systematic review identified 17 similar cases in addition to our case. PG was mimicking other tumors, including meningiomas (55%), cavernous angiomas (22%), or vestibular schwannomas (22%). Symptoms varied across all cases. Gross total resection was achieved in 9 cases (50%).The radiologic hall marks of PG are a "*salt and pepper*" appearance in MRI T1/T2 and bony erosion in high-resolution thin-cut CT. As in the presented case, PG may only fill the CPA with no/ minor connection to the jugular foramen. In doubtful cases nuclear imaging (e.g. DOTATE PET) or an angiography settle the diagnosis.

### Conclusion

Pure CPA paragangliomas are extremely rare and may mimic vestibular schwannomas. Typical radiological hallmarks may predict their hemorrhagic nature and hypervascularity. Awareness of such cases and careful pre-operative imaging analysis may improve surgical safety.

Abb. 1



### P089

Konsistenzvorhersage von Schädelbasismeningeomen anhand von Signalintensitätsverhältnissen aus präoperativen T2-gewichteten Magnetresonanzaufnahmen Prediction of skull base meningiomas consistency using signal intensity ratios from preoperative T2-weighted magnetic resonance images.

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### Objective

Predicting the preoperative consistency of meningiomas is challenging. Several studies have demonstrated a correlation between tumor consistency and the signal intensity of preoperative T2-weighted magnetic resonance images (MRI). This study aims to evaluate this correlation specifically for skull base meningiomas using quantitative intensity measurement and to derive cut-off values.

### Methods

Preoperative T2-weighted MRI scans from 148 patients who underwent surgical resection of skull base meningiomas were retrospectively analyzed. The signal intensity (SI) of the meningioma and the contralateral cortex was quantified by placing a region of interest (ROI) within the tumor and the cortex. The tumor-to-cortex SI ratio was then calculated. The consistency (categorized as soft, intermediate, or hard) was retrospectively extracted from the surgical reports.

### Results

Among the analyzed tumors, 25% were classified intraoperatively as hard (n=37), 60.1% as soft (n=89), and 14.9% as intermediate (n=22). The median SI ratio was 1.3 (range: 0.43-3.0; 95%-CI: 1.2-1.3). A significant correlation was observed between tumor consistency and the SI ratio (soft vs. hard, p=0.0019). The median SI ratio of the soft meningiomas was 1.3 (range: 0.43-3.0; 95%-CI: 1.3), compared to 1.2 for hard tumors (range: 0.6-1.7; 95%-CI: 1.1-1.3). Using a ROC curve analysis, a cut-off value for hard tumors was determined at <1.305, with a sensitivity of 78.3% and a specificity of 52.8%.

### Conclusion

This analysis demonstrates a significant correlation between preoperative T2-weighted MRI signal intensity and the consistency of skull base meningiomas. These findings have the potential to aid in preoperative planning, particularly by improving risk assessment and tailoring surgical strategies.

### P090

Fallbericht und Literaturreview über eine ausgeprägte IgG4-assoziierte Entzündung, bei initialem Verdacht eines rezidivierenden Clivus-Chordoms

Extensive IgG4-associated inflammation mimicking a recurrent clivus chordoma - Case report and review of the literature

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### Objective

Chordomas are rare malignant bone tumours typically located at the skull base, cervical and sacral spine and rarely metastasize. They have typical radiological features. Recurrences are predominantly local. We report the first case of an extensive IgG4-associated inflammation that was pre- and intra-operatively suspected to be a recurrence.

### Methods

Patient data were obtained from the local administration programme Medico and PACS programme and summarised as a case presentation.Illustrative radiological imaging was critically discussed.Literature research was performed on PubMed using the keywords: "chordoma" and "IgG4" and "CNS.

### Results

A 74-year-old male patient presented on 10/24 with a radiological suspicion of recurrent clivus chordoma.In 02/24 (India),the tumour had been subtotally resected endoscopically and irradiated (*CyberKnife, 35 Gy*).The histopathological diagnosis was "chondroid chordoma".On 09/24, the MRI showed a typical aspect of tumour regrowth.After an interdisciplinary discussion on the tumour board, a re-resection was offered.The tumour was re-resected via an endoscopic transsphenoidal/clival approach.Intra-operatively the tissue was fibrous and only partially soft, not resembling classical scar tissue.The entire dura mater of the ventral skull base from one cavernous sinus to the other was exposed.The defect was closed by muco-septal Hadad flap.The postoperative course was uneventful.A left abducens nerve palsy resolved after some days.Postoperative MRI revealed minimal residual contrast enhancement at the resection margins.Histopathology then showed no evidence of recurrent chordoma.Instead, extensive plasma cell-rich, fibrosing inflammation with increased IgG4-positive plasma cells was noted.This finding was confirmed by external reference pathology.Literature research did not reveal any other cases of IgG4 inflammation and Chordoma.Hence, the aetiology and a possible causal link remain unclear.It is important to be aware of such an extremely rare condition mimicking chordoma relapse, as less invasive diagnosis, e.g. metabolic or nuclear imaging or biopsy may have been proposed.

### Conclusion

IgG4-related diseases involving the central nervous system (CNS) are known to manifest as hypophysitis and/or pachymeningitis.Solid tumours only have been described in single case reports, resembling pituitary macroadenoma and meningioma-like lesions.We here present the first case of IgG4 plasma cell-rich inflammation of the skull base mimicking a recurrent chordoma.

### P091

Quantifizierung der Einschränkung der Lebensqualität durch Schwindel bei Patienten mit Tumoren im Kleinhirnbrückenwinkel anhand des Dizziness Handicap Inventory (DHI) Fragebogens Quantification of dizziness-related quality-of-life impairment in patients with cerebellopontine angle tumors using the Dizziness Handicap Inventory

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### Objective

Cerebellopontine angle (CPA) tumors are often associated with symptoms like vertigo and unsteadiness in walking. Although these complaints can severely affect patients' everyday lives, their impact on quality of life is still rarely considered in routine clinical practice. The current study prospectively examines the effect of dizziness on quality of life in terms of functional, physical and emotional well-being in different CPA pathologies.

### Methods

Patients with indication for surgery due to CPA tumors were prospectively assessed in the preoperative setting. The effect of dizziness on quality of life was evaluated and quantified using the Dizziness Handicap Inventory (DHI) incorporating functional, physical and emotional aspects.

### Results

32 patients were included in this study with a mean age of 48.7 years. With 22 female patients, more women were affected. Most of the tumor entities were vestibular schwannomas (56,3%), followed by meningiomas(28,1%), epidermoids (12,5%) and ependymoma (3,1%). 17 tumors affected the right and 15 the left side. 15 patients (46,9%) reported symptoms of dizziness in their medical history, while 17 patients (53,1%) experienced no dizziness. There was a correlation with the DHI assessments, with significantly reduced quality of life (higher DHI score) in patients reporting dizziness (median DHI score: 42) compared to those not reporting dizziness (median DHI score: 6), p = 0,005. When analyzing DHI subscales (functional, physical, emotional), the significant difference between the two patient groups was also evident in each of these categories. In addition, a significantly higher DHI score was found in patients with brain stem compression compared to those without brain stem compression (p = 0,039). When comparing different tumor entities, there was no significant difference in terms of symptoms of dizziness or DHI scores.

### Conclusion

This study demonstrates that the DHI is a useful instrument to assess dizziness-related impairment of quality of life in patients with CPA tumors. Subjective perception of dizziness correlated with a significant reduction of symptom-specific quality of life. We recommend the routine use of DHI in patients affected by CPA tumors in order to monitor long-term clinical course.

### P092

Klinische Anwendung einer Standard Operating Procedure (SOP) des frühen postoperativen Wachstumshormon-Serum-Wertes bei Akromegalie zur Prüfung der Indikation zur frühen intrastationären Re-Operation — vorläufige Ergebnisse

Clinical trial of a Standard Operating Procedure (SOP) about the early postoperative serum growth hormone in acromegaly regarding checking the indication for another early surgery during the same in-stay — preliminary results

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### Objective

In acromegaly, surgery is the first-line therapy. Currently measuring GH (growth hormone) and IGF-1 (insulin-like growth factor 1) twelve weeks after surgery is the central tool to evaluate remission. If remission could not be determined at this time point, scarring, which would make reoperation more difficult, would already have taken place. Therefore, it seems to be of benefit to identify the persistence of hypersecretion early in the postoperative course and to indicate reoperation within the same hospital stay. Previously, we had described cut-offs for GH on postoperative day (POD)1 (GH<sub>1</sub>  $\ge$  1,42 ng/mL) and on POD 4 (GH<sub>2</sub>  $\ge$  0,58 ng/mL) in a retrospective analysis of 86 cases (Knosp grades I to III), that would identify those who should early be checked for persistence of hypersecretion. We implemented these items into an SOP for clinical practice (Fig.1). The aim is to test our SOP for feasibility and for predictability.

### Methods

Up to 12/2024, we included 13 cases that underwent adenoma resection in acromegaly (Knosp grades I to III). We used the SOP to evaluate any case and to define further procedure interdisciplinarily. Up to 01/2025 seven cases are completed with a follow up to one year. Remission was stated endocrinologically according to the current guidelines (1).

(1) Katznelson L, Laws, E. R., Jr., Melmed S, Molitch ME, Murad MH, Utz A, Wass JA (2014) Acromegaly: an endocrine society clinical practice guideline. J Clin Endocrinol Metab 99:3933–3951

#### Results

Five of the seven completed cases were in remission during the first year after surgery. One case without remission got another early surgery according to our SOP and then reached remission; the other refused early reoperation and underwent radiosurgery. This patient currently is in a controlled endocrinological state under medication with somatostatin analogues. So far, we did not observe any side effects using our SOP.

#### Conclusion

Our preliminary results suggest that the postoperative SOP described here is capable of 1. identify cases with postoperative persistence of GH-hypersecretion early after surgery, therefore leading to 2. interdisciplinary work-up of those cases within the same hospital stay and 3. early reoperation in cases without remission. We recommend applying this SOP in neurosurgical centers with specialization for pituitary surgery.





### Abb. 2

Figure 1: Standard operating procedure (SOP) for early secondary surgery during the same inpatient treatment for acromegaly
# Schädelbasis 1 | Skull base 1

### P093

Photo-dynamische Therapie (PDT) von Vestibularis Schwannomen – Eine neuartige adjuvante Therapieoption? *Photodynamic Therapy (PDT) for Vestibular Schwannoma – A Novel Adjuvant Therapy Option?* 

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#### Objective

Photodynamic therapy (PDT) based on 5-aminolevulinic acid (5-ALA) has shown efficiency in treating various brain tumors in preclinical studies [1]. Additionally, mTOR inhibitors have demonstrated significant lethal effects on vestibular schwannoma (VS) cells [2]. Doxycycline performed inhibition of mTOR signaling pathway activation [3]. The aim was to evaluate the effect of 5-ALA-PDT as a novel treatment option for VS and to assess whether doxycycline could enhance the therapeutic efficiency of 5-ALA-PDT.

#### Methods

The immortalized VS cell line HEI193 was incubated with different 5-ALA concentrations (0-105  $\mu$ g/ml for 2, 4, or 8 hours) or with varying doxycycline concentrations (0-100  $\mu$ g/ml for 1, 2, or 4 days), or a combination of both doxycycline and 5-ALA. Following incubation, the 5-ALA-PDT cells were irradiated using a laser ( $\lambda$  = 635 nm). Cell viability was assessed with MTT assay. Protoporphyrin (PPIX) was quantified after 5-ALA incubation using flow cytometry.

#### Results

5-ALA concentration and incubation time correlated with intracellular PPIX. Cells incubated with 105  $\mu$ g/ml of 5-ALA for 8 hours exhibited the highest PPIX levels (p < 0.05). The highest lethal effect of 5-ALA-PDT was observed at a concentration of 105  $\mu$ g/ml, irrespective of incubation time (p < 0.05). Doxycycline alone showed the most lethal effect at a concentration of 100  $\mu$ g/ml (p < 0.05). The combination of doxycycline and 5-ALA-PDT significantly increased cell lethality compared to treatment with doxycycline or 5-ALA-PDT alone (p < 0.05).

#### Conclusion

5-ALA-PDT demonstrated dose-dependent efficacy in an immortalized VS cell line. Doxycycline alone had a lethal effect. Pretreatment with doxycycline before 5-ALA-PDT enhanced lethality even at lower 5-ALA concentration. The results encourage to further investigate the potential of 5-ALA-PDT for VS as adjuvant therapy.

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- Giovannini M et al. mTORC1 inhibition delays growth of neurofibromatosis type 2 schwannoma. Neuro Oncol. 2014 Apr;16(4):493-504. doi: 10.1093/neuonc/not242. Epub 2014 Jan 10. PMID: 24414536; PMCID: PMC3956353.
- 3. Zhou H et al. mTOR Inhibitor Rapalink-1 Prevents Ethanol-Induced Senescence in Endothelial Cells. Cells. 2023 Nov 11;12(22):2609. doi: 10.3390/cells12222609. PMID: 37998344; PMCID: PMC10670449.

# Schädelbasis 1 | Skull base 1

### P094

Ergebnisse der Zweitoperation bei Patienten mit wachstumshormonsekretierendem Hypophysenadenom bei persistierender oder rezidivierender Akromegalie: Eine retrospektive Monozenter-Analyse. Outcomes of Second Surgery in Patients with Growth Hormone-Secreting Pituitary Adenoma for Persistent or Recurrent Acromegaly: A Retrospective Monocenter Analysis.

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#### Objective

Acromegaly results from excessive growth hormone (GH) secretion by pituitary adenomas, leading to persistently elevated GH levels, increased morbidity, and reduced life expectancy. The primary goals of treatment are lowering GH and IGF-1 levels, controlling tumor size, reducing morbidity and mortality, and improving quality of life. Surgery provides the advantage of immediate GH reduction compared to other therapies. This retrospective analysis evaluated clinical outcomes, therapeutic goals, and factors influencing the success of second surgery for persistent or recurrent acromegaly in 95 patients.

#### Methods

Between 1999 and 2017, 95 patients (38 women, 57 men; mean age 38 years) underwent second surgery for persistent or recurrent acromegaly (94 transsphenoidal, 1 transcranial). Follow-up was conducted 12 weeks postoperatively. Parasellar tumor extension was graded using the Knosp classification to ensure consistent radiological evaluation.

Surgical outcomes were assessed based on the latest stringent criteria for cure. We analyzed whether surgical goals were achieved and examined influencing factors, including tumor invasiveness, preoperative GH/IGF-1 levels, tumor histology, preoperative medical treatment, and the interval between surgeries. Additionally, we reviewed the rates of transient and persistent complications after the second procedure.

#### Results

Surgical goals were achieved in 87.1% of cases. Remission rates were significantly correlated with Knosp grade, the extent of tumor mass reduction, and the relationship between preoperative GH levels and early postoperative outcomes. Intraoperative complications, such as bleeding, were minimal and did not require secondary surgical intervention.

#### Conclusion

Second surgery is an effective treatment option for patients with persistent or recurrent acromegaly, offering the potential for remission or cure. Success is influenced by factors such as preoperative GH/IGF-1 levels, tumor size, invasiveness, and surgical expertise.

### P095

Vorhersage von postoperativer Aphasie bei Gliompatienten durch präoperativer MRT-basierter Radiomics *Prediction of aphasia in language-eloquent glioma patients using preoprative MRI-based radiomics* 

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#### Objective

Gliomas affecting language-eloquent areas often result in aphasia. We aimed to investigate whether radiomic features extracted from preoperative MRI scans can predict postoperative language outcomes, measured by the Aachener Aphasie Test (AAT). Our focus was on identifying imaging predictors to enhance neurosurgical planning and inform patient decision-making.

#### Methods

We analyzed data from 49 right-handed patients with left-hemispheric gliomas (24 females, 25 males, age range 22–78). Preoperative MRI datasets included T1-weighted (T1w) and diffusion MRI (dMRI). Preprocessing of the dMRI data was conducted using MRtrix3, FSL, and ANTs, ensuring uniform denoising, motion correction, and artifact removal. Tumor regions were manually segmented by an expert. Radiomic features were extracted using PyRadiomics from T1w and diffusion scalar maps, including ADC and FA. Language function was assessed preoperatively using AAT. AAT subtests included the token test, naming, repetition, and speech comprehension. Feature extraction included first-order statistics, shape-based features (e.g., volume, sphericity), and texture features derived from gray-level matrices (GLCM, GLRLM, GLSZM). Feature selection was performed using LASSO regression to identify the most relevant radiomic features. Ordinary Least Squares (OLS) regression was then applied using the selected features to predict postoperative AAT scores and explain their variance.

#### Results

Radiomic features from especially T1w were significantly associated with postoperative AAT outcomes. T1wbased models explained up to 52.7% of the variance in postoperative AAT scores (adjusted  $R^2 = 0.387$ ), with significant predictors including GLCM Information Measure of Correlation 1 (p = 0.015), which captures how orderly or random the tissue structure is, while GLRLM Run Variance (p = 0.028) reflects the variability in the lengths of continuous texture patterns.

#### Conclusion

Our results highlight the potential of radiomics to predict language outcomes in patients undergoing glioma resection, providing clinicians with additional tools for preoperative risk assessment. Radiomic features reflecting tumor texture, shape, and intensity offer valuable insights into postoperative aphasia severity. The analysis of a larger cohorts may further improve prediction accuracy.

### P096

#### Intraoperatives Sprachmapping und -monitoring in fremdsprachigen PatientInnen Intraoperative language mapping and monitoring of patients with foreign native language

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#### Objective

In patients with brain tumours in language-associated areas, awake surgery with intraoperative language monitoring optimises the functional outcome, provided that the patients are eligible, i.e. can cope with the intraoperative situation, demonstrate stable task performance and share their native language with the monitoring observer. In times of migration and cultural exchange, non-compliance with the latter condition often leads to the rejection of advisable language monitoring. Here we present a novel and largely observer-independent approach to map and monitor basic language functions in patients with a foreign mother tongue.

#### Methods

100 pictures from the Cologne Naming Test (CoNaT) were named by the patient in his/her mother tongue, audio-recorded and saved as separate audio-files. The intraoperative task, based on these recordings, was coded in Psychpy (python) with two conditions:

(1) Word recognition: auditive presentation of a word in the patient"s native language and choice of the corresponding object (drawing) via button press, providing a real-time output with traffic-light colour codification integrating response correctness as well as the button press delay.

(2) Naming of randomly presented CoNaT images with subsequent playback of the preoperatively recorded words. Replay was triggered by the observer and presented to the monitoring team via headphones. This setting enabled a simple and at least rough confirmation of the correctness of word production.

#### Results

We present pilot data including experience from two glioma patients (native languages: Romanian and Arabic). The intraoperative set up included the use of an additional laptop connected to an external monitor (to display the traffic light judgement in task 1 and the CoNaT objects in task 2, an external numpad to detect button press, and earphones for the monitoring team. Feasibility was good, allowing to achieve a safe bilingual mapping and monitoring (native language and German) in both patients. Postoperatively the patients showed no new communication deficit according to the standardised cognitive and language test battery.

#### Conclusion

We here present an innovative and feasible option for basic monitoring of a foreign language during awake surgery. Although further validation in a clinical study is needed, we demonstrate the potential to widen the indication for language monitoring beyond the restrictions of matching language proficiency between the patient and the monitoring team.

### P097

Der frontal aslant tract (FAT) und postoperative Sprachdefizite: eine Studie mit 12 Patienten nach Resektion von linkshemisphärischen Low-Grade Gliomen und Durchtrennen des FAT The frontal aslant tract (FAT) and postoperative language deficits: report of 12 patients with FAT disruption after low grade glioma surgery

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#### Objective

The effect of frontal aslant tract (FAT) lesions on speech deficits following glioma surgery remains debated. This study examines the role of FAT injury in post-surgical language impairments.

#### Methods

We screened 286 patients with left hemispheric low-grade glioma (LGG) between May 2019 and June 2024. Of those, 12 patients with left frontal LGG were included. All patients had preoperative diffusion tensor imaging (DTI) and logopedic evaluations. Patients without DTI imaging or speech therapy assessment were excluded. DTI was used for fiber tracking of the FAT. Intraoperative awake surgery with speech mapping was performed in 9 patients. FAT disruption was assessed by comparing pre- and postoperative MRI and classified as: 1) total disruption, 2) partial disruption, or 3) no disruption.

#### Results

The cohort included 8 patients with grade 2 CNS WHO IDH-mutated glioma and 4 patients with grade 3. Total disruption of the FAT was found in 10 patients, while 2 had partial disruption. Preoperative anomia was present in 4 patients. Postoperatively, anomia was the most common deficit (8/12), including one severe aphasia case. Two patients had reduced verbal fluency, and 2 were asymptomatic. Language deficits persisted for an average of 5 months (range 1-22).

#### Conclusion

FAT injury can lead to temporary but reversible speech deficits, with speech therapy aiding recovery. In contrast to prior studies, our cohort experienced longer-lasting but still transient speech deficits.

Patients	Duration of aphasia (months)	Speech and executive function disorder
1	22	Anomia
2	8	Anomia
3	1	Reduction of verbal fluency
4	2.5	Anomia
5	1.5	Reduction of verbal fluency
6	3	Anomia
7	1	Anomia
8	1.5	Anomia
9	17	Anomia, pronounced aphasia
10	0	0
11	2	Anomia
12	1	0



Abb. 2

### P099

Assoziation von Veränderungen des intraoperativen Neuromonitorings bei Resektion von Inselgliomen mit sensomotorischen Defiziten im Langzeitverlauf Association of intraoperative neurophysiological changes with long-lasting postoperative sensorimotor deficits in insular glioma surgery

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#### Objective

This study aimed at analyzing the predictive value of intraoperative neurophysiological monitoring (IONM) changes in insular glioma surgery and their association with long-lasting postoperative sensorimotor deficits.

#### Methods

Clinical charts of 42 patients undergoing 44 tumor resections with IONM were reviewed. Significant changes in motor evoked potentials (MEP) and somatosensory evoked potentials (SSEP) were defined as a reduction in the respective amplitudes by more than 50% as compared to the initial measurements at dura opening. Changes were classified as "temporary" if they restored to above 50% and "permanent" if they remained below 50% at the time of dura closure. Postoperative MRI was performed within 72 h after surgery. Sensitivity and specificity of IONM-changes as well as the relative risk (RR) for developing a permanent sensorimotor deficit were calculated. Logistic regression was used to assess the association of IONM changes with the Berger-Sanai zone and territorial ischemia on postoperative MRI.

#### Results

The median age of the cohort was 43 years (IQR 34–51). Approximately one-third of patients had tumors located in the left insula with the most frequent localization within the insular Zone I. The overall rate of postoperative new neurological deficits at 3-months follow-up was 13.6%. Permanent significant MEP and SSEP changes demonstrated a sensitivity and specificity of 83% and 97.3% respectively to predict a sensorimotor deficit at 3-months follow-up. The RR of those patients for developing a permanent neurological deficit was 26.43 (95% CI 4.664-154.6; p=0.0001). Permanent significant IONM were more frequent during resection of giant insular gliomas (invading zones I-IV), although this finding did not reach statistical significance (OR 3; 95%CI 0.445-25; p=0.259). Additionally, significant MEP and SSEP changes were strongly associated with territorial ischemia on postoperative MRI (OR 8.250; 95%CI 1.146-73.97; p=0.038). Notably, temporary MEP decreases occurred in four patients, none of them exhibited a permanent sensorimotor deficit at 3 months follow-up evaluation.

#### Conclusion

In our study, permanent significant IONM changes (but no transient IOM findings) were associated with permanent sensorimotor deficits at the 3-month follow-up, partially due to territorial ischemia. These findings highlight the value of IONM in predicting postoperative sensorimotor deficits in insular glioma surgery.

### P100

Behandlung von Tumoroperations-bedingter Hemiparese mit navigierter transkranieller Magnetstimulation (rTMS) - Präsentation erster Resultate aus unserem Behandlungsprotokoll Treating tumor surgery related hemiparesis with navigated repetitive transcranial magnetic stimulation (rTMS) – Presentation of first results of our treatment protocol

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#### Objective

Treatment of hemiparesis after stroke with repetitive transcranial magnetic stimulation (rTMS) has a history of more than 10 years. More recently, the use of rTMS for post-operative hemiparesis in neurosurgery has been established and data from high-volume centers have been published. To contribute to the further development of this treatment option, we present the first results of our data using a combined pre-/post-operative protocol.

#### Methods

This randomized, sham-controlled, double-blinded study so far included 10 patients from January to September 2024 who suffered from tumor surgery related hemiparesis. Patients were randomized to receive either low-frequency nrTMS (1 Hz, 110% RMT, 900 pulses, 15 min) or sham stimulation to the motor cortex hand area contralateral to the hemiparesis for at least 5 days after surgery. If feasible, a preoperative preparatory stimulation was performed using the same protocol but on the affected hemisphere.Clinical outcome was measured by the Karnofsky-Index (KI), Medical Research Council (MRC) strength grades and ability to walk by a blinded neurosurgeon after surgery, before discharge and at a 3-month follow-up (FU).

#### Results

Of the 10 patients included, 7 patients received rTMS and 3 received sham treatment.Of the 7 patients who received nrTMS, 5 improved motor function of the upper extremity (MFUE) at FU, 2 remained stable. Motor function of the lower extremity (MFLE) improved in 6 and remained unchanged in 1.The 3 patients in the sham group seen at FU all showed improved MFUE and MFLE.While none of the 3 sham-treated patients were able to walk at discharge, 2 out of 5 rTMS patients who were unable to walk after surgery were able to walk at discharge (with and without walking aids). At FU, 5 out of 7 patients in the rTMS group were ambulatory, whereas all 3 patients in the sham group improved to full ambulation.Regarding KI, at discharge 4/7 and at FU 6/7 showed improvement in the rTMS group, compared to 2/3 at discharge and 3/3 at FU in the sham group.

#### Conclusion

Our study shows a trend towards faster recovery of walking ability in the rTMS treated population, which seem to level out over time. Recovery of motoric strength seems to be uninfluenced. To further support this finding we will be enrolling more patients in this study.

### P101

Longitudinale neurokognitive Untersuchung von Patienten mit niedrig gradigen Gliomen Longitudinal neurocognitive assessment in patients with low-grade glioma

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#### Objective

Low-grade gliomas (LGG) are rare cerebral tumors that mostly develop in young adults with an active lifestyle at the time of diagnosis. Early and repeated treatments for LGG, including surgical resection, have been shown to postpone malignant transformation and thus maximize survival benefit. However, it has been recognized that tumor- as well as surgically induced impairments of neurocognitive functioning negatively affect patients" health-related quality of life (HRQOL). In this study we assessed the neurocognitive sequelae and the impact on HRQOL from the tumor and its treatment in a total of 38 LGG patients over a time course of one year.

#### Methods

LGG patients received neurocognitive testing on the day before surgery as well as within one week after surgery. Follow-up neurocognitive testing was performed in a 6-month interval matched with clinical follow-ups and imaging. Whenever patients required repeated surgery, they were again tested pre- and postoperatively. The neurocognitive test battery consisted of 9 standardized tests covering a wide span of neurocognitive domains. In addition, participants completed questionnaires for HRQOL, fatigue, depression and distress.

#### Results

Repeated measures ANOVA (n=25) revealed significantly worse postoperative results in comparison to preoperative testing concerning many neurocognitive domains like MoCa score (p< .001), processing speed (p= .002) and verbal learning performance (p< .001). Comparison between postoperative and 6-month and 12-month follow results showed that patients performed significantly better during follow-ups, reaching results that did not significantly differ from their preoperative performance. Over all times of measurement, we found significant correlations between patients" MoCa scores and levels of self-reported role functioning (r= .52, p= .008).

#### Conclusion

On the base of these results, it can be assumed that surgery in LGG patients does indeed cause initial impairment of different neurocognitive functions. However, the results also show that the preoperative level of these neurocognitive functions can be regained over a 6- to 12-month period, possibly due to processes of neural plasticity and functional reorganization. Patients with higher levels of neurocognitive functioning over all times of measurement, which stresses the importance of conserving neurocognitive functioning during treatment in patients with LGG to optimize HRQOL.





### P102

Die Bedeutung sozialer Netzwerkcharakteristika hinsichtlich alter-alter Verbindungen auf den klinischen Verlauf neuroonkologischer Patient\*innen: Eine prospektive Studie zu sozialer Unterstützung, kognitiver Funktion und Lebensqualität

The Impact of Alter-Alter Social Network Characteristics on Clinical Outcomes in Neuro-Oncological Patients: A prospective study on Social Support, Cognitive Function and Quality of life

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#### Objective

In neurooncological diseases, patients often experience a decline in quality of life (QoL), increased psychosocial stress (distress), and cognitive deterioration. Patients" social networks, particularly the connections between their social contacts (alteri), can provide social support, buffering the impact of stressors and influencing cognitive demands through various social stimuli. But the role of theses patients' social embedding remains unexplored. We investigate the effects of alter-alter network characteristics on QoL, distress, and cognitive functioning.

#### Methods

This prospective, exploratory, single-center study includes patients who underwent surgical treatment for brain tumors. Egocentric network analysis is employed to obtain quantitative measures of social networks. Network data is collected during patient interviews supported by the Network Canvas software. We assess QoL through the EORTC QLQ-C30/BN-20 questionnaire and measure distress using a distress scale (DT). Alter-alter network characteristics are defined as network density, size, mean strength of alter-alter ties (MST), and effective size (ES). Linear regression is used to evaluate their effects on clinical outcomes.

#### Results

Preliminary data analysis includes 62 patients (f:35/ 51y; m:27/ 50.7y). Linear regression analyses, using social and cognitive functioning scales, the communication deficit scale and the DT as dependent variables, revealed distinct effects: Network size improves perceived cognitive functioning ( $\beta$ =1.471, p<0.001) and reduces communication deficits ( $\beta$ =-1.105, p=0.016). MST increases social ( $\beta$ =1.202, p=0.001) and cognitive functioning ( $\beta$ =1.456, p<0.001), and reduce communication deficits ( $\beta$ =-1.173, p=0.001) and distress ( $\beta$ =-0.930, p=0.009). ES decreases social ( $\beta$ =-0.964, p=0.007) and cognitive functioning ( $\beta$ =-0.735, p=0.032). Interaction effects reveal that high network density combined with strong alter-alter ties reduces social ( $\beta$ =-1,909, p=0.001) and cognitive functioning ( $\beta$ =-1.485, p=0.008), while raising distress ( $\beta$ =1.258, p=0.022).

#### Conclusion

Social network characteristics have a complex impact on clinical outcomes in neurooncological patients. The findings highlight the dual role of social networks: strong ties offer psychosocial benefits but close-knit networks can raise emotional burden, while broader networks support cognitive functioning facilitating resource access and interaction diversity, emphasizing the need for a balanced approach to network-based interventions.

### P103

#### Rückkehr zur Arbeit bei Patient:innen nach Gliomoperation: die Rolle von semi-strukturierten Interviews Return to work in patients after glioma surgery: the role of semi-structured interviews

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#### Objective

Studying return to work (RtW) is a promising method to determine successful postoperative outcomes in glioma patients [1-3]. A working individual needs to adapt cognitive resources to job requirements, necessitating high levels of cognitive functioning [4-7]. Importantly, data on RtW conditions are lacking (e.g. reduced working hours) [3,8]. The aim of this study is to use semi-structured interviews to explore how or not glioma patients RtW.

#### Methods

18 glioma patients (female= 9; mean age= 36.22; SD= 9.49; LGG= 7; LH= 15; frontal= 7; temporal= 8; parietal= 3; mean tumor volume= 47.03cm3; SD= 45.04) underwent semi-structured interviews after surgery (mean FU months= 10; SD= 3.33; mean duration= 45.28min; SD= 24.92). The analysis focused on RtW or factors hindering RtW, namely, treatment effects (e.g. chemoradiotherapy), cognitive deficits, both, and others.

#### Results

Eight patients could RtW. Of these, four reported no changed conditions. Two patients reduced their working hours, one due to cognitive deficits, one due to changed life priorities. One patient RtW due to their self-employment status despite severe cognitive deficits, only being able to execute few easy tasks. The remaining patient changed jobs due to changed life priorities, unrelated to cognitive impairments. The main reasons for ten patients not RtW were tumor treatment effects and cognitive deficits. While four patients struggled with both treatment effects and cognitive deficits, two patients named only cognitive deficits, and one treatment effects as RtW limitation. One person developed depression, without other complaints. The remaining two patients reported to resume work shortly and to be looking for a new job at the same level, but changed work tasks due to personal preference.

#### Conclusion

Semi-structured RtW interviews revealed that the amount of patients not RtW is unexpectedly high and contrasts traditionally assessed neurosurgical outcomes (e.g. paresis, aphasia). Patients who do not RtW complained about treatment effects and cognitive deficits. While side effects of treatment may be difficult to diminish, capturing the scope of cognitive deficits on RtW may illustrate a greater need for testing cognitive functioning. Such interviews may hence be a useful addition.

### P104

Psychoonkologische Intervention für Patient\*innen mit Erstdiagnose eines Glioblastoms oder IDH-mutierten Astrozytoms, ZNS WHO Grad 4 und deren Angehörige zur Verbesserung der Therapietreue bei TTFields Therapie – ein Protokoll für eine randomisiert kontrollierte Studie

*Psychooncological intervention for patients diagnosed with a glioblastoma or astrocytoma CNS WHO grade 4 and their caregivers to improve compliance to TTFields – protocol of a randomized controlled study.* 

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#### Objective

Patients diagnosed with glioblastoma and their family caregivers are mainly impaired by the poor prognosis and the high symptom burden. Caregivers even may experience significantly higher levels of anxiety and depression than patients themselves. Several studies regarding TTFields usage in glioblastoma showed an association of the daily compliance rate with overall survival and progression-free survival (PFS). Family caregivers" support might be associated with the patients" compliance. However, so far few supportive programs for patients and their caregivers have been established. It has been shown that the delivery of supportive care via telehealth is feasible. However, studies examining the effectiveness, adoption and maintenance of telehealth interventions in glioblastoma patients and family caregivers are still lacking. The aim of the study is to evaluate if patients" compliance with TTFields might be improved by a psycho-oncological video intervention in patient and caregiver dyads.

#### Methods

A protocol for a multi-center, randomized controlled study was developed in several steps. Main inclusion criteria are 1) diagnosis of a GBM or astrocytoma, IDH-mutant, CNS WHO grade 4, respectively being a patient's caregiver, 2) patient eligible for radiochemotherapy with TMZ and 60Gy and for TTFields therapy, 3) access to a computer and internet, 4) absence of medical reasons precluding participation.

In the intervention group, supportive care via telehealth intervention will be delivered including six sessions of a specific psychological intervention and information/educational support regarding the disease, therapy and self-help options in family caregivers and patients. In the control group patients receive psychooncological care according to the local standard.

#### Results

The primary outcome is compliance to TTFields compared in intervention and control group. Secondary outcomes will be patients" and caregivers" health-related quality of Life (HRQoL), symptom burden, self-efficacy, anxiety, depression and its association to the intervention. Patient- and caregiver-reported acceptance of intervention and patients' acceptance of TTFields will be evaluated. As adverse event of special interest skin irritation will be assessed.

#### Conclusion

We developed a protocol for a structured psycho-oncological intervention and will evaluate if this leads to higher compliance to TTFields.

### P105

# Förderung der Patient:innenbeteiligung in der neurochirurgischen Forschung: Abbau von Barrieren und kollaborative Entwicklung von Strategien Enhancing Patient Engagement in Neurosurgical Research: Addressing Barriers and Co-Designing Strategies

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#### Objective

Historically, patients" roles in research were limited to data provision without active involvement. Recently, recognizing the benefits of patient involvement in all research stages—planning, execution, and dissemination—has grown. Patient engagement enhances the relevance of study outcomes, empowers patients, boosts self-efficacy, and improves overall well-being. For researchers, this can increase recruitment and reduce drop-outs. This project aims to employ patient engagement workshops for neurosurgically treated brain tumor patients to address participation barriers, identify relevant research questions and outcomes, and co-design dissemination strategies.

#### Methods

Brain tumor patients, their relatives, relevant stakeholders, researchers, and neurosurgeons participated in two co-creation workshops. The first workshop introduced patient engagement and gathered patients" wishes for subsequent topic-specific workshops. The second workshop focused on science communication, identifying patient information sources, addressing dissemination issues, and co-designing strategies for three clinical studies. Engagement levels were assessed via questionnaires.

#### Results

Twenty patients and relatives, four researchers, and two neurosurgeons attended the first two workshops. Key issues in science communication were identified, including difficulties in finding information about ongoing studies, identifying suitable studies, understanding study details, differentiating standard treatments from study procedures, and accessing and understanding results. To address these issues, a designated section on ongoing clinical studies on the Neurosurgical Department's website was proposed, along with co-created abstracts in easy language and concepts for short illustrative videos, which will be refined in future workshops. High levels of perceived engagement were reported by patients and relatives.

#### Conclusion

Identifying communication limitations and potential solutions with patients and relatives led to a high level of engagement. Co-designing strategies may enhance patient access to science, improve self-efficacy, and motivate study adherence.

### P106

Beschreibung der Lebensqualität, sowie der neurokognitiven, motorischen und neurologischen Leistungsfähigkeit von Glioblastom-Patienten Assessment of quality of life, and neurocognitive, motor, and neurological skills of glioblastoma patients

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#### Objective

Glioblastoma multiforme is an aggressive and rapidly progressing brain tumor characterized by poor prognosis and limited life expectancy, often resulting in swift neurological and clinical decline. This study aims to assess the quality of life and neurocognitive, motor, and neurological performance in glioblastoma patients.

#### Methods

A total of 39 patients diagnosed with glioblastoma multiforme were included in the study, along with a reference group of 15 individuals. The experimental and reference groups were matched for age, education, and morbidity. Both groups were assessed using a standardized test battery that evaluated quality of life, and neurocognitive, motor, and neurological skills. The glioblastoma group was tested preoperatively, as well as postoperatively at five days, two weeks, three months, and six months. The reference group was tested once. Statistical analysis was performed using IBM SPSS Statistics.

#### Results

Preoperatively, the experimental group performed worse than the reference group in all categories. Neurocognitive skills were considerably worse at the first postoperative assessment but improved considerably at three and six months postoperatively. Neither quality of life nor motor skills showed significant changes throughout disease progression. At three months postoperatively, 29 of 39 patients survived (overall survival: 0.74); at six months postoperatively, only 17 of 39 patients remained (overall survival: 0.44).

#### Conclusion

Our findings illustrate the evolution of the parameters in glioblastoma patients. This data contributes to optimizing counseling regarding expected outcomes after tumor resection surgery, particularly regarding cognitive performance, motor skills, and quality of life. No significant correlation was identified between overall survival and any of the assessed parameters.

### P108

# Vergleich der ABC/2-Formel mit Computer-basierten Volumetrie von ischämischen Kleinhirninfarkten Comparison of the ABC/2 Formula with Computer-assisted Volumetry of Ischemic Cerebellar Stroke

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#### Objective

Current guidelines suggest surgical decompression for ischemic cerebellar stroke in case of significant mass effect. Recent research has aimed to identify a possible threshold for mass effect. However, a computer-assisted volumetry in acute setting is time consuming and impracticable, wherefore the aim of this study was to assess the accuracy and clinical applicability of the ABC/2 method in case of ischemic cerebellar stroke.

#### Methods

Imaging data of 125 patients, including preoperative CT or MRI scans were used for volumetric analysis. The ABC/2 formula using scans in axial and coronal planes. BrainLab® Elements software was used for computer assisted volumetry by defining the region of interest allowing automated volumetric calculation. Measurements were conducted independently by blinded clinicians. Pearson correlation and Bland-Altmann test were used for statistical analysis.

#### Results

Among the 125 cerebellar infarctions analyzed, there was no statistical difference of mean infarct volume measurement between the ABC/2 formula and computer-assisted volumetry (16.6mL vs. 15.91mL; range 0.8-67.7mL; p=0.76). The Spearman correlation test indicated a strong correlation between the two methods (r=0.985, 95% CI: 0.979–0.990, p<0.0001). Discrepancies were most notable in smaller infarction volumes (

#### Conclusion

ABC/2 formula shows a good correlation with computer-assisted volumetry. Consequently, it could serve as a fast and practical tool for estimating cerebellar infarct volume and aiding decision-making in clinical practice. However, the limitations and variability of the ABC/2 method, particularly for smaller infarcts, must be considered.









### P110

# Zerebrale Kavernöse Malformationen: Systematische Übersichtsarbeit über molekulare Signalwege und zirkulierende Biomarker. Wo stehen wir?

# Cerebral Cavernous Malformations: Systematic Review about Molecular Pathways and Circulating Biomarkers. Where do we stand?

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#### Objective

Cerebral Cavernous Malformations (CCM) are low-flow vascular lesions located within the central nervous system, with a prevalence of 0.16-0.5%. CCM patients may remain asymptomatic or present new onset symptoms such as seizures, or focal neurological deficits related to the occurrence of intracerebral hemorrhage. CCM may appear as sporadic, or as part of familial forms linked to mutations in the CCM-gene cluster, affecting endothelial cell integrity and triggering molecular cascades, including the MEKK3/KLF2/4 signaling pathway. Recent studies have highlighted the roles of inflammatory, angiogenic, and coagulation pathways alongside the emerging evidence of a gut-brain axis influencing microbiome-driven TLR4 signaling. This review aims to describe molecular biomarkers associated with CCM pathophysiology, emphasizing their potential use as diagnostic and prognostic tools.

#### Methods

We conducted a systematic literature research to identify all publications describing current knowledge regarding plasma and imaging biomarkers and their diagnostic, prognostic, and therapeutic applications in patients with CCM. The data query was performed between January 15th and March 31st, 2024. Data were collected according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines 2020.

#### Results

A total of 57 studies published between 1984 and 2024 were reviewed. Regarding biomarker types, 45 studies (78.94%) described 55 circulating plasma molecules proposed as potential biomarkers in both familial and sporadic cases. Eight studies (14.03%) focused on two specific MRI sequences with potential diagnostic and prognostic applications as "neuroimaging biomarkers". Three studies (5.26%) explored at least two molecular biomarkers related to gut microbiome composition and its clinical relevance in CCM disease. Lastly, one study (1.75%) described a set of tissue biomarkers identified in endothelial cells of CCM lesions. Based on the mechanisms involved in CCM pathology, 60 biomarkers (96.77%) identified in the reviewed studies are associated with inflammation, endothelial angiogenesis, and immune response regulation. The remaining two biomarkers (3.22%) are linked to the gut micro-environment, reflecting the emerging recognition of the gut-brain axis in CCM disease.

#### Conclusion

Our review emphasizes the relevance of these biomarkers in improving diagnostic accuracy, predicting disease progression, and guiding personalized treatment approaches.

### P111

Arterielle Anatomie Erkennung und chirurgische Planung bei Patienten mit nicht-rupturierten Aneurysmen der Arteria communicans anterior mittels Virtual-Reality-Technologie Arterial anatomy detection and surgical planning in patients with unruptured anterior communicating artery Aneurysms using virtual reality technology

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#### Objective

Anterior communicating artery (ACoA) aneurysms are known to have diverse configurations, vascular relationships, and anatomical variations. Evaluation and operative treatment of these aneurysms necessitate perfect surgical strategy based on review of three-dimensional (3D) angioarchitecture using several radiologic cranial imaging methods. We retrospectively analyzed the potential influence of 3D virtual reality (VR) reconstructions compared to conventional computed tomography angiography (CTA) scans on the identification of vascular anatomy and neighboring structures, and on the surgical planning in patients with unruptured ACoA aneurysms.

#### Methods

Medical files were retrospectively analyzed regarding patient- and disease-related data. Preoperative CTA scans were retrospectively reconstructed to 3D-VR images and visualized via VR software to detect the characteristics of unruptured ACoA aneurysms. A questionnaire of experienced neurosurgeons evaluated the influence of VR visualization technique on identification of aneurysm morphology and relevant arterial anatomy and on surgical strategy.

#### Results

Twenty-six patients were included and 520 answer sheets were evaluated. Image presentation using 3D-VR modality significantly influenced the detection of the aneurysm-related vascular structures (p = 0.0001), as well as the recommended head positioning (p = 0.005) and surgical approach (p = 0.001) in the planning of microsurgical clipping.

#### Conclusion

In patients with unruptured ACoA aneurysms, the reconstruction of conventional preoperative CTA scans into 3D images and the spatial and anatomical presentation in VR models enable greater understanding of the anatomy and pathology, provide realistic haptic feedback for aneurysm surgery, and thus influence operation planning and strategy.

Abb. 1



(e)

(f)





(c)

(d)

### P112

Untersuchung des sensomotorischen Systems mittels fMRT bei Patienten mit vaskulären Läsionen Assessment of the sensorimotor system using fMRI in patients with vascular lesions

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#### Objective

Assessment of eloquence is one of the main hallmarks to define treatment strategies in the management of AVMs and other vascular pathologies. Functional MRI (fMRI) provides a valuable tool to anatomically depict the localization of eloquent brain functions in the patient-specific anatomy. The aim of this study was to assess the feasibility of fMRI to functionally depict the specific parts of the somatosensory system in patients with vascular lesions.

#### Methods

We assessed a cohort consisting of 15 patients with AVM (N=7) and cavernoma (N=8) with a mean age of 38.6 years. fMRI data were preoperatively acquired at a 3T-scanner using a block-design paradigm. During stimulation phases, a finger tapping task was performed with each hand being tested separately. Analysis of fMRI data was done using SPM12. Percent Signal Changes (PSC) and Laterality Indices (LI) were calculated for Regions of Interest (ROIs) in the motor cortex, premotor cortex and the supplementary motor area (SMA) using the MarsBaR- and LI-toolbox.

#### Results

PSCs in the motor and premotor cortex as well as in the SMA showed reliable results in the affected as well as in the unaffected hemisphere. No significant differences were found between the PSCs in the affected and unaffected hemisphere (paired t-test, P=0.310, P=0.769 and P=0.501 respectively). In 14 of 15 patients, clear LIs could be determined for hand-associated activation (left or right hand movement). Median LI for tapping of the left hand was -0.65, for tapping of the right hand 0.67.

#### Conclusion

Preoperative localizational assessment of sensorimotor function is reliably possible using fMRI. fMRI can therefore help to assess the eloquence of vascular lesions and provide a valuable base to individually define patient-specific treatment strategies in patients with vascular lesions.

### P113

Intrakranielle Aneurysmen bei Patienten mit autosomal-dominanter polyzystischer Nierenerkrankung - systematischer Review und Metaanalyse.

Intracranial aneurysms in patients with autosomal dominant polycystic kidney disease – a systematic review and meta-analysis.

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#### Objective

Autosomal dominant polycystic kidney disease (ADPKD) is known to be associated with intracranial aneurysms (IAs), but criteria for aneurysm screening in these patients remain debated. In this regard, we assessed in ADPKD patients 1) the proportion with subarachnoid haemorrhage (SAH) from a ruptured IA, 2) the proportion with an unruptured IA detected by screening, and 3) the occurrence of de-novo formation, growth and rupture of IAs.

#### Methods

We systematically searched PubMed and EMBASE for articles published until October 2023. Study selection and data extraction were performed by two authors independently from each other. We included cohort- and registry-based studies reporting on at least ten ADPKD patients with at least one IA. We calculated proportions with corresponding 95%CIs of ADPKD patients with ruptured and unruptured IAs, and compared risk factors between ADPKD patients with and without IAs with Chi<sup>2</sup> test for categorical variables and Mann-Whitney-U test for continuous variables.

#### Results

Sixteen studies described 846 ADPKD patients with one or more IAs (totaling 1135 IAs); IAs had a mean size of 3.9±0.5mm and 91.4% were located in the anterior circulation. Twelve studies reported the total amount of ADPKD patients who underwent brainvessel imaging for screening or for diagnostics in SAH patients. In 578/6656 (8.7%;95%CI:8.0-9.4%) an unruptured IA was found on screening and 87/6656 (1.3%;95%CI:1.1-1.6%) had a ruptured IA causing SAH. ADPKD patients with IA, compared to those without IAs, more often had a positive family history (35.8% vs. 19.3%), female sex (61.7% vs. 52.2%), arterial hypertension (79.5% vs. 71.9%) and smoking (45.6% vs. 31.0%) (p<0.001). For 222 ADPKD patients with an unruptured IA follow-up was reported with a mean of 5.0±2.6 years. New IAs were detected in 11% (95%CI:6.7-15.7%) of patients, IA growth in 13% (95%CI:7.6-20.1%), and IA rupture in 2% (95%CI:0.3-4.3%) of patients.

#### Conclusion

The proportions of ADPKD patients with an unruptured IA, with de novo IA development, and with SAH from a ruptured aneurysm are substantially higher than those in the general population. These findings support serial screening strategies for IA in ADPKD patients. Established risk factors for IAs also play a role in ADPKD patients, which underscores the need for early detection and treatment of hypertension and for discouraging smoking in these patients.



### P114

# Thrombozytenzahl-Dynamik nach aneurysmatischer Subarachnoidalblutung in Prädiktion von zerebralen Vasospasmen und verzögert eintretender zerebraler Ischämie: retrospektive Kohortenstudie. *Thrombocyte Count Dynamics After Aneurysmal Subarachnoid Hemorrhage to Predict Cerebral Vasospasm and Delayed Cerebral Ischemia: A Retrospective Monocentric Cohort Study*

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#### Objective

Cerebral vasospasm (CVS) and delayed cerebral ischemia (DCI) are significant complications following aneurysmal subarachnoid hemorrhage (aSAH). Reliable predictors for these complications are lacking. This study investigates the thrombocyte count dynamics in prediction of CVS and DCI after aSAH, aiming to provide a potential marker for early risk stratification.

#### Methods

A retrospective cohort study was conducted involving 233 aSAH patients. Data were collected from medical records, and various parameters, including thrombocyte count, C-reactive protein (CRP), hematocrit (Hct), presence of CVS and DCI, were analyzed. Statistical analyses, including Chi<sup>2</sup>, univariate and multivariate logistic regressions, ROC analysis, Spearman correlation and time-to-event analysis, were employed to examine the association between TC decrease and the occurrence of CVS and DCI.

#### Results

CVS and DCI occurred in 71.1% and 41.2% of patients, respectively. A relative thrombocyte count decrease >12.6% within the early post-aSAH period was significantly associated with increased risks of CVS (p<0.001; OR 10.6; 95% CI 4.74–25.3) and DCI (p=0.003; OR 2.7; 95% CI 1.39–5.43). This prediction model showed good discriminatory power for CVS (AUC 0.76, sensitivity 81.87%, specificity 70.59%) and a moderate discriminatory power for DCI (AUC 0.61, sensitivity 83.33%, specificity 38.69%). Temporal analysis revealed that greater TC decrease correlated with earlier CVS onset (p=0.00016; R=-0.28).

#### Conclusion

Thrombocyte count dynamics within the early post-aSAH period may serve as a potential marker for identifying higher risk of developing CVS and DCI. Early detection based on thrombocyte count dynamics could facilitate timely interventions to mitigate these complications and improve outcomes in aSAH patients. Further prospective studies are warranted to validate these findings.



Abb. 2



### P115

Fallbericht: Perioperativer zerebellärer Schlaganfall während der elektiven Behandlung eines Aneurysmas der Arteria cerebri media, kompliziert durch nicht offengelegte Amphetaminanwendung *Case Report: Perioperative Cerebellar Stroke During Elective Treatment of a Middle Cerebral Artery Aneurysm Complicated by Undisclosed Amphetamine Use* 

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#### Objective

Perioperative strokes are a rare but recognized complication of cerebral aneurysm surgeries, often influenced by patient-specific factors. Amphetamine use, known for its vasospastic and cerebrovascular effects, is an underexplored risk factor in the neurosurgical setting. This report highlights the clinical and perioperative challenges associated with acute undisclosed amphetamine use in a patient undergoing elective clipping of an unruptured middle cerebral artery (MCA) aneurysm.

#### Methods

We report a case of a 45-year-old male with a 3mm unruptured aneurysm in the proximal M1 segment of the right MCA. Post-clipping, he developed an unrelated superior cerebellar infarction, with toxicology confirming acute amphetamine use.

#### Results

The patient reported a history of illicit drug use, including intravenous consumption, prior to admission. Upon further questioning, he admitted to intermittent use of amphetamines, although he denied any recent use. The patient was advised to abstain from drug use during the peri-operative period. The elective aneurysm clipping was uneventful via a transsylvian approach. Postoperatively, the patient developed anisocoria, prompting an emergency CT with CT perfusion and angiography, which showed no significant findings. While in the ICU, the patient experienced a seizure and required re-intubation. Further imaging via CT and MRI revealed a bilateral superior cerebellar artery infarction (Figure 1). Given the patient's medical history and family reports indicating potential amphetamine use on the day before surgery, and possibly immediately before the procedure, a drug screening was conducted, which was positive for amphetamines. This result was consistent with the family''s account, as amphetamines are detectable in urine for up to 3-4 days after consumption. After successful weaning and extubation, the patient displayed disorientation, possibly due to withdrawal symptoms. Following an otherwise uneventful hospital stay, the patient discharged himself against medical advice after consultation with psychiatry colleagues.

#### Conclusion

This case highlights the need for thorough preoperative evaluation, including routine toxicology screening, in patients with a history of substance abuse. Amphetamine use may present perioperative challenges and increase the risk of complications like vasospasm and stroke.





Figure 1. CT/MRI findings showing postoperative bilateral superior cerebellar artery infarction

### P116

# Geschlechtsspezifische Unterschiede bei Patienten mit intrakraniellen Aneurysmen: Eine gepaarte Kohortenstudie

#### Sex Differences in Intracranial Aneurysms: A Matched Cohort Study

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#### Objective

Aneurysmal subarachnoid hemorrhage (SAH) primarily affects women, accounting for 65% of cases, with a 1.3 times higher relative risk compared to men. The incidence is particularly elevated in women aged 55–85 years. Additionally, women over 50 exhibit a higher prevalence of unruptured intracranial aneurysms (IAs), along with an increased likelihood of aneurysm growth and rupture. This study aimed to evaluate the influence of sex on rupture rates, bleeding severity, functional outcomes, and complications using a matched cohort. It also investigated the impact of sex on aneurysm localization and multiplicity.

#### Methods

A retrospective database of 300 patients with 511 IAs was analyzed. Inclusion criteria required available clinical data and 3D angiography to enable semi-automatic reconstruction of IA morphology. Female patients were matched with male counterparts based on clinical parameters and 21 morphological characteristics using an interactive visual exploration tool for multidimensional matching (Figure 1).

#### Results

Our findings challenge previously published data by demonstrating no significant sex differences in aneurysm rupture rates or vasospasm incidence. SAH severity, functional outcomes, and complications, including hydrocephalus, were similar between men and women. However, women showed a higher prevalence of multiple aneurysms and distinct localization patterns.

#### Conclusion

This study highlights the nuanced role of sex in IA development and rupture. While sex-specific biological factors influence aneurysm characteristics, they do not appear to affect clinical outcomes significantly. These findings emphasize the need for further research to clarify the relationship between sex-specific factors and aneurysm pathophysiology, with implications for personalized management strategies.



Figure 1. Illustration of cohort formation based on inclusion criteria, including the matching process and the clinical and morphological matching parameters.

### P117

Präoperative 3D-Druckmodelle und 3D-Clip Bibliothek zur Planung bei reperfundierten, gecoilten oder geclippten intrakraniellen Aneurysmen Preoperative 3D print models and 3D-Clip Library for planning reperfused, coiled or clipped intracranial aneurysms

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#### Objective

The aim of this study is to evaluate the benefits of patient-specific 3D printed models in the preoperative planning of previously treated (coiled or clipped) and reperfused intracranial aneurysms. The focus is on the optimisation of surgical access planning, the therapeutic strategy and the reduction of intraoperative risks through a realistic representation of the anatomical conditions.

#### Methods

In three cases, preoperative 3D print models were created based on DSA and CTA image data, segmented and converted into an STL format for high-resolution 3D printing. The models enabled precise visualisation of the vascular anatomy. In addition, a digital 3D clip library was integrated into the planning to improve visualisation and enable preoperative training. The combination of physical model and virtual imaging was retrospectively analysed with regard to its influence on intraoperative orientation and decision-making.

#### Results

The 3D printed models significantly improved the spatial orientation compared to purely virtual imaging. The integration of the digital clip library offered additional training options and optimised the simulation of the procedure. In both cases, precise planning and realisation of the surgical approach was achieved, which led to a reduction in potential risks. Both patients were successfully treated without intraoperative complications.

#### Conclusion

The use of patient-specific 3D printed models in combination with a digital clip library offers considerable advantages in the preoperative planning of complex interventions on intracranial aneurysms. This technique improves spatial orientation, enables preoperative training and reduces intraoperative risks.

### P118

Klinisches Outcome der chirurgischen Behandlung symptomatischer spinaler arteriovenöser Shunts: Signifikante motorische und sensorische Erholung

Clinical outcomes of surgical treatment for symptomatic spinal arteriovenous Shunts: Significant motor and sensory Recovery

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#### Objective

Spinal arteriovenous Shunts (sAVSs) are rare but represent the most prevalent vascular malformations of the spinal cord and a treatable cause of progressive para- or tetraplegia. The goals of this study were to analyze clinical, treatment and outcome associated with symptomatic patients diagnosed with sAVSs at a single institution in an 18 years period.

#### Methods

Asymptomatic patients and those with mixed intracranial and spinal shunts were excluded. The clinical outcome was determined by a modified mJOA-score (Benzel *et al.* 1991), the Nurick score and the mRS score. The data was analyzed by using GraphPad Prism performing One way ANOVA followed by Tukey's test.

#### Results

Between 2006 and 2024, our institution diagnosed and treated 37 symptomatic patients (male/female ratio 5,17:1, mean age 59,89; 6 women, 31 men) with sAVSs. Of the total 37 patients, 32 patients were initially treated surgically and 5 patients initially endovascular.

Patients with endovascular treatment showed no recovery on modified mJOA-score (Pre-OP=  $11,80 \pm 4,03$  and present=  $11,20 \pm 5,26$ , p= 0,9948).

In contrast, surgically treated patients demonstrated could show a significant improvement at various time points on modified mJOA-score (Pre-OP= 12,59 ± 2,62; Post-OP= 13,22 ± 2,95; after Rehabilitation=14,48 ± 2,91 and present=15,38 ± 2,45; p= 0,0012) the Nurick score (Pre-OP= 3,38 ±1,16; Post-OP= 2,97 ± 1,51; after finishing rehabilitation=2,30 ± 1,59 and present= 2,00 ± 1,62, p= 0,0023). and the mRS-score (Pre-OP= 3,18 ±1,15; Post-OP= 2,75 ± 1,52; after finishing rehabilitation=2,11 ± 1,60 and present= 1,79 ± 1,61, p= 0,0023).

Lower limb motor and sensory symptoms in surgically treated patients showed significant improved at different time points on modified mJOA-score (lower sensory Pre-OP= 1,76  $\pm$  0,79; Post-OP= 2,03  $\pm$  0,73; after finishing rehabilitation= 2,29  $\pm$  0,66 and present= 2,62  $\pm$  0,57, p= <0,0001; lower motory Pre-OP= 4,06  $\pm$  1,60; Post-OP= 4,34  $\pm$  1,70; after Rehabilitation= 5,15  $\pm$  1,59 and present= 5,50  $\pm$  1,383, p= 0,0026). Upper limb sensory symptoms, as well as bladder and bowel symptoms, did not show improvement in all patients.

#### Conclusion

Our findings demonstrate that surgical treatment leads to significant and sustained improvement in motor and sensory function of the lower limbs and overall functional outcomes in patients with sAVSs, as assessed by the modified mJOA, mRS scale and the Nurick score.

#### Abb. 1

Modifed mJOA-Score.

Motor dysfunction score of the upper extremities

- 0 Inability to move hands
- 1 Inability to eat with a spoon, but able to move hands
- 2 Inability to button shirt, but able to eat with a spoon
- 3 Able to button shirt with great difficulty
- 4 Able to button shirt with slight difficulty
- 5 No dysfunction

Motor dysfunction score of the lower extremities

- 0 Complete loss of motor and sensory function
- 1 Sensory preservation without ability to move legs
- 2 Able to move legs, but unable to walk
- 3 Able to walk on flat floor with a walking aid (i.e., cane or crutch)
- 4 Able to walk up and/or down stairs with hand rail

5 Moderate to significant lack of stability, but able to walk up and/or down stairs without hand rail

- 6 Mild lack of stability but walks with smooth reciprocation unaided
- 7 No dysfunction

Sensory dysfunction score of the lower extremities

- 0 Complete loss of leg sensation
- 1 Severe sensory loss or pain
- 2 Mild sensory loss
- 3 No sensory loss

Sphincter dysfunction score

- 0 Inability to micturate or defecate voluntarily
- 1 Marked difficulty with micturition or defecation
- 2 Mild to moderate difficulty with micturition or defecation
- 3 Normal micturition and defecation

Abb. 2
### Vaskuläre Neurochirurgie 1 | Vascular neurosurgery 1

### P234

#### Kognitive Funktion bei familiären zerebralen kavernösen Malformationen *Cognitive function in familial cerebral cavernous malformations*

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#### Objective

Familial cerebral cavernous malformations (CCM) are vascular malformations of the central nervous system, associated with multiple lesions; CCMs are a rare disease with a yearly incidence rate of 0.56 per 100 000 of the  $\geq$ 16 year-old (Zafar et al., 2019). So far, to our best knowledge, cognitive function has only been studied at the level of the individual case (Silva et al., 2023; Nagamine, 2021). New lesions appeared in 30% of patients during a mean period of 2 years (Labauge et al., 2001).

#### Methods

We conducted a large neuropsychological test battery on N=20 patients with familial CCM (preliminary data), including Health-related Quality of Life (HRQoL), screening of depression and anxiety and subjective cognitive impairment. Data analysis yielded, in addition to descriptives, correlation of HRQoL, anxiety and depression symptoms and subjective cognitive function. Parametric and non-parametric measures were applied after testing for normal distribution.

#### Results

Mean age was 39.7±16.6, with a minimum of 15 and a maximum of 65, 12 male, 8 female. Mean time since diagnosis was 9.65±7.48. 6 had known epilepsy, 9 had experienced surgery.

Cognitive scores showed on average no clinical relevant impairment. Lowest percentiles were achieved in attention measures and verbal memory (recognition; compare Figure 1).

Mean depression (3.05±2.31) and anxiety scores (6.6±3.38) were under the cutoff of clinical relevance ( $\geq$ 11), mental and physical HRQoL corresponded to the average of the normal population. Anxiety scores correlated significantly with mental HRQoL (r=-.650, p=.002) and self-perceived cognitive impairment (r=-.583, p=.007), depression scores did not.

Figure 1: N=20, percentiles (median, 25%, 75%) compared to the normal population; the red line indicates the 50th percentile; clinical relevant impairment below the 16th percentile.

#### Conclusion

Familial CCMs (N=20, preliminary data) about ten years after diagnosis showed no clinical relevant impairment on a group-level in cognitive functions, subjective cognitive function, depression, anxiety and HRQoL. Subjective cognitive function was associated with anxiety level, as is known across various populations and age groups. Figure 1



### P120

Effekte von Apomorphin und MK801 auf die Verarbeitung auditorischer Informationen im Dreiton-Oddball-Paradigma

Effects of apomorphine and MK801 on processing of auditory information in the three-tone oddball paradigm

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#### Objective

In our environment only few of the sensory stimuli are behaviorally relevant. The distinction between relevant and irrelevant information is impaired in certain neuropsychiatric disorders characterized by disturbed information processing (e.g., in schizophrenia). Injections of the dopamine receptor agonist apomorphine and the glutamate NMDA receptor antagonist MK801 are used in rat models. In this study, we investigated the effect of apomorphine and MK801 on behavior in the auditory oddball paradigm, which allows to investigate the processing of behaviorally relevant auditory events.

#### Methods

Male Sprague-Dawley rats (n=11) were trained in the auditory three-tone oddball paradigm, in which they had to respond by nose poking to a rare target tone (5000 Hz, rewarded with a casein pellet), while ignoring a rare distractor (1500 Hz) and frequent standard tone (3000 Hz). After reaching a pre-defined success criterion of correct response to the target tone and correct rejection of the standard and distractor tones (80%, each), rats were injected with different doses of either apomorphine (vehicle, 0.0625, 0.125 and 0.250 mg/kg) or MK801 (vehicle, 0.05, 0.1, and 0.15, and 0.2mg/kg) and then behaviorally tested in the oddball paradigm.

#### Results

Both, apomorphine and MK801 impaired performance in a dose-dependent manner. After apomorphine, rats gradually stopped responding to all stimuli, resulting in a reduced hit rate to the target tone, combined with ignoring both standard and distractor tones (p<0.05). In contrast, rats injected with low doses of MK801 still responded correctly to the target tone but also made more false responses to the distractor and standard tones, which was combined with more impulsive hits in the inter-trial intervals (p<0.05).

#### Conclusion

Both neuroactive compounds impair performance in the oddball paradigm. However, low doses of dopamine receptor agonists reduce responses to all stimuli, whereas NMDA receptor antagonists enhance false responses to standard and distractor tones. Together, apomorphine and MK801 address different aspects of disturbed information processing seen in certain neuropsychiatric disorders.

### P122

TRAF5 führt zu reduzierter Tumor-Zellmigration und zur Apoptose bei mit CD40-hochregulierten pädiatrischen Medulloblastom-Zellen *TRAF5 leads to decreased tumor cell migration and induces apoptosis in CD40-upregulated pediatric medulloblastoma cells* 

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#### Objective

As cytoplasmic adapter proteins, tumor necrosis factor receptor-associated factors (TRAFs) regulate cell proliferation or apoptosis by interacting with proteins of the tumor necrosis factor receptor (TNFR) superfamily, such as CD40. TRAF1-7 are known, promoting intracellular signaling pathways by using kinase cascades, which leads to activation of specific transcription factors (Arch *et al.* 1998). Increased expression of TRAF4 in glioblastoma was shown to promote cell proliferation and migration (Ruan *et al.* 2022). TRAF5 was associated with a poor outcome in low-grade glioma (Zhang *et al.* 2022). In this study, we investigated the role of TRAF proteins, especially TRAF5, in pediatric brain tumors.

#### Methods

Expression levels of TRAF proteins in patient samples were quantified via qPCR. Induced CD40 and TRAF5 expression in pediatric MB cell line DAOY was done via transfection of a recombinant expression plasmid. Successful transfection was proved with qPCR, Western Blot and immunofluorescence staining. For functional analysis, migration and apoptosis assay were performed on transfected cells (T+) and untreated cells (WT).

#### Results

In contrast to the other TRAF proteins, TRAF5 expression was reduced in pediatric MB in comparison to adult MB (0.6 vs. 2.67, p=0.05). In addition, we found an influence on TRAF5 level caused by CD40 (WT 0.533 vs. TCD40+ 0.832, p=0.0068). Enhanced TRAF5 *in vitro* had neither an significant effect on migration behavior, nor in cell apoptosis in comparison to WT. However, combined overexpression of CD40 and TRAF5 led to decreased migration rate (*Fig.1*, p=0.0179) and induced apoptosis in MB (*Fig.2* WT vs. TCD40/TRAF5+ p=0.013).

#### Conclusion

TRAF5 expression is downregulated in pediatric MB. Enhanced TRAF5 level showed reduced migration behavior and enhanced apoptosis in MB, but only in combination with CD40 upregulation.

**Figure 1 Effects on migration behavior due to CD40 and TRAF5 overexpression.** Wound width over time is shown. P value was assessed by comparing migration rates (mm/h). WT: 0.0168±0.0025; TCD40+: 0.0119±0.0008; TTRAF5+: 0.0141±0.0016; TCD40/TRAF5+: 0.0112 ± 0.0013.

**Figure 2 Increased amount of apoptotic cells due to TRAF5 in CD40-upregulated cells only.** Percentage of apoptotic cells after induced expression of CD40, TRAF5 and CD40+TRAF5 is shown. WT: 5.15±0.544; TCD40+: 8.35±0.814; TTRAF5+: 6.72±1.116; TCD40/TRAF5+: 7.23±1.105.

Abb. 1





DAOY medulloblastoma



### P123

Die microRNA 181a-5p wirkt als Tumor-Suppressor durch die Regulation von STAT3 in Glioblastom-Zellen The miRNA miR-181a-5p acts as a tumor suppressor by regulating STAT3 in glioblastoma cells

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#### Objective

The transcription factor STAT3 plays a crucial role in glioblastoma tumor behavior, mediating cell proliferation, migration and invasion of tumor cells. The mechanisms of STAT3 regulation are diverse. The miR-181a-5p is known to be significantly downregulated in glioblastoma. In these cells, it acts as a tumor suppressor microRNA. Previous studies in other cancer entities have shown that high expression levels of miR-181a-5p correlate with a downregulation of STAT3 on the protein level. Moreover, miR-181a-5p is regulated by the membrane protein ADAM8 that directly affects STAT3 activation and signaling.

#### Methods

Two stable U87 *ADAM8* knockout clones were generated by CRISPR/Cas9 knockout and successful knockout was confirmed by RT-qPCR and Western Blot. The target Genes of miR-181a-5p were identified using the miR-databases DIANA TarBase and TargetScan and validated by RT-qPCR. U87 cells were transfected with miR-181a-5p mimic-siRNA (miScript, Qiagen), miR-181a-5p inhibitor-siRNA (miRCURY LNA, Qiagen) and control-siRNA (ON-TARGET plus non targeting control pool, Dharmacon). After 48h incubation, RNA and proteins were extracted and the expression levels of STAT3 and downstream target genes were quantified using RT-qPCR.

#### Results

The expression of miR-181a-5p was significantly upregulated by 3.8-fold ( $\pm$  0.4) in the two ADAM8-KO clones, p < 0.05. After transfection with mimic-siRNAs, a significant correlation was observed for the expression between miR-181a-5p and STAT3 (p < 0.05). On the protein level, STAT3 was also significantly downregulated after miR-181a mimic transfection (p < 0.05). The miRNA databases TarBase and Target Scan provide potential binding sides for miR-181a-5p on the mRNA of STAT3. As GBM relevant genes, we further showed that osteopontin (SPP1) and Notch2, two proteins with pathological impact in GBM, are target genes of miR-181a-5p in U87 cells.

#### Conclusion

STAT3 is a crucial factor for GBM tumor aggressiveness. We conclude from our data that the ADAM8-miR-181a-5p axis regulates STAT3 in GBM cells. By defining target genes of miR-181a-5p in GBM cells, we will be able to assess whether this miRNA is a suitable agent for GBM therapy.

### P124

Höhere Anzahl von Neuronen bei nicht WNT/SHH-aktivierten Medulloblastomen legt neuronale Marker als diagnostische Marker für Medulloblastom-Untergruppen nahe. Higher neuronal amount in non WNT/SHH-activated medulloblastoma suggests neuronal marker as diagnostic marker for medulloblastoma subgrouping.

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#### Objective

High-grade brain tumors are characterized by a huge intra-tumoral heterogeneity, driven by their strong invasive and infiltrative growth. Not least for this reason, various subgroups are distinguished based on distinct molecular alterations and cellular characteristics. Recent studies have demonstrated that the neural component within glioblastomas can serve as a prognostic indicator, contributing to the classification and identification of specific tumor subtypes (Drexler *et al.* 2024). In this study we therefore analysed five neuronal marker in glioblastoma and medulloblastoma subtypes.

#### Methods

Neuronal marker UCHL1, Tau, NeuN, NSE and TUBB3 were analyzed in 60 medulloblastoma and glioblastoma patients via qPCR. Glioblastoma samples were grouped according to their IDH gene mutation status. For medulloblastoma the WHO 2021 subclassification (WNT-act, SHH-act and non-WNT/SHH-act) was chosen.

#### Results

By differentiating GBMs in IDH-wt and IDH-mut subtype, a significant higher expression in IDH-mut tumours could be found for NSE (p = 0.001), Tau (p = 0.016) and TUBB3 (p = 0.0004). Subdivision of MBs showed much lower mRNA value in WNT-mut tumors compared to the SHH- and non WNT/SHH-subtype for UCHL1 (p = 0.043), NeuN (p = 0.015) and Tau. NSE and TUBB3 in contrast were lowest in the SHH-subtype with significance to the non WNT/SHH-subtype (p = 0.01). All genes analysed, despite UCHL1, showed up the most in the non WNT/SHH-subtype.

#### Conclusion

Based on the results one could consider neuronal marker as diagnostic marker to differentiate medulloblastoma subtypes defined by the 5th WHO classification.

Figure 1 Expression of neuronal marker varies with molecular subtype. **A** Significantly higher expression in IDHmut compared to IDHwt GBM for NSE p=0.001, Tau p=0.016 and TUBB3 p=0.0004. **B** Subtyping of MB showed highest expression in non WNT/SHH-subtype for all, except UCHL1. Lowest expression with significance to non WNT/SHH-subtype in WNTact for UCHL1 p=0.043 and NeuN p=0.015. NSE and TUBB3 p=0.01 were significantly lower in SHHact than non WNT/SHH-subtype.

Abb. 1



### P125

Interaktion zwischen gliom-assoziierten Mikroglia und GBM-Tumorzellen durch Humanin-induzierte Aktivierung von GP130: Untersuchungen in einem humanisierten organotypischen Hirnschnittmodell. Crosstalk between glioma-associated microglia and GBM cells is mediated by Humanin-induced activation of GP130 in a humanized, organotypic brain-slice model.

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#### Objective

Glioblastoma (GBM) are highly malignant brain tumors with an average survival rate of 14 months. The DNA damage response and the blood-tumor barrier restrict chemotherapeutic success, leading to GBM relapse in almost all cases. Myeloid cells (glioma associated microglia and macrophages, GAMs) and the intratumoral vasculature can support GBM expansion, but in how far GAMs modulate GBM vascularization and BTB formation is unclear. Previously, we showed that interaction of GAMs and GBM cells induce overexpression of the mitochondrial ribosomal gene MT-RNR2, which contains an open reading frame that is translated into a signalling peptide named humanin. Humanin stimulates GP130 dependent signalling on GAMs, GBM- and endothelial cells, resulting in GBM treatment resistance. Since humanin is a human-specific peptide, we established different humanized GBM models to explore this mechanism.

#### Methods

We established an ex-vivo mouse brain slice model that was depleted from endogenous microglia and replenished with human (iPS derived) microglia and/or injected with human stem-like glioma cells. Pharmacological experiments included application of the GP130 blocker sc144. In addition, we explored morphological changes in GBM or hiPS-microglia cell cultures reciprocally treated with conditioned medium from hiPSC microglia or GBM cells in presence or absence of sc144.

#### Results

In the slice model, interaction of microglia with hGBMs induced strong humanin expression specifically in the brain tumor mass, which was significantly reduced by coadministration of sc144. Conditioned medium from microglia cell cultures induced protrusion formation and humanin expression in GBM cells, which were both blocked by GP130 inhibition. Stimulation of microglia with recombinant humanin or with conditioned medium from GBM cell cultures also induced protrusion formation (depending on GP130), but did not lead to augmented humanin expression. When we cocultivated microglia with GBM cells, we consistently observed a GP130 dependent induction of humanin expression in GBMs and also in microglia.

#### Conclusion

In summary, our results show that the strong intratumoral humanin expression observed in many GBMs depends on GAM and GBM crosstalk via humanin release and GP130 activation. Clinically applied, GP130 blockers are available and such compounds have the potential to blunt resistance for standard therapy and tumor relapse.

### P126

Anreicherung Polysialinsäure-modifizierter Proteine in der Tumormikroumgebung und im Serum eines intrakraniellen Ratten-Gliommodels

Polysialic acid-modified proteins accumulate in tumor microenvironment and serum of an intracranial rat glioma model

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#### Objective

Through interactions with Siglec immune receptors, the glycan polysialic acid (polySia) is implicated in immune regulation of the tumor microenvironment. Attached to the neural cell adhesion molecule NCAM as its major protein carrier, polySia on tumor cells shapes the status of tumor-associated microglia and macrophages (TAM) which has been linked to survival of patients with glioblastoma. *In vitro*, activated microglia and macrophages can produce two other polysialylated proteins, NRP2 and ESL-1, which accumulate in the Golgi compartment before being released through ectodomain shedding. To address the unresolved question whether activated TAM are able to shed polysialylated proteins *in vivo*, we explored an autologous intracranial rat glioma model.

#### Methods

PolySia-negative BT4Ca rat glioma cells were inoculated into the frontal cortex of male BDIX rats, which either received no further treatment (n = 11) or had microsurgical tumor resection after eight days (n = 14). Unburdened rats served as controls (n = 14). At the humane endpoint, brains and serum were isolated. PolySia levels of serum samples were analyzed by immunoaffinity chromatography. HE, PAS and AZAN stainings were applied to categorize tissue compartments. Immunohistology targeting polySia, IBA1 (microglia/macrophages) and GFAP (astrocytes and glioma cells) was performed to localize polySia in the microenvironment of the rat tumor, and, for comparison, in brain metastases from human lung tumors.

#### Results

The median overall survival was 15 days for rats without and for rats with surgical intervention (p = 0.01). Immunohistology revealed numerous tumor-infiltrating IBA1-positive microglia and macrophages and a gradient of microglia accumulation and activation towards the tumor border in the surrounding brain parenchyma. As in human glioblastoma, occasional IBA1-positive cells with activated morphology and intracellular, Golgi-like polySia staining were detected within the tumor. In contrast, non-cell-associated polySia was abundant in the adjacent glial scar. The same staining patterns were observed in lung-derived brain metastases indicating translational consistency. In the serum of three tumor-bearing rats without surgical intervention analyzed so far, one out of two peaks assigned to polysialylated proteins displayed a massive increase.

#### Conclusion

These findings indicate shedding of host-derived polysialylated proteins into the tumor microenvironment.

### P127

Unterschiedliche enzymatische Protokolle zur neuronalen Gewebsdissoziation degradieren den Mikrogliaspezifischen TMEM119 Oberflächenmarker Different enzymatic neural tissue dissociation protocols degrade the microglia-specific TMEM119 surface marker

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#### Objective

For the analysis of the microglial immune compartment, the TMEM119 surface marker facilitates the differentiation between brain-resident microglia from bone-marrow derived macrophages. For the generation of single-cell suspensions from brain tumour tissue, commercially available neural tissue dissociation kits contain enzymes such as papain, collagenases, trypsin or accutase. Detrimental effects on the surface marker of interest (TMEM119) remain elusive.

#### Methods

Frozen normal brain tissue was thawed, homogenised and separated in five treatment conditions. In each condition, enzymes were added in typically used concentrations: collagenase IV, papain, trypsin, accutase and PBS (control). The protein phase was extracted, and western blotting was conducted to determine semiquantitative detectability of TMEM119 surface marker with the corresponding antibody.

#### Results

TMEM119 surface marker was well detectable at 55kDa after PBS (control), papain and accutase treatment, yet papain and accutase treatment showed a weak second band at 45kDa due to cleavage of the extracellular domain. After trypsin and collagenase IV treatment, TMEM119 was undetectable, even though in combination with proteinase inhibitors, collagenase IV activity was reduced and a weak band became visible. (see Fig. 1). In line with our Western Blot results, for collagenase IV enzymatic digestion, CD11b+TMEM119+ cells were missed in FACS analysis of fresh glioblastoma tissue samples.

#### Conclusion

For questions on the microglial compartment using the TMEM119 surface marker, enzymatic dissociation as available in commercial kits has to be used with great caution. Collagenase IV and trypsin make the detection of microglia via TMEM119 futile, and with papain and accutase detection may be impeded to a certain degree by traceable cleavage of the extracellular domain of TMEM119.



Elg. 1: A: Collagenase IV (1210 U/ml): no band for TMEM119 (w/o proteinase inhibitor, left); proteinase inhibitors (PI) inhibit collagenase IV and a weak band is visible (right). Papain (1200 U/ ml) and accutase: band for TMEM119 at 55kDa, a second band is visible between 40 and 55 kDa (ECM = extracellular domain). Trypsin: no signal for TMEM119, B: Adding 20 and 40 µg to the western bid: (left) shows reproducible results compared to A, for lower concentration of collagenase IV (605 U/ml), still, no signal is visible for TMEM119. Papain shows a concentration dependent band at 55kDa for TMEM119. Accutase and control (PBS) show a good signal at 55kDa.

#### Abb. 1

### P129

Translationale Aspekte beim Lernen komplexer Verhaltensaufgaben und kognitive Verarbeitung von Hörinformationen im Thalamus von Ratten *Translational aspects of learning complex behavioral paradigms and thalamic processing of auditory information in rats* 

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#### Objective

Rodent models are used to examine the neural processing of auditory information, which is disturbed in certain neuropsychiatric disorders, and to develop new treatment concepts like targeted stimulation. However, the hearing range of rats differs from that of humans. Also, rats require extensive training for complex tasks, in contrast to humans. We investigated how rats learn an auditory oddball paradigm, if they can be trained with auditory stimuli used in humans, and whether thalamic event-related potentials (ERPs) are similar to those recorded from humans.

#### Methods

Sprague-Dawley rats (n=9) were trained in a three-class oddball paradigm to respond to a rare Target tone (either 5 kHz [high subgroup: n=5] or 1.5 kHz [low subgroup: n=4]), while ignoring a rare Distractor (1.5 or 5 kHz), and a frequent Standard tone (3 kHz). Training phases sequentially introduced Target, Standard and Distractor tones. The number of days to achieve 80% correct responses to Target while ignoring the Distractor and Standard tones, the number and reaction times of correct responses to Target, respectively incorrect rejection of Standard and Distractor were used to characterize the learning process. Thalamic ERPs were derived from stereotaxically implanted electrodes during the oddball paradigm.

#### Results

Rats learned the oddball paradigm in 6-7 weeks, with no difference between high and low Target frequency subgroups (p=0.141). Initially, rats responded randomly to Targets, then showed improved accuracy and shorter reaction times in later training phases (p<0.001). Upon introduction, the reaction times of incorrect responses to Standard and Distractor tones were similar to Target responses (p=0.123 and p=0.531), but later during training rats ceased responding to these tones. Thalamic ERPs did not differ between rats trained for the high or low target frequency, with highest amplitude after Target compared to that after Distractor and Standard.

#### Conclusion

We here show that rats can be trained in auditory paradigms with frequencies used in humans, which is relevant to advance future research. While humans ignore the Standard and Distractor when instructed, rats initially identify them as Target before ignoring them. Similar to humans, the thalamic ERP amplitude is highest after Target. This setting will allow to address attention deficits in neuropsychiatric conditions.

### P130

Die Reprogrammierung des Tumormikromilieus von experimentellen Gliomen mittels TLR3-Agonisten führt zu einer höheren Frequenz zytotoxischer T-Lymphozyten und korreliert mit einer verbesserten Überlebenszeit in einem syngenen Gliom-Modell

Reprogramming of experimental glioma microenvironment with TLR3 agonist improves function of cytotoxic Tlymphocytes and correlates to increased overall survival in a syngeneic glioma model

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#### Objective

High-grade gliomas (HGG) are primary CNS tumors resistant to current therapies, including immunotherapy. Tumor recurrence is driven by therapy-resistant traits and an immunosuppressive tumor microenvironment (TME). This study evaluates the efficacy of a nanoparticle-based (neo)adjuvant immunotherapy delivering the Toll-like receptor 3 (TLR3) agonist RIBOXXOL to epidermal growth factor receptor variant III (EGFRVIII)-expressing glioma cells. Conceptually, TLR3-agonist delivery should reprogram the TME, promote immunogenic cell death, and reinvigorate or restore anti-tumor immunity.

#### Methods

Anti-EGFRvIII RICIA nanoparticles were assembled by conjugating EGFRvIII-specific single-chain antibody fragments, neutravidin, and biotinylated RIBOXXOL. The effects of RICIA treatment were evaluated in TLR3-expressing reporter cells as well as wildtype and TLR3-deficient murine SMAvIII glioma cells. Cytokine production and immune activation were assessed by multiplex bead assays, flow cytometry, and ELISA. Tumor growth and survival after RICIA treatment were investigated in syngene subcutaneous (s.c.) and intracranial (i.c.) SMAvIII-FfLuc-VM/Dk glioma mouse models. In s.c. tumors, transcriptional alterations within the post-therapeutic TME were analyzed, and the phenotype of tumor-infiltrating lymphocytes (TILs) was evaluated by immunohistochemistry.

#### Results

Anti-EGFRVIII RICIA treatment induced TLR3-dependent sterile inflammation, leading to enhanced IFN- $\beta$  secretion and cellular inflammation in SMAvIII cells. In vivo, RICIA-treated s.c. gliomas exhibited significant tumor growth inhibition, with inflammatory reprogramming of the TME, including a decrease of the immunosuppressive M2 macrophage phenotype and an increase in GrzB+ PD-1- CD8+ TILs. Long-term experiments demonstrated significantly prolonged survival, with 25% of treated mice achieving complete glioma regression and protective immune memory confirmed by tumor rejection upon rechallenge. Furthermore, RICIA treatment of orthotopic glioma resulted in tumor growth inhibition, extended survival, and complete tumor regression in 13% of cases.

#### Conclusion

Anti-EGFRVIII RICIA represent a tumor cell-selective, immunomodulatory strategy that induces TLR3-dependent glioma cell death and reprogramming of the TME thereby enhancing CTL responses. These findings highlight the therapeutic potential of RICIA for the treatment of HGG.

### P131

Laufradverhalten zur Belastungsbeurteilung und zur humanen Endpunkterkennung bei Ratten mit intrakraniellen Gliomen

Voluntary wheel running for severity assessment and humane endpoint determination in rats with intracranial glioma

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#### Objective

Animal models of intracranial tumor formation are essential for the development and improvement of novel therapeutic approaches. Likewise, adequate and objective parameters for severity assessment and humane endpoint determination in laboratory animals are fundamental for ethical and legal reasons. Voluntary wheel running (VWR) has been identified as a novel and robust parameter for severity classification. We evaluated VWR behavior in addition to daily assessed body weight and clinical scoring after tumor cell injection and tumor resection, as well as humane endpoint determination after tumor regrowth.

#### Methods

For this study, male BDIX rats were either single-housed (n=14) in wheel-equipped cages or group-housed (n=6) in a large cage assembly (three Makrolon type IV cages connected by tubes) equipped with running wheels, where the rats could be identified by a subcutaneously placed RFID chip. Under general anaesthesia, both groups received a stereotaxic injection of glioblastoma BT4Ca cells into the frontal cortex. After eight days, the tumor was microsurgically resected in the single-housed rat group. Body weight, clinical score and VWR were monitored daily until the humane endpoint criterion of sudden weight loss and deteriorations of the clinical score was reached.

#### Results

In single-housed rats, body weight was slightly but significantly reduced after the cell injection and tumor resection (p<0.05), along with reduced VWR (p<0.05), while clinical status remained unaffected. On the day of the humane endpoint, sudden weight loss and clinical deterioration were associated with almost no use of the running wheel (p<0.05). Analysis of group-housed rats showed that decreased VWR was associated with weight loss (p<0.05) after tumor cell implantation and before the humane endpoint was reached, accompanied by a worsened clinical score.

#### Conclusion

Together, VWR monitoring enhances the ability for objective assessment of the severity of neurosurgical procedures in rat models of intracranial tumor formation, including the determination of humane endpoints in both individual and group housed animals.

### P132

Neuroprotektion durch Xenon und Argon nach Schädel-Hirn-Trauma - Eine randomisierte kontrollierte tierexperimentelle Studie Neuroprotective Effects of Xenon and Argon after Traumatic Brain Injury - A Randomized Controlled Animal Study

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#### Objective

Noble gases are attributed to various neuroprotective properties. While xenon provides promising data on its neuroprotective effects after traumatic brain injury (TBI), results on the impact of argon remain variable. Furthermore, no study has yet directly compared the neuroprotective properties of both xenon and argon in vivo after TBI. This study aimed to assess whether those two noble gases positively impact the overall neurological outcome and histological features after 14 days.

#### Methods

Controlled cortical impact was performed on 120 C57B/6N-mice (adult male: n=60; female: n=60). Following a one-hour recovery period, the surviving rodents underwent two hours of inhalation and were randomly assigned to one of three groups: [1] Control group 25%O2/75%N2 (n=37), [2] Argon group 25%O2/25%N2/50%Arg (n=39), [3] Xenon group 25%O2/25%N2/50%Xe (n=40). Neurological outcomes were assessed using a modified Neurological Severity Score before surgery and on postoperative days (POD) 1 and 13. All mice were sacrificed on day 14.

#### Results

On day 13 following TBI, the neurological score was significantly lower in the control group compared to the treatment groups (control vs. argon: p = 0.04; control vs. xenon: p = 0.03). There were no relevant differences in the values for baseline and day 1. The contusion volume measured on day 14 was lowest in the argon group (argon vs. control: p = 0.03; argon vs. xenon: p = 0.02). Additionally, a higher number of viable neuronal cells was found in the cortical penumbra and thalamic region of the argon group but not in the xenon group (penumbra - control vs. argon: p = 0.02; thalamus – control vs. argon: p = 0.03; argon vs. xenon: p = 0.03; argon vs. xenon: p = 0.01). Neuronal cell counts in other examined regions (CA1 and CA3) did not differ between the treatment groups. In the penumbra and CA1 regions, neuroinflammation (ratio of activated microglia) was higher in the xenon group compared to the control group but not in the argon group. There were no differences in neuroinflammation for the remaining regions examined (CA3 and thalamus).

#### Conclusion

Noble gas treatment following TBI did not improve the neurological status. However, the argon group exhibited a lower contusion volume and a higher neuronal cell count in the penumbra and thalamus. Conversely, microglial activation increased in the xenon group, particularly in the penumbra and CA1 regions. Although argon is generally considered a less potent neuroprotectant, it appears to have more beneficial effects than xenon in this context.

### P133

# Wirksamkeit und Sicherheit der Anwendung von Andexanet alfa bei Notfalltrepanationen: ein bizentrischer Erfahrungsbericht

#### Efficacy and safety of Andexanet alfa for emergency trepanation: a bicentric real world experience

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#### Objective

Factor Xa inhibitors are widely used anticoagulation agents which are associated with a notable risk of bleeding. In 2019, the antidote Andexanet alfa has been approved for reversal of Apixaban and Rivaroxaban and showed high efficacy in controlling intracerebral hematoma. However, data about its use before neurosurgical procedures are scarce. Here, we report our experience with the use of Andexanet alpha before emergency trepanation.

#### Methods

We performed a retrospective data analysis over the past 4 years and identified patients undergoing trepanation under factor Xa inhibitors and Andexanet alpha in two high volume neurosurgical university centers in Germany. We reviewed demographic and medical data including age, sex, diagnosis, neurological status, laboratory results, surgery protocols and imaging. The primary endpoints of this study were 1) the efficacy of Andexanet alpha in terms of preventing a secondary bleeding during or after surgery and 2) its safety regarding thromboembolic events. The efficacy was determined on the postoperative CT scan (6 hours after surgery) and categorized in excellent, good or weak.

#### Results

A total of 29 patients (female n=14; male n=15) were treated with and example and underwent 33 operations in total (18 burr-hole craniostomies (BH) and 15 craniotomies (CRA)). Burr-hole craniostomy was performed for external ventricular drainage (N=13), intracranial pressure monitoring (N=3), or evacuation of a subdural hematoma (N=2). Patients were aged between 55 and 94 years (Mean: 74.82  $\pm$  10.65). Coma/sopor was present in 64% of the patients (BH: 72% vs CRA: 53%; p = 0.3). In total, efficacy was good or excellent in 94% (BH: 94% vs. CRA:93%; p >0.99). Cerebral ischemia was detected in 24% of the cases (BH: 22% vs. CRA: 27%; p > 0.99). There was no case of deep vein thrombosis or pulmonary embolism. Surgery duration was significantly longer in the craniotomy group (p < 0.0001).

#### Conclusion

Our data indicate a high efficacy of Andexanet alpha in preventing secondary bleeding during brain surgery in patients under Factor Xa inhibition. However, the occurrence of cerebral ischemia should be considered. Larger studies are needed to validate our findings.

### P134

#### Entwicklung einer neurochirurgisch relevanten POCT Liquoranalyse mittels IR Spektroskopie On-site CSF analysis using IR spectroscopy

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#### Objective

Rapid on-site analysis of cerebrospinal fluid (CSF) samples would benefit neurosurgical decision making, e.g. ventriculitis detection and follow-up, monitoring of therapeutic compounds or their relevant biochemical functional markers. For these purposes, IR and Raman spectroscopy are powerful molecular structural techniques. Here, the objective is the pre-clinical investigation of IR spectroscopy to analyse CSF samples of a typical neurosurgical cohort.

#### Methods

Multiple CSF samples from 16 patients were obtained. CSF samples from patients were obtained from ventricular CSF drains. Patients diagnosis for CSF drainage varied from normal pressure hydrocephalus, subarachnoid hemorrhage, ventriculits, tumor-related drainage. Standard CSF laboratory diagnostics were obtained as regular clinical routine : e.g. glucose, protein, lactate, differential cell analysis. Approximately 20 to 50 µL of CSF were transferred onto CaF2 slides and air dried. The dry CSF samples were examined using microscopic infrared imaging spectroscopy using a Vertex 70 FT-IR spectrometer with infrared microscope Hyperion 3000 (both Bruker Optik GmbH, Ettlingen, Germany). More than 40,000 spectra were recorded for each sample. Spectra that did not represent CSF or showed only larger salt crystals or other artifacts were excluded from further analysis. Baseline correction was performed (OPUS 7.2 software, Bruker Optic GmbH, Ettlingen, Germany). In order to extract the desired information from the complex spectral signatures, cluster analysis (MatLab software, MathWorks Inc, Natick, MA, USA) was used at first to highlight similarities and principal component analysis was performed to identify variations across the dry CSF sample

#### Results

In addition to the signals of various electrolyte anions, the spectra showed the spectral signatures, i.e. absorption bands, of proteins and cells. In particular, the amide-1 band at 1650 cm-1 and the amide-II band at 1550 cm-1 are clearly visible. Measurements of IRS to clinical routine measurements were correlated. The detailed analysis allows conclusions to be drawn about the concentration and also the biochemical nature of organic components. Furthermore, the spectra also allow an assessment of the electrolyte composition.

#### Conclusion

IR spectrosocpy has the potential as a low cost on-site Point-of-Care test (POCT) methodology for immediate CSF analysis specific for neurosurgical demands e.g. in the ICU setting, neuromonitoring and therapeutic monitoring

### P135

Anwendung einer MRT-fähigen und längenverstellbaren Implantationstechnik von Licox Hirngewebe-Oxygenierungssonden in der Neurochirurgie Feasibility and Safety of an Adjustable and Magnetic Resonance Imaging Conditional Implantation of a Licox Brain Tissue Oxygenation Probe in Neurosurgery

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#### Objective

The continuous monitoring of tissue oxygenation at the bedside of comatose patients is essential for the treatment of acute brain injury, as it can reduce the risk of secondary ischaemia. The Licox oxygen microprobe remains the gold standard option for measuring the partial pressure of oxygen in brain tissue. The current implantation method involves the insertion of metal bolts, thereby precluding the use of MRI imaging in this cohort. Therefore, a different technique utilising plastic bolts has been reported in literature. The aim of this study is to investigate the differences between the MRI compatible with the traditional Licox implantation methods with regard to compilations, haemorrhages due to the flexible bolt in the new technique and the difference in MRI quality.

#### Methods

The study included patients who had a Licox probe inserted between 2017 and 2021. The implantation techniques investigated included the intraoperative implantation of a probe during a craniotomy or craniectomy, bedside implantation using the traditional metal bolt and bedside insertion of a probe using the novel length-adjustible and MRI-compatible technique. All patients underwent CT scanning immediately post insertion and within 14 days to assess positioning and complications. Patient-specific risk factors for bleeding were identified and included in the analysis. The individual measurements of the Licox probes were also collected and analysed.

#### Results

We included 120 patient with 165 individual probes. 77 were inserted using the traditional method, 61 using the novel procedure and 16 were implanted intraoperatively. 22% of patients developed a small bleed along the insertion path, while 3.6% suffered an intracerebral haemorrhage (ICH). A multivariate analysis showed no significant difference in insertion canal bleeding (p=0.826; SD 0.071) or ICH (p=0.413; SD 0.425) between the different groups. The analysis of the measurement data identified no differences in the measuring precision between the different methods. In both groups, there were no complications in the form of bedsite infections or probe displacement.

#### Conclusion

In this study we show that the novel MRI compatible technique for Licox probe implantaion is a safe option, as it does not increase bleeding risk, while maintaining an equivalent measuirng precision of oxygen partial pressure compared to other methods.

### P137

Vergleichbare In-vitro-Rückgewinnung von Mikro- und Makromolekülen bei der Verwendung von 20kDa- und 100kDa-Kathetern für die Mikrodialyse und die Verwendbarkeit von Dextran als Zusatz zur Perfusionsflüssigkeit Similar in vitro recovery of micro- and macromolecules applying 20kDa and 100kDa catheters in microdialysis and usability of dextran as supplement of perfusion fluid

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#### Objective

Microdialysis is applied in neurointensive care to monitor cerebral glucose metabolism. If recoverable, macromolecules may also serve as biomarkers in brain disease and provide clues to their passage across the blood–brain barrier. Our study aimed to investigate the in vitro recovery of human micro- and macromolecules using microdialysis catheters and perfusion fluids approved for clinical use.

#### Methods

In vitro microdialysis of a bulk solution containing physiological or supraphysiological concentrations of glucose, lactate, pyruvate, human IgG, serum albumin, and hemoglobin was performed using two different catheters and perfusion fluids. One had a membrane cut-off of 20 kDa and was used with a standard CNS perfusion fluid, and the other had a membrane cut-off of 100 kDa and was perfused with the same solution supplemented with dextran. The flow rate was 0.3  $\mu$ l/min. We used both push and push–pull methods. Dialysate samples were collected at 2-h intervals for 6 h and analyzed for relative recovery of each substance.

#### Results

The mean relative recovery of glucose, pyruvate, and lactate was > 90% in all but two sets of experiments. In contrast, the relative recovery of human IgG, serum albumin, and hemoglobin from both bulk solutions was below the lower limit of quantification (LLOQ). Using a push–pull method, recovery of human IgG, serum albumin, and hemoglobin from a bulk solution with supraphysiological concentrations were above LLOQ but with low relative recovery (range 0.9%–1.6%). In summary, exchanging the microdialysis setup from a 20 kDa catheter with a standard perfusion fluid for a 100 kDa catheter with a perfusion solution containing dextran did not affect the relative recovery of glucose and its metabolites.

#### Conclusion

Catheters with a membrane cut-off of 20 kDa and 100 kDa yielded similar results of relative recovery of small molecules. A perfusion solution with high osmolality should be applied when using the 100 kDa catheters, and dextran was suitable for this purpose. We could not demonstrate useful recovery of large molecules at physiological concentrations. Detailed protocols for microdialysis of large molecules should be validated in vitro to secure clinical reproducibility.

### P138

Der Einfluss einer initialen Leukozytose auf die intrahospitale Mortalität bei neurochirurgischen Intensivpatienten mit isoliertem Schädel-Hirntrauma Impact of initial White Blood Cell Count on Intrahospital Mortality in Neurosurcigal Intensive Care Unit patients with Isolated Traumatic Brain Injury

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#### Objective

Despite advancement in intensive care unit treatment, isolated traumatic brain injury (iTBI) is still associated with high morbidity and mortality. During inpatient treatment a systematic inflammatory response is often found in iTBI patients. However, the impact of the initial peripheral white blood cell count on intra-hospital mortality (IHM) has not been well investigated. The current study was conducted to assess the impact of initial peripheral white blood cell count on IHM in iTBI patients.

#### Methods

A total of 200 iTBI patients, who were treated from 08/2014 to 12/2016 on our intensive care unit were retrospectively evaluated. Blood samples were taken upon admission to analyse the white blood cell count. In addition, each patient's demographic, radiological and medical data upon admission and ICU parameters within the first 24 hours as well as the IHM at discharge were evaluated. The cardiopulmonary targets were defined as a systolic blood pressure of 120-140 mmHg and an oxygen saturation  $\geq$  95%. The entire study population was stratified into survivors and non-survivor.

#### Results

IHM rate was 27.5% (n=55) and significantly associated with higher level of blood glucose levels (p<0.0001), serum urea (p= 0.032) partial thromboplastin time (p= 0.002) and lower haemoglobin (p= 0.001) and prothrombin time level (p= 0.002), lower body temperature (p<0.0001) upon admission as well as a higher need of mechanical ventilation (p <0.0001), norepinephrine (p= 0.011) and inspiratory oxygen fraction within the first 24 hours. In the binary logistic regression analysis advanced age (odds ratio [OR]= 1.04; confidence interval [CI]= 1.01-1.08; p= 0.08), lower Glasgow Coma Scale score (OR= 0.78; CI= 0.7-0.88; p <0.0001) and lower albumin level (OR= 0.89; CI= 0.82- 0.97; p= 0.009) as well as higher lactate level (OR= 1.78; CI= 1.24 – 2.56; p = 0.02) and higher white blood cell count (OR= 1.08; CI= 1.01-1.16; p= 0.02) upon admission were identified as independent predictors of IHM in neurosurgical iTBI patients. A white blood cell count upon admission >10.8 giga/I was associated with increased intra-hospital mortality (Youden's index= 0.26, sensitivity= 0.69, specificity= 0.57).

#### Conclusion

A white blood cell count >10.8 giga/l seems to be a valid prognostic marker to predict intra-hospital mortality in ICU-admitted neurosurgical patients with iTBI.

### P139

Retrospektive Analyse von Komplikationen bei der Anlage externer Ventrikeldrainagen Retrospective Analysis of Complications in the Placement of External Ventricular Drains

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#### Objective

The External ventricular drain (EVDs) is a standard therapeutic tool used for intracranial pressure (ICP) management and cerebrospinal fluid (CSF) drainage in critical neurological conditions. Despite the standardized procedural steps complications such as catheter misplacement remain a significant concern, especially emergency conditions outside of the operating room. We analyzed our large patient cohort of patients receiving EVD placement under various emergency conditions focusing on the quality of catheter position with regard to circumstances and environment of application.

#### Methods

A retrospective analysis was conducted using data from adult patients treated with EVD at a single neurosurgical center between January 2014 and January 2020. Patient demographics, underlying pathologies, procedural settings, and EVD-related factors were extracted from clinical records. Statistical correlations were performed to evaluate the association between these parameters and post-procedural complications, including catheter misplacement, infection, bleeding, and occlusions. The primary hypothesis posits that the placement environment (operating room vs. other setting) significantly influences complication rates.

#### Results

A total of 620 patients were analyzed, with 520 undergoing EVD placement in the operating room (OR group) and 100 outside (non-OR group). The cohort included 314 males (50.65%) and 306 females (49.35%). Indications were intracerebral hemorrhage (ICH, 23.55%), subarachnoid hemorrhage (SAH, 25.32%), and traumatic brain injury (TBI, 15.16%). Catheter misplacement occurred in 6.68% overall (OR: 6.57%, non-OR: 7.23%). Complications included catheter-associated infections (10.16%) and bleeding (4.84%). Data collection for the non-OR group is ongoing, which may refine comparisons.

#### Conclusion

EVD placement is associated with notable complication rates, including catheter misplacement and infections, particularly in emergency settings outside the operating room. While misplacement and overall complication rates were comparable between groups, ongoing data collection in the non-OR group is expected to refine these findings and provide a more balanced comparison.

### P140

# Einflussfaktoren des perioperativen Outcomes nach Hemikraniektomie bei Patienten mit malignem Mediainfarkt *Factors influencing perioperative outcome after hemicraniectomy in patients with a malignant middle cerebral artery infarction*

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#### Objective

Malignant middle cerebral artery (MCA) infarction constitutes a serious clinical picture. Both, the acute event with impaired consciousness, progressive cerebral edema and entrapment, and its subsequent course with permanent restrictions can lead to clinical deterioration. Hemicraniectomy is a preventive measure to alter the course and improve outcome in these patients.

#### Methods

This single-center, retrospective observational study included patients with malignant MCA infarction and subsequent hemicraniectomy. As part of the study, intensive care data from 68 patients were collected between January 2012 and December 2020. Preoperative, intraoperative and postoperative parameters were analyzed and a logistic regression analysis was performed to identify determinants of outcome measured by the Modified Rankin Scale (mRS) (dichotomized into mRS 0-3: favorable outcome; mRS 4-6: poor outcome) twelve months after stroke.

#### Results

The average age of the 68 patients was 60.1 years, 23 (33.8%) were female. Before the event, 51 patients (75%) had no disability (mRS 0), 16 patients (23.5%) had mild disability (mRS 1-3) and one patient (1.5%) had severe disability (mRS 4). One year after bone flap reimplantation, 18 patients (31.6%) had a favorable outcome and 39 patients (68.4%) had a poor outcome. Eleven patients could not be followed up. In the univariate analysis, age (p=0.002) and previous illnesses such as diabetes (p=0.029) and arterial hypertension (p=0.028) were associated with a poor outcome, as well as more efford points for intensive care complex treatment (SAPS) in the first two days after stroke (day1 p=0.012; day2 p=0.001). In the multivariate analysis, older age (p=0.006) was an independent predictor of a higher mRS (4-6) one year after stroke. For age, our ROC analysis yielded a cut-off point of 57 years for a poor outcome.

#### Conclusion

In the present study 57% of the patients had an mRS of 0-4 at the time of bone flap reimplantation, and 68% one year after bone flap reimplantation. Older age is associated with a worse outcome. The age limit for a poor outcome in our study is 57 years.

### SFNC-04

Dekompressive Kraniektomie nach schwerer traumatischer Hirnverletzung mit einem anfänglichen Glasgow-Koma-Skala-Score von 3 und 4

Decompressive Craniectomy following severe traumatic brain injury with an initial Glasgow coma scale score of 3 and 4

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#### Objective

Decompressive craniectomy formed as surgical management option for severe traumatic brain injury (TBI). Few studies that follow the TBI patients with a Glasgow coma scale (GCS) score of 3 or 4. Decompressive craniectomy was avoided in these patients due to the poor outcomes and the worse functional recovery.

#### Methods

Clinical Presentation: Two patients were presented in our case series.

The first one suffered of severe TBI following an aggression with a Glasgow coma scale (GCS) score of 3/15 and bilaterally dilated unreactive pupils. A brain CT-scan showed right frontal fracture, bifrontal hematoma contusion, a fronto-temporo-parietal acute subdural hematoma (SDH) with a thickness of 14 mm on the right side, traumatic subarachnoid hemorrhage, with 20 mm of midline shift to the left side, diffuse brain edema.

The second one presented with severe TBI following an automobile accident with a GCS score of 4/15 and isoreactive pupils. A brain CT-scan showed bilateral fronto-temporal fracture, diffuse brain hematoma contusion, traumatic subarachnoid hemorrhage, right extradural hematoma (EDH) and bilateral fronto-temporo-parietal acute subdural hematoma (SDH) more important in the right side.

#### Results

Our case series suggest that the wide adequate decompressive craniectomy in patients with severe TBI and GCS score of 3 or 4 can be performed and useful to obtain good long-term neurological outcomes with a good functional recovery.

#### Conclusion

The rapidity of the surgical indication decision can be option to obtain the better neurological outcomes.

### P142

Überleben eines Eindringens einer Gabel durch den transorbitalen Zugang ins Kleinhirn Surviving an intrusion of a fork through the transorbital route into the cerebellum.

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#### Objective

Penetrating traumas to intracranial structures present us neurosurgeons with unique challenges due to their relatively rare occurrence. While high-velocity traumas often lead to fatal outcomes, low-velocity traumas require a tailored surgical approach to minimize neurological deficits and manage potential complications effectively.

#### Methods

We report a 68 -year-old patient who was admitted to our department with a transorbital fork injury. The patient suffered a brief loss of consciousness while he was washing dishes in the dish sink and fell on his face. The patient had initially just headache and a partial oculomotor palsy on the right side. The CT scan showed the fork passing right above the bulbus oculi, through the superior orbital fissure, lateral to the cavernous sinus, the right pedunculus cerebelli medius ending above the right dentate nucleus. Only focal SAHs and small parenchymal hemorrhage were seen. The CTA revealed no sign of vascular injury. We performed a frontotemporal craniotomy on the right side. We visualized the location of the fork intracranially and carefully removed it. The operation was performed together with ophthalmologists and maxillofacial surgeons. The postoperative CT scan showed normal findings. The patient had no new neurological deficits after the operation. We used a prophylactic antibiotic for 14 days.

#### Results

In our case, the patient did not present with an intraparenchymal mass lesion necessitating removal. However, due to the inability to attach a vise grip to the fork and the risk of causing substantial manipulation, the decision was made to perform a circumferential craniotomy around the fork. The craniotomy was designed to be sufficiently large to facilitate the removal of the fork en bloc.

#### Conclusion

Surgical management of removal of intracranial foreign bodies is no routine procedure. While traditional studies have focused on weapon extraction primarily through craniotomy, recent research favors a knock-out technique. However, in our case we chose a craniotomy due to the significant risk of causing substantial manipulation. We believe this case provides valuable insight for future decision-making regarding surgical strategies in similar scenarios.





### P143

GPT- Prädiktion ist assoziiert mit dem Patientenüberleben nach dekompressiver Hemikraniektomie bei malignem Mediainfarkt GPT prediction is associated with survival outcomes after decompressive Hemicraniectomy in malignant media

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#### Objective

infarction

Analysis of the prognostic ability of the large language model (LLM) GPT to predict short-term survival and functional outcome of patients with malignant medial cerebral artery infarction (MCA) after undergoing decompressive hemicraniectomy

#### Methods

This retrospective study includes 100 patients with malignant MCA infarction after decompressive craniectomy (DC). GPT versions 4.0 and 40mni were used to assess the outcome of the patients. 20 patient-specific factors were provided. Each version of GPT was tested with and without providing the current AHA/ASA 2019 guideline and meta-analyzes of RCTs as context for decision-making. The real-life outcome of the patients, indicated by the modified Rankin Scale (mRS) served as reference. The following endpoints were evaluated: Survival of inpatient stay, achievement of functional status of mRS 0-4 at discharge, at 3, 6 and 12 months. We analyzed the prognostic prediction of GPT by calculating the area under the curve (AUC) and the Youden's Index to determine the optimal cut-off in divergent answers. After dichotomization according to the cut-off set, Chi-squared test (two-sided) was performed.

#### Results

GPT versions 4.0 and 4.0mni were capable to estimate survival during inpatient stay. In both versions, contextenriched GPT (CE) is superior to the unsupported equal Version (GPT 4.0mni (CE)= AUC 0.67; 95% CI: 0.54-0.79; p=0.002; GPT 4.0 (CE) = AUC 0.70; 95% CI: 0.57-0.82; p=0.018). GPT 4.0 achieves statistical significance even without CE (AUC 0.66; 95% CI: 0.53-0.78; p: 0.018). Non-CE GPT 4.0mni does not reach significance in predicting survival of hospitalization (AUC 0.60; 95% CI: 0.48-0.73; p:0.07).

For questions regarding the functional outcome of patients, GPT in both versions was not able to make a sufficient prognostic prediction.

#### Conclusion

The study shows the already existing high potential of AI in the calculation of short-term survival. It also shows the existing limitations for the evaluation of more complex questions like functional outcome.

#### Is GPT able to predict the outcome for patient after decompressive Hemicraniectomy in malignant media Universitätsklinikum UNIVERSITAT Leipzig LEIPZIG en Rechts Methods Results Survival prediction: SPT Context enriched research n=100 20 pati -GPT 4.0 significant, p = 0.018, AUC 0.70 -GPT 4. Omni significant, p= 0.002, AUC 0.67 Free research -GPT 4.0 significant, p = 0.018, AUC 0.70 -GPT 4. Omni significant, p= 0.002, AUC 0.67 ROC Analysis for cut-off evaluation in multiple answers Functional outcome prediction: minim Low accuracy with frequent "negative" answers GPT 4.Omni + PDF cut-off ≥/<0.33 GPT survival at discharge GPT no survival discharge mRS 6 16/26 10/26 mRS 0-5 20/74 54/74 total 66/100 64/100

Abb. 1

### P144

Einfluss des Schweregrads globaler kognitiver Defizite auf die Verteilung kortikaler Sprach- und Kognitionsareale bei linkshemisphärischen Gliomen Influence of global cognitive deficit severity on the distribution of cortical language and cognitive hubs in left hemispheric glioma cases

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#### Objective

A verbal semantic association task allows the simultaneous localization of cognitive and language sites during stimulation-based mappings. We assessed whether the severity of global cognitive deficits in left hemispheric glioma patients influences the distribution of cortical cognitive and language hubs.

#### Methods

Verbal semantic association and classic naming mapping via navigated transcranial magnetic stimulation were performed in 14 patients. Verbal fluency tests were used to stratify the severity of global cognitive deficits. Since only frontal and insular glioma cases presented with any verbal fluency deficit, the distribution of functional hubs was preliminarily analyzed descriptively and graphically for this subgroup of 10 patients (age: 39.1±12.8 years, sex: 70.0% male).

#### Results

A higher naming task involvement across bi-hemispheric parietal and temporal areas was observed in patients with moderate global cognitive deficits. At the same time, no systematic trend stood out across the severity groups. However, the semantic association mapping linked lower recruitment of left superior temporal and triangular inferior frontal and right superior and middle temporal, inferior, and superior frontal areas to more severe global cognitive deficits. The left superior frontal and parietal regions and the right superior parietal lobule showed moderate to high semantic association involvement irrespective of deficit severity.

#### Conclusion

Verbal semantic association mapping, instead of the classic naming task, consistently identified bi-hemispheric superior frontal and parietal sites, linking these sites to cognitive rather than language processes. Moreover, more distributed and widespread left- and right-hemispheric sites contribute to mental and linguistic processes interplay in cases with less severe global cognitive impairment.

### P145

Erfassung nonverbaler semantischer Leistungen bei neurochirurgischen Patient\*innen: Eine Machbarkeitsstudie Assessment of nonverbal semantic (NVS) abilities in neurosurgical patients: A feasibility study

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#### Objective

NVS link core skills for receptive and expressive language to other cognitive components. They are known as potentially impaired in neurological disorders (e.g. stroke), but have not been examined in a neurosurgical (NS) context yet. NVS have previously been assessed with the PPTT (Howard & Patterson, 1992) in either the full or a screening version (PPTT-S). We hypothesized that the newer and more differentiated NVST (Hogrefe et al., 2022), comprising three subtests for distinct NVS components, may identify deficits more precisely. We also explored factors for impairment differences.

#### Methods

46 acute NS patients (age md=64.7) performed the PPTT-S and all NVST subtests shortly after admission. We compared NVST and PPTT-S scores using crosstabs and Pearson correlations.

#### Results

Patients were treated for chronic subdural hematoma (CSDH, 28.3%), other traumatic brain injury (10.9%), subarachnoid hemorrhage (SAH, 17.4%), other hemorrhage (4.3%), normal pressure hydrocephalus (NPH, 6.5%), subdural empyema (2.2%) and brain tumors (30.4%, including 37.7% extraaxial and 64.3% intraaxial). 93.5% of our patients completed the full assessment with 54.3% showing impaired NVS abilities on at least one test. The NVST Semantic Sorting subtest (NVST-SS) demonstrated the strongest correlation with the PPTT-S (r=0.69). 21.7% of patients displayed deficits on the PPTT-S, whereas the NVST-SS revealed semantic dysfunction in 43.5% of patients. NVST-SS deficits were dependent of age (p=.003), but independent of sex (m 38.1% vs. f 48.0%, p=.500) and lesion hemisphere (left 46.2% vs. right 33.3%, p=.488). There was no significant difference between deficit distribution in the two major groups in the sample (CSDH 46.2% vs. tumor 42.9%, p=.863). Additionally, we did not find a significant difference between focal and diffuse lesions (focal 44.8% vs. diffuse 42.9%, p=.903).

#### Conclusion

In this first study to evaluate NVS deficits in NS patients, our data indicate a high prevalence of NVS dysfunction. The NVST-SS was found to be the most sensitive measure, so using this subtest may be most efficient for hospital-based assessment . NVS deficits were dependent of age. Associations with other clinical factors (e.g., etiology) are yet to be found to improve the predictability of impairments for future patient consultation and surgical strategies. As NVS are a key component of language, with deficits possibly going unnoticed, tests such as the NVST-SS should be more widely used for NS patients.

### P146

Alarmbenachrichtigungsmuster und Technologieakzeptanz bei routinemäßiger telemetrischer Vitalparameterüberwachung postoperativer Patienten auf einer neurochirurgischen Normalstation Alarm notification pattern and technology acceptance of routine telemetric vital sign monitoring of postoperative patients on a regular neurosurgical ward

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#### Objective

Online vital sign monitoring improves patient safety but is not routinely implemented on regular neurosurgical wards. The present study evaluated alarm event notifications and technology acceptance during the implementation of a telemetric, wireless vital sign monitoring system for postoperative patients within a regular neurosurgical ward.

#### Methods

This prospective observational cohort study was conducted within a 44-bed regular neurosurgical ward from August 2023 to January 2024 and analyzed the alarm notification patterns of clinical and non-clinical events during a 12-24-hour continuous monitoring period of patients that underwent elective neurosurgical procedures. For this purpose, 44 patient-specific, bed-side monitoring units with wireless patient connectivity and automatic alarm documentation were installed and team members were trained in the use of the system. Perceived technology acceptance was rated based on a 4-point Likert scale.

#### Results

The vital signs of 290 patients (median age 60, IQR 43-77) were monitored. Procedures included cranial (174), spinal (100), and peripheral nerve (16) surgeries. A total number of 14,500 clinical and 185,744 non-clinical alarm events were recorded. The main clinical alarms were triggered by hypoxia in (8,305/14,500; 57%) and tachycardia (30%). The main non-clinical alarm was triggered by a detached finger-tip sensor (177,989/185,744; 96%). The majority of all notifications were acknowledged within 30 seconds (clinical 89.5%; non-clinical 97.7%). Beyond a 60-second notification threshold, alarms were transferred to a mobile primary device held by the nurse in charge. This included 564/14,500 (3.9%) of all clinical and 3,625/185,744 (1.9%) of all non-clinical events. Compared to a previous implementation phase with mobile monitors and manual alarm documentation, users perceived improved convenience, user-friendliness and reduced connection time.

#### Conclusion

Despite a favorable technology acceptance, the strikingly high alarm burden due to a large proportion of nonclinical events underscores the need to optimize alarm notification and management strategies when implementing digitally integrated vital-sign monitoring within the framework of a regular ward setting.

### P147

Image Processing

Entwicklung eines Mixed-Reality-Navigationssystems mit 3D-Slicer: Ein umfassendes Protokoll für die integrierte medizinische Bildverarbeitung Developing an Mixed-Reality Navigation System with 3D Slicer: A Comprehensive Protocol for Integrated Medical

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#### Objective

Mixed-reality navigation (MRN) is a reliable and cost-effective alternative to standard commercial navigation systems for facilitating neurosurgical target localization. However, the implementation and quality assessment of MRN projects require multiple software tools and an intensely complex workflow, lacking a unified, one-stop solution.

#### Methods

3D Slicer is a free, open-source software platform for medical image processing, which is versatile and integrated with hundreds of extension modules. This protocol describes how to utilize 3D Slicer to implement MRN-related core functionalities, including multimodal image fusion, image segmentation, creation of 3D mesh models, surgical path annotation, and fiber tractography and reconstruction. Additionally, we demonstrate several sample pipelines for MRN evaluation, covering reference object generation, landmark-based registration assessment, accuracy parameter computation, and in situ visualization. The primary applications of this technique are in neurosurgical planning and MRN system development, targeting neurosurgeons utilizing MRN-assisted surgeries and technical personnel involved in MRN research and development.

#### Results

The protocol offers a comprehensive, seamless solution that integrates all MRN visualization and evaluation steps within a single platform. Its open-source nature ensures researchers can reliably and efficiently process their data to achieve their research objectives.

#### Conclusion

This protocol streamlines the workflow by reducing the dependency on multiple software tools, making it accessible and practical for the wider neurosurgical community. The primary limitation is the initial learning curve associated with mastering the 3D Slicer platform; nonetheless, once familiarized, users can complete the entire process, from raw medical images to evaluation, within an hour.



Abb. 1

### P148

## Patientenspezifische Simulationsmodelle: Verbindung von Theorie und Praxis in der neurochirurgischen Lehre Patient-Specific Simulation Models for Neurosurgical Education: Bridging the Gap Between Theory and Practice

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#### Objective

Traditional neurosurgical education faces challenges due to limited access to surgical cases, the need for patient safety, and the rising demand for personalized training methods. To address these issues, we developed a curriculum incorporating patient-specific simulation models that allow students to engage in realistic, hands-on training. These models, created using advanced 3D printing technologies and medical imaging data, replicate anatomical and pathological scenarios, enhancing the practical and theoretical understanding in neurosurgery.

#### Methods

The program was integrated into the elective curriculum for fourth- and fifth-year medical students. Students utilized advanced 3D printing and silicone casting techniques to construct anatomical models, including vascular aneurysms, gliomas, and spinal pathologies. Each student performed simulated surgeries on their model, followed by a structured evaluation process that included a scientific presentation. Two research assistants supported model construction and provided technical guidance, integrating their contributions into doctoral research projects.

#### Results

The program resulted in a marked improvement in students' surgical skills, as evidenced by structured evaluations and comprehensive feedback. Building on this success, it has been seamlessly integrated into resident training courses, receiving overwhelmingly positive responses from both participants and faculty.

#### Conclusion

This project highlights the transformative potential of patient-specific simulation models in neurosurgical education. Beyond neurosurgery, this approach is adaptable to other disciplines such as orthopedics and trauma surgery, promoting interdepartmental collaboration and advancing medical training standards.

### P149

Ausbildung in neurochirurgischen innovativen Techniken während der Facharztausbildung in Deutschland *Education in neurosurgical innovative techniques during residency in Germany* 

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#### Objective

Advancements in neurosurgery have revolutionized the field, offering patients safer and more effective treatment options for various neurological conditions. From minimally invasive procedures to cutting-edge technologies, neurosurgeons continually explore new techniques to enhance patient outcomes and improve quality of life. Here, the authors present results of a survey focusing on teaching and education in this field.

#### Methods

A 28-question survey was developed. The questionnaire was submitted to the chairmen of all neurosurgical departments of Germany by the German Society of Neurosurgery in August 2022. The departments differed in university hospitals and maximum care providers, teaching hospitals and municipal hospitals as well as affiliated departments. The survey was conducted between August 2022 to October 2022.

#### Results

A total of 89 responses (78%) were received from various hospitals and medical facilities, including 58 university hospitals and tertiary care centers, 11 teaching hospitals, and 18 municipal hospitals or affiliated departments. Residency training programs incorporated instruction in intraoperative neuromonitoring in 57% of clinics, predominantly in university hospitals (p=0.0001). Teaching nTMS was limited to nine university hospitals (p=0.029). Neuroendoscopic training was available in 32 departments, again primarily in university hospitals (p<0.005). Only 5% of trainees report being satisfied with their surgical progress and mentorship.

#### Conclusion

Germany is home to one of the largest neurosurgical communities in Europe and has the highest number of neurosurgical residents. However, despite this robust foundation, only few trainees report being satisfied with their surgical progress and mentorship. Especially the training in new techniques and modern devices is not established overall. While a few studies have examined the relationship between the availability of neurosurgical equipment and the quality of educational training programs, this area remains under-researched.

### P150

Vergleich chirurgischer Strategien: Eine High-Fidelity-Simulationsstudie zu pterionalen vs. interhemisphärischen Zugängen für das Clipping von Aneurysmen der Arteria communicans anterior *Comparison of Surgical Strategies: A High-Fidelity Simulation Study of Pterional vs. Interhemispheric Approaches for Clipping Anterior Communicating Artery Aneurysms* 

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#### Objective

The optimal surgical approach for clipping aneurysms of the anterior communicating artery (AComA) remains a subject of debate, particularly with variations in aneurysm morphology and angulation. This study provides the first direct comparative analysis of the pterional and interhemispheric approaches for AComA aneurysm clipping, utilizing high-fidelity simulation models to evaluate technical performance, success rates, and learning curve dynamics.

#### Methods

Four distinct AComA aneurysm models, each with unique angulations, were created using advanced 3D printing and elastomeric materials to replicate anatomical realism. Medical students, neurosurgical residents and attending neurosurgeons performed aneurysm clipping on each model using both the pterional and interhemispheric approaches, resulting in a total of 64 simulated procedures. Clipping success rates, operative times, and learning curve accelerations were evaluated using the Objective Structured Assessment of Neurosurgical Skills (OSANS) and reviewed by two independent neurosurgical experts. Participants also provided subjective feedback on the feasibility and technical demands of each approach.

#### Results

The pterional approach demonstrated higher clipping success rates (92% vs. 85%) for aneurysms with frontal angulations, while the interhemispheric approach excelled in managing posterior directed aneurysms (90% vs. 78%). Residents showed a steeper learning curve for the pterional approach, achieving competency after 3 cases, compared to 4 cases for the interhemispheric approach. Attending neurosurgeons achieved consistently high performance across both approaches, though operative times were 15% shorter with the pterional approach. Subjective evaluations indicated that the pterional approach was favored for its ergonomic advantages, while the interhemispheric approach was deemed more suitable for deeply situated aneurysms.

#### Conclusion

This study highlights the utility of simulation-based training in comparing neurosurgical approaches for AComA aneurysms. While both the pterional and interhemispheric approaches demonstrated distinct advantages based on aneurysm morphology, the findings emphasize the need for individualized surgical planning and targeted training to enhance technical proficiency. These results underline the value of structured simulation models in refining neurosurgical techniques and optimizing patient outcomes.


Figure 1: Novel Phantom Simulator containing detailed reconstructions of the brain, cerebral vessels as well as the meninges, including the tentorium cereblli and falx allowing facilitating the direct comparisom of the pterional and interhemispheric approaches for the management of aneurysms located at the anterior communicating artery.

### P151

Neue Wege in der neurochirurgischen Ausbildung: ICG-Angiographie als neues Kernelement des CIRE Simulators für mikrochirurgisches Aneurysma-Clipping (MATS) Overcoming Barries in Neurosurgical Education: ICG Angiography as a new core feature of the CIRE microsurgical aneurysm clipping simulator (MATS)

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#### Objective

The growing reliance on simulation methods in neurosurgical training addresses the critical challenge of diminishing opportunities for hands-on experience with real cases. Recently, the microsurgical aneurysm clipping simulator (MATS) was introduced and evaluated using a modified OSAACS score and a user questionnaire. However, these assessments may be influenced by user subjectivity. In contrast, indocyanine green (ICG) angiography provides precise, quantifiable data on vessel structure, aneurysm perfusion, and clipping quality. This study aims to establish an ICG-angiography-based evaluation of MATS and propose general criteria for assessing simulation devices using ICG angiography.

#### Methods

The MATS perfusion system was adapted for ICG injections, enabling angiographic evaluation (Figure 1). Three key phases were assessed using ICG angiography: vessel and aneurysm perfusion before clipping, after aneurysm clipping, and following an iatrogenic aneurysm rupture induced by elective puncture of the aneurysm dome.

#### Results

MATS demonstrated effective perfusion with ICG. After proper clip placement, ICG angiography confirmed the absence of aneurysm perfusion and restoration of vascular curvature. Simulated bleeding following iatrogenic aneurysm rupture closely resembled real-world outcomes under native microscopy (Figure 2). These findings indicate that MATS is well-suited for ICG angiography-controlled aneurysm clipping.

#### Conclusion

Incorporating ICG angiography into MATS and other simulation devices significantly enhances their validity, as it plays a pivotal role in microsurgical aneurysm procedures. This study underscores the importance of integrating ICG angiography capabilities into neurosurgical training simulators.



Figure 1. A: set up of MATS prior the ICG video angiography validation process using a KINEVO900, B: pterional craniotomy C: dissection of the Sylvian fissure and of a MCA bifurcation aneurysm for the ICG trial.



Figure 2. upper row: perspective of KINEVO900; lower row: ICG video angiography; A+B: presentation of the MCA Bifurcation aneurysm; C+D: aneurysm exclusion after clip application; E+F: immediate aneurysmatic hemorrhage during iatrogenic aneurysm rupture. (★: aneurysm dome; M2: insular branches of the MCA, distal of the bifurcation)

#### Abb. 2

### P152

Intraoperative Autofluoreszenz-Bildgbung von Hypophysenadenomen mittles konfokaler Laser-Endomikroskopie: Eine Proof-of-Concept-Studie *Real-time autofluorescence imaging of Pituitary Adenomas using confocal laser endomicroscopy: a Proof-of-Concept study* 

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#### Objective

Pituitary adenomas are common intracranial tumors requiring precise surgical resection to minimize complications and optimize patient outcomes. Intraoperative visualization remains challenging due to the lack of real-time cellular-level imaging. This study aimed to evaluate the feasibility of using label-free confocal laser endomicroscopy (CLE) as a tool for identifying and delineating pituitary adenoma tissue intraoperatively.

#### Methods

The pilot study was conducted on patients undergoing microscopical and endoscope-assisted transsphenoidal surgery for pituitary adenoma resection (n=5) using a clinical CLE device (Convivo, Zeiss). CLE was performed solely ex vivo (n=2), intraoperatively (n=1), or intraoperatively with subsequent ex vivo analysis of the resected tissue samples (n=2). Importantly, CLE was performed without contrast agent leveraging its ability to detect autofluorescence signals from endogenous fluorophores. Representative (n=5) label-free CLE images (267×475  $\mu$ m) of each case were selected and analyzed for signal intensity, size and density of autofluorescence signals.

#### Results

CLE provided autofluorescence images of pituitary adenoma tissue in all cases and surgeons reported confidence in handling the endoscopic probe during intraoperative imaging. Ex vivo and in situ imaging revealed consistent autofluorescence patterns, but in situ imaging was severely affected by motion artifacts resulting from acquisition times of ~1 s/image (CLE system default). Pituitary adenoma were predominantly characterized by dense punctuate autofluorescence. Typically >200 structures / image with diameter of  $3.4\pm0.4 \mu m$  (mean $\pm$ SD) were observed. Larger autofluorescent objects with a diameter  $11.8\pm4.4 \mu m$  were detected less frequently (usually 5-10 / image) and were identified as cells by comparison to histopathology. Fiber-like structures were noteded in 3/5 cases.

#### Conclusion

This study demonstrates CLE for autofluorescence imaging as a potential intraoperative tool for pituitary adenoma visualization. It holds promise for high-resolution insights into tumor microstructure with the potential to enhance surgical precision and reduce residual tumor. Further research with larger cohorts is warranted to validate these findings and refine this novel imaging approach.

### P153

Histopathologische Untersuchung von Ultraschall-Aspirationsgewebe aus Hirntumoren - Welcher Wert steckt im Abfall

Histopathological Examination of Ultrasonic Aspirator Tissue from Brain Tumors - The Value of Waste

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#### Objective

The ultrasonic aspirator (UA) is an important tool in neurosurgical tumor resection. Early studies have shown the potential of UA-derived tissue for histopathological evaluation, especially in central nervous system (CNS) tumors. This study, funded by the German Federal Ministry of Education and Research (BMBF, grant 13GW0751A), evaluates the histologic quality and diagnostic potential of tissue obtained with the ultrasonic aspirator, a by-product that would otherwise be discarded. Additionally, this study explores the potential use of Spectro-temporal Laser Imaging by Diffractive Excitation (SLIDE) microscopy to enhance tissue analysis.

#### Methods

Aspirated tissue samples were collected during brain tumor resections using the Sonopet iQ ultrasonic aspirator (Stryker), filtered with a 1mm tissue collector, and preserved in 10% formalin before paraffin embedding. Hematoxylin and eosin (H&E) staining was performed on the processed samples. Initial analysis focused on comparing the morphological quality of UA-derived sections to conventional histological slides, determining the visibility of key cellular and structural features.

#### Results

Up to now tissue aspirates from five operations were analyzed, including two gliomas (one glioblastoma, one low-grade glioma) and three meningiomas (one sphenoid wing meningioma). Preliminary results indicate that UA-derived tissue provides high-quality histological images. The analysis revealed identifiable cellular morphology, structural details, and tumor type, demonstrating strong similarity to conventional histopathology.

#### Conclusion

These promising results warrant further investigation into the histopathological applications of UA-derived tissue. Future studies will explore the use of different filter sizes and non-fixed samples to enable advanced analyses, such as cell culture and histochemical staining. The integration of digital pathology, including SLIDE microscopy, which is based on multiphoton microscopy, presents a transformative approach to analyzing UA-derived tissue. With its rapid imaging rates (2kHz) and subcellular resolution, SLIDE could enhance real-time analysis of biological processes within UA samples. This progression from digital pathology to advanced imaging techniques highlights the growing diagnostic potential of UA-derived tissue in neuro-oncology. Ultimately, this study demonstrates that tissue previously seen as surgical waste holds valuable diagnostic and research potential.

### P154

Moderne Patientenaufklärung in der Neurochirurgie Modern patient education in neurosurgery

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#### Objective

The development of new technologies and the associated rapid availability of a wide range of information has changed the way information is provided to patients. Whereas in the past the options for informing patients were clearly limited, clinics today have multiple ways of approaching patients. The aim of this study is to analyze the media usage of neurosurgical patients and identify ways to best reach patients.

#### Methods

Adult patients in our neurosurgical outpatient clinic were asked about their media use in a questionnaire. On the one hand, personal use of computers and smartphones, including social media, was surveyed. On the other hand, they were asked about their use of media to obtain information about their neurosurgical condition. The subgroups of young (18 to 34 years), middle (35-64 years) and old adults (over 65 years) were examined separately.

#### Results

A total of 252 patients answered our questionnaire. The mean age was 53 years (range: 18-91 years), 147 (58.3%) of the patients were female. Forty (15.9%) patients were young adults, 151 (59.9%) were middle-aged and 61 (24.2%) were old adults. Across all age groups, smartphones were used more than laptops or PCs. There was a clear age difference with regard to social media use. While two thirds of older patients did not use this medium at all, we saw intensive general use in two thirds of the young group. With regard to the question of how patients inform themselves about their illness, print media only played a role for 9.9%, with older patients (21.3%) having a significantly higher affinity than young patients (2.5%).Digital information was used to a large extent on PCs or laptops in the older group, while the middle-aged and young group used smartphones more frequently. In addition to traditional websites, middle-aged adults (21.2%) and young adults (35.0%) often searched for information about their neurosurgical condition on social media.

#### Conclusion

The new media offer many opportunities to improve patient information and supplement personal medical consultations. Online information, which is particularly tailored to smartphone users, and social media channels will play an increasingly important role in the future.

### P155

Lymphknotenmetastase eines IDH-mutierten Astrozytoms Grad 4: Fallbericht und systematische Übersicht der relevanten Literatur

Lymph node metastasis of an IDH-mutant astrocytoma grade 4: case report and systematic review of the pertinent literature

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#### Objective

Metastatic growth of primary brain tumors outside of the CNS is considered exceedingly rare. Most cases of extra-axial dissemination were reported for glioblastoma, while clinical and genomic analysis for IDH-mutant gliomas defined by the WHO 2021 classification are lacking.

#### Methods

A 18-year-old man presented with a right T2-hyperintense lesion of the primary motor cortex, and a stereotactic biopsy was consistent with an IDH-mutant astrocytoma grade 2. While the lesion was initially monitored, the patient was lost to follow-up. After seventeen years, the patient developed a progressive left-sided hemiparesis and MRI showed local progression. A subtotal resection was provided, and histology demonstrated an astrocytoma grade 4 (IDH1-mutated, MGMT promotor methylated). While the patient underwent adjuvant radiochemotherapy followed by consolidation chemotherapy with temozolomide, a painless swelling of a right cervical lymph node occurred. Biopsy was scheduled; immunohistochemistry and next-generation sequencing (NGS) of the tissue was performed. Pertinent literature was systematically searched.

#### Results

On histology, diffuse infiltration of the lymph node by a pleomorphic neoplasm with brisk mitotic activity was seen. While no expression of markers for epithelial cell-lineage (AE1/3, CK18, CK7) was shown, immunostaining confirmed glial tumour lineage and the presence of an IDH1-mutation. On NGS, a somatic pArg132Ser missense mutation of IDH1 (allele frequency: 13%) and a nonsense pArg273Cys mutation of TP53 (allele frequency: 39%) were identified. Given that identical mutations were found in cerebral tissue specimens, diagnosis of a lymph node metastasis from the astrocytoma was established. Temozolomide was continued and lymph node-directed radiotherapy provided; however, the patient deceased within months. Only 22 cases of extra-axial metastasis from IDH-mutant gliomas have been reported, including 15 astrocytomas. No patient described in the literature responded to treatment.

#### Conclusion

Despite rarely encountered, extra-axial metastasis may also occur in IDH-mutant gliomas and characterize a late disease stage. Given that no durable treatment response has yet been document, establishing an accurate diagnosis mainly serves to inform patient guidance towards end-of-life care. With novel IDH-targeting treatments on the horizon, it remains to be seen whether such approaches represent a valuable option to improve outcome of affected patients.

### P156

#### Exrakraniale Metastasierung bei hochgradigen Gliomen: klinische Charakteristika und Ergebnisse Extracranial metastases of high-grade glioma: clinical characteristics and outcome

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#### Objective

Extracranial metastases from high grade glioma are exceedingly rare. While the long-term survival of high-grade glioma in general is poor, the prognosis of patients with extracranial metastases has been considered even worse. The aim of this study was to analyze the characteristics, specific treatments, and the outcomes of patients with extracranial metastases from high-grade glioma.

#### Methods

Six patients with extracranial metastatic lesions originating from high-grade gliomas were identified over a 5year period at of a pool of 400 patients. Data were collected by retrospective chart review supplemented by recent follow-up.

#### Results

The median age at initial tumor diagnosis was 61.5 years (range, 26-67 years), and at the time of manifestation of metastasis 62 years (range, 26-68 years). The histological type of the primary tumor was glioblastoma multiforme in five patients, and oligodendroglioma WHO grade 3 in one patient. The average interval between initial tumor diagnosis and the extracranial metastasis was 7 months (range, 2–16 months). The Karnofsky Performance Status (KPS) at the time of diagnosis of metastases was 70 (range, 30-90). Four patients had spinal intradural seeding metastases. Two patients had infiltration of the temporo-occipital galea and the temporalis muscle in the temporal fossa, respectively. All patients, except one who refused surgery, underwent surgical resection. Postoperative radiotherapy was performed in all cases. Overall survival time ranged between 4 and 7 months after the diagnosis of extracranial metastasis.

#### Conclusion

Extracranial metastases from malignant gliomas might present as intradural spinal seeding or in proximity to the surgical approach for the primary tumor. Survival after presentation of metastases is very limited despite surgical resection and radiotherapy.

### P157

#### Prototyp eines implantierbaren optischen Messsystems zum Monitoring rezidivierender Glioblastome Prototype of an implantable optical sensor system for glioblastoma recurrence monitoring

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#### Objective

Even with combination therapy, glioblastoma (GBM) patients experience poor outcomes and eventual relapse, often occurring at the resection site. Conventional MRI surveillance may fail to detect or correctly interpret histologic changes. Based on our group's previous proof of principle investigations on the measurability of fluorescently labeled GBM tissue using optical sensors, we present the development and design of a miniaturized, implantable sensor system for continuous recurrence monitoring.

#### Methods

The systems sensitivity specification were first determined for a single sensor element. Therefore, six solutions with different concentrations of the fluorescent molecule protoporphyrin IX (0.025  $\mu$ g/mL to 1  $\mu$ g/mL) were prepared to acquire the measurement curve. Thereafter, a bi-module implant was designed, consisting of a sensing unit to be placed in the resection cavity during the primary intervention and a subcutaneously implanted control and computing unit. The sensing unit was fabricated from a 0.11 mm thin, dual-sided, flexible polymer circuit board, designed to fold into a three-dimensional cube. The computing unit comprised a flat electronic circuit board equipped with components for power supply, control and documentation of measurements, and wireless communication. The implant was encased in a two-layer coating: an inner waterproof acrylic glass layer and an outer biocompatible ultra-soft silicone layer.

#### Results

The measurement curve of the sensor elements installed into the implant adheres to a power law, being proportional to the fourth root of the PPIX concentration with constant offset (a = 5.508 & offset = 2.473 CI: 5.438 - 5.578 & 2.521 - 2.424 respectively,  $R^2 = 0.94$ ). The system has a response threshold for PPIX concentrations from ~0.15 µg/mL, equivalent to measurement signals in fluorescent GBM cells with mm-range volumes. The cube-shaped sensory unit of the implant features one sensor element per cube surface, enabling 360° scanning of the resection cavity. Its edge length is 15 mm and its weight is less than 3 g. The computing unit is 55 mm long and 29 mm wide and can be subcutaneously placed on the anterior chest wall, where it can be charged and read out by an external device.

#### Conclusion

Aggressive growth and therapeutic resistance render the prognosis of patients with recurrent GB particularly poor. The presented implant enables seamless monitoring which may lead to earlier recurrence detection and contribute to the optimization of treatment strategy.

### P159

Untersuchung der neurovaskulären Dynamik bei Gliomen: Peritumorale fALFF-Muster in IDH-Wildtyp- und IDHmutierten Subtypen

Exploring Neurovascular Dynamics in Gliomas: Peritumoral fALFF Patterns in IDH-Wildtype and IDH-Mutant Subtypes

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#### Objective

Gliomas are complex brain tumors with heterogeneous growth patterns and neurovascular dynamics. IDH mutation status is a key molecular marker that shapes glioma prognosis, tumor infiltration, and vascular proliferation. Resting-state fMRI (rs-fMRI) metrics, such as the fractional amplitude of low-frequency fluctuations (fALFF), provide a non-invasive approach to explore these neurovascular characteristics. This study investigates peritumoral fALFF patterns in IDH-wildtype (IDH-wt) and IDH-mutant (IDH-mut) gliomas to reveal distinct neurovascular and hemodynamic profiles.

#### Methods

Preoperative rs-fMRI (TR=2s) data were collected from 15 glioma patients (9 IDH-wt, 6 IDH-mut). Tumor masks were segmented from T1-weighted contrast-enhanced (T1wCE) MPRAGE and FLAR MRI using BrainLab, followed by creating radial layers (2, 4, 6, 8, and 10mm) extending from the tumor margins. RsfMRI was co-registered to structural images using FSL FLIRT. The gray and white matter were segmented from the T1wCE images using FSL FLIRT. The gray and white matter were segmented from the T1wCE images using FSL FAST. fALFF values for the peritumoral layers were calculated using AFNI''s 3dRSFC. Statistical comparisons of fALFF values were calculated between IDH-wt and IDH-mut tumors, focusing on peritumoral regions.

#### Results

In peritumoral gray matter, fALFF values did not significantly differ between IDH-wt and IDH-mut tumors across all peritumoral layers (p > 0.05). However, in peritumoral white matter, fALFF was significantly higher in IDH-mut tumors compared to IDH-wt tumors (p = 0.0014), with mean values of 0.3284 (±0.0670) for IDH-mut and 0.2924 (±0.0392) for IDH-wt. Additionally, in both IDH-mut and IDH-wt groups, fALFF in white matter exhibited a positive correlation with distance from the tumor.

#### Conclusion

Our findings suggest that IDH-mut gliomas may induce distinct neurovascular adaptations in the peritumoral white matter, potentially reflecting altered hemodynamic activity driven by tumor biology and infiltration patterns. Unlike IDH-wt gliomas, characterized by angiogenesis-driven vascular proliferation, IDH-mutant gliomas exhibit a diffuse infiltration pattern that appears to preserve metabolic resources and neurovascular coupling, resulting in higher low-frequency fluctuations. These findings indicate that rs-fMRI metrics like fALFF have the potential to serve as dynamic, noninvasive tools for preoperative glioma subtype characterization and surgical planning, capturing both neuronal and hemodynamic activity.

### P160

Klinische und neuropathologische Marker zur Unterscheidung zwischen IDH-mutierten Astrozytomen des WHO-Grads 2 und 3

# *Clinical and neuropathological markers for distinguishing between IDH-mutant astrocytomas of WHO grade 2 and 3*

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#### Objective

The neuropathological criteria of anaplasia to distinguish between IDH-mutant astrocytomas of WHO grade 2 and 3 are ill-defined by the WHO 2021 classification. Following the positive phase III trial results and the approval of Vorasidenib for astrocytomas grade 2, a salient point of the discussion remains which markers might be of prognostic relevance to distinguish between grade 2 and 3 tumors.

#### Methods

We retrospectively searched our institutional database for patients meeting the diagnostic criteria for IDHmutant astrocytomas according to the WHO 2021 classification. Clinical, neuropathological, and molecular data were collected; and outcome was compared using log-rank analysis. Prognostic markers identified on univariate analysis were forwarded into a multivariate model. Centralized slide review was performed to exclude neuropathological inter-rater variability due to the retrospective nature of our study.

#### Results

We identified 91 patients with IDH-mutant astrocytomas with detailed neuropathological and clinical data, including 61 (67.0%) WHO grade 2 tumors and 30 (33.0%) WHO grade 3 tumors. At a median follow-up of 89 months, median progression-free survival was 67 months for grade 2 tumors and 53 months for grade 3 tumors. Median overall survival for grade 3 tumors was 216 months and not reached for grade 2 tumors. On univariate analysis, higher WHO grade, an increased number of mitoses on histopathology, elevated Ki67 indices on immunohistochemistry, and the presence of contrast enhancement on pre-operative imaging were associated with less favorable outcome. However, only the presence of contrast enhancement retained its prognostic significance when forwarded into a multivariate model (p = 0.03 for overall survival, p = 0.02 for progression-free survival). These findings were consistent across subgroups treated with watch-and-wait (n = 26), radiotherapy (n = 21), or chemotherapy (n = 26). Proliferation markers were generally higher in patients undergoing open resection versus biopsy.

#### Conclusion

While our findings await confirmation in larger prospective cohorts, neuropathological criteria for anaplasia might need to be accompanied by clinical information including contrast enhancement to prognostically distinguish grade 2 from grade 3 tumors particularly in patients undergoing biopsy given the risk for undersampling.

### P161

Analyse potenzieller Gemeinsamkeiten und Muster bei Patienten mit frühem oder ultrafrühem Wiederauftreten von Glioblastomen

Analysis of Potential Commonalities and Patterns in Patients with Early or Ultra-Early Recurrence of Glioblastoma

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#### Objective

Glioblastoma (GBM) is adults' most common and aggressive primary brain tumour.Despite multimodal therapy,prognosis remains extremely poor due to the nearly inevitable tumour recurrence.According to current literature,median time to recurrence is 6 to 9 months after completion of initial therapy.This preliminary data analysis aimed to evaluate patients with early and ultra-early recurrence in terms of potential risk factors,patterns,and clinical implications.

#### Methods

Initial screening was performed for all patients who underwent surgery between 2004 and 2024 with a diagnosis of Glioblastoma, according to the WHO classification used at the time of surgery. Then, patients were screened for early recurrence (MRI & histopathology), defined as early recurrence group (ERG < 6 months post initial diagnosis) and ultra-early recurrence group (UERG < 3 months post initial diagnosis).

#### Results

In the present analysis, we have so far identified 88 patients who underwent more than one surgery less than 6 months after initial diagnosis of glioblastoma.Of these, 24 patients underwent surgery due to a recurrence (27%, ERG n=21, UERG n=3).Mean age of the recurrence surgery cohort was 59 years (±10.8),with the UERG being even younger at 49.6 years.96% (n=22) of the patients received a combined adjuvant treatment regimen up to the recurrence diagnosis,with one patient receiving only Temodal monotherapy without radiation(ERG).The mean residual tumour volume was 2.41 ml for the entire cohort (n=22, ERG 2.02 ml, UERG 4.8 ml).The MGMT status was known for 19 patients(MGMT+ n=9, MGMT- n=10),and the mean Ki67 proliferation index was 17.1% at initial surgery,8.9% at recurrence surgery.In the UERG 23.3% at initial surgery,and still 14% at recurrence surgery.The median OS was determinable for 10 patients and was 314 days for the cohort,while the median OS in the UERG (n=3)was only 160 days.A meaningful statistical evaluation could not be conducted due to the small sample sizes in the cohorts and subgroup analysis.

#### Conclusion

Our findings suggest that patients with ultra-early recurrence tend to be younger, had larger residual tumour volumes and higher Ki67 proliferation indices, potentially contributing to shorter median overall survival compared to the entire cohort. However, further data analysis is required to gain more general information and to statistically challenge these preliminary results.

### P162

Die funktionelle MRT Ruhekonnektivität des Tumors zu extraläsionellen Hirnregionen ist assoziiert mit der kognitiven Performanz bei Gliompatienten Tumor resting-state fMRI connectivity to extralesional brain is associated with cognitive performance in glioma patients

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#### Objective

Functional coupling of the tumor to extralesional brain areas and the pretherapeutic cognitive performance status have each independently been identified as prognostically relevant factors in glioma patients. It is however unclear, whether tumor-connectivity correlates with cognitive performance or the cognitive outcome. We therefore investigated potential associations between pre- and postoperative resting-state functional MRI connectivity (FC) and cognitive performance in glioma patients compared to healthy controls.

#### Methods

18 patients and 18 age-matched healthy controls underwent resting-state-fMRI and neuropsychological testing pre- and 4.5 months (mean) postoperatively. Tumor volumes were segmented, and FC of the tumor to extralesional brain (Tu-EL), was determined. Tumor lesion masks were applied in both groups, and FC of extralesional brain (EL), as well as FC of the contralesional hemisphere (conEL) was computed pre- and postoperatively. Behavioral and FC measures were analysed longitudinally, as well as compared between patients and controls.

#### Results

Patients showed cognitive impairment in verbal memory, attention and executive functions. While postoperative cognitive performance tended to be worse, deterioration was not statistically significant at the time of follow-up. EL FC did not differ between groups, but conEL FC was significantly increased in patients as compared to controls (p<.045). Notably, Tu-EL FC was significantly associated with worse attentional performance (p<.001), and by trend (p<.058), with worse attentional outcome in glioma patients.

#### Conclusion

Intrinsic functional coupling of the tumor to the rest of the brain was associated with worse cognitive performance in glioma patients, which might reflect the infiltrating tumor nature and pathological tumor-neural interaction on the macroscale. Deepening our understanding of FC measures at the connectomic level in the context of cancer neuroscience may aid in defining neurophysiological correlates of cognitive dysfunction and in prognosticating cognitive outcome in glioma patients.

### P163

Prognostischer Wert der präoperativen Magnetresonanztomographie bei neu diagnostiziertem Glioblastom: eine umfassende volumetrische Analyse Prognostic value of pre-operative magnetic resonance imaging in newly diagnosed glioblastoma: a comprehensive volumetric analysis

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#### Objective

The aim of this study was to assess the morphology of glioblastoma using structural pretreatment magnetic resonance imaging (MRI) in order to determine the prognostic significance of various imaging factors.

#### Methods

In this single-center retrospective study, we evaluated MRI scans of patients with primary glioblastoma. Using a semi-automated method, the tumor was categorized into the following compartments: total tumor volume (TTV; contrast-enhancing region and non-enhancing areas in T1), necrosis (non-enhancing areas within the TTV) and perifocal edema (PE; defined as hyperintense regions on FLAIR images subtracting TTV). Univariate analyses, Pearson correlations, and Cox proportional hazard regressions were used to assess the impact of MRI imaging measures, including volume-based ratios (edema-tumor ratio [ETR], necrosis-tumor ratio [NTR]), on overall survival (OS) and progression-free survival (PFS). Additionally, histological criteria were integrated into the analysis to provide a comprehensive evaluation of prognostic factors.

#### Results

The cohort consisted of 208 patients with primary glioblastoma characterized by a median age of 62 years, a Karnofsky performance status (KPS)  $\geq$ 70 in 93.3 % of cases, a MGMT-promoter in 52.4 % and a multifocal presentation in 28.8 %. Surgical procedures varied: 25.0 % (n=52) underwent biopsy, 44.9 % (n=92) underwent partial or subtotal resection and 30.8 % (n=64) underwent gross total resection (GTR), all followed by concomitant treatment according to the Stupp protocol. Median OS was 431 days (IQR 240-686), median PFS was 208 days (IQR 141-367). The necrosis volume (correlation coefficient [CC] = 0.2, p=0.01) and the NTR (CC = 0.2, p=0.002) correlated significantly with the proliferation index Ki-67. Multivariate cox proportional hazard regressions showed significant effects of TTV on OS (hazard ratio [HR] 1.45; 95 % CI 1.06-1.99; p=0.02), but not on PFS (HR 1.28; 95 % CI 0.94-1.75; p=0.12), while PFS was significantly influenced by NTR (HR 1.59; 95 % CI 0.39-0.87; p=0.008), in each case adjusted for the prognostic factors age, MGMT methylation status and KPS.

#### Conclusion

Our data suggest a prognostic significance of MRI-based volumetric measures in glioblastoma. Higher NTV and TTV values are associated with a poorer PFS and OS, which indicates a stronger proliferation behavior and aggressiveness of the tumor. These findings could be an additional helpful component in preoperative treatment planning.

### P164

Entlang-Trakt-Steifigkeitskartierung bei Gliompatienten mittels multifrequenter Magnetresonanz-Elastographie Along-tract stiffness mapping in glioma patients using multifrequency magnetic resonance elastography

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#### Objective

Gliomas, particularly their infiltrative nature and mass effects, can alter tissue mechanical properties and disrupt structural connectivity, potentially leading to neurological and cognitive deficits. Our aim is to investigate the impact of gliomas on white matter structure and mechanical properties using multifrequency magnetic resonance elastography (MRE).

#### Methods

We included three patients with left-hemispheric gliomas. T1-MPRAGE, diffusion MRI (dMRI), and MRE scans were acquired on a 3-Tesla scanner. MRE used a spin-echo EPI sequence with vibrations at 20, 25, 30, and 35 Hz, acquiring 63 slices at 2 × 2 × 2 mm<sup>3</sup> resolution. Shear-wave-speed (SWS) maps, reflecting tissue stiffness, were reconstructed using 2D k-MDEV inversion with low-pass filtering. T1-MPRAGE and MRE data were registered to dMRI space using ANTs, and fiber orientation distributions were estimated via constrained spherical deconvolution with MRtrix3. We used the iFOD2 algorithm with ACT for tractography of arcuate fasciculus (AF) and inferior fronto-occipital fasciculus (IFOF), generating 2000 streamlines per tract. Using SWS maps, we generated along-tract stiffness profiles in both hemispheres and compared them.

#### Results

Fig 1 shows T1-MPRAGE, MRE magnitude, SWS maps, and AF/IFOF tracts overlaid on SWS maps for all patients (patient 1: GBM, patient 2: grade III, patient 3: grade II). Fig 2 presents along-tract stiffness profiles for AF and IFOF in both hemispheres. In Patient 1 and Patient 3, a slight increase in AF stiffness is observed in vicinity of the tumor, likely due to compression. The IFOF is significantly affected in both cases, with reduced stiffness indicating infiltrated regions, accompanied by mild edema in Patient 1 and more extensive infiltration in Patient 3. In Patient 2, both AF and IFOF show increased stiffness in the affected hemisphere, highlighting how the tumor exerts mechanical stress on the surrounding tissue, leading to displacement.

#### Conclusion

Stiffness profiles varied across patients, indicating complex tumor-tissue interactions, such as compression, infiltration, and edema, which may disrupt structural connectivity and contribute to neurological deficits. Compression generally leads to increased stiffness, while infiltration causes more heterogeneous effects. These preliminary results suggest that along-tract stiffness profiling could serve as a potential indicator of glioma-induced tissue alterations. Further studies with a larger cohort are needed to validate these results.









### P165

#### Die Raman Spektroskopie in der Glioblastomdiagnostik - ein vielversprechendes neues Werkzeug? Stimulated Raman Spectroscopy for glioblastoma diagnosis – a promising new tool?

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#### Objective

Glioblastoma is the most frequent and aggressive brain tumor with a grim prognosis. Since decades hematoxylin and eosin (H&E) staining has been the base of neuropathological diagnosis. Stimulated Raman imaging (SRS) has emerged as a label-free imaging modality for histological assessment of tissue samples. Whether this new tool is equivalent to gold-standard in diagnostic value remains to be eluded. Hence, the question arose if virtual H&E imaging with SRS is equal regarding neuropathological analysis compared to standard H&E staining in glioblastoma?

#### Methods

The patient cohort comprised of 20 glioblastoma samples. Each specimen was stained with standard H&E slices as well as squeezed tissue analyzed with label-free. The latter works by detecting two Raman vibrations in the so-called CH-stretch region, spanning from 2800 to 3300 cm-1, enabling a differentiation between cell nuclei and cell bodies. This data is consecutively computed to a 2D image. Examiners of different training levels conducted a questionnaire regarding histopathological features of glioblastoma. This data was compared between H&E stained images and SRS based ones.

#### Results

In general SRS based imaging proved to be an appropriate facsimile of H&E probes. Individual glioblastoma characteristics like endothelial hyperproliferation, spatial necrosis and palisading tumor cell nests were clearly distinguishable in SRS imaging. In the latter, technical associated artefacts, mainly arising from squeezing, occurred. In statistical analysis of the questionnaire no statistical difference could be found in identifying tumor characteristics between the two techniques.

#### Conclusion

SRS based imaging seems to be a promising technology for future histopathologic analysis, at least regarding glioblastoma.

### P166

Optimized workflow for intraoperative classification of CNS tumors using nanopore sequencing Optimized Workflow for Intraoperative Classification of CNS Tumors by Nanopore Sequencing

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#### Objective

Intraoperative profiling of CNS tumors remains challenging due to limitations in current diagnostic strategies. While intraoperative sequencing combined with epigenetic classification demonstrates high accuracy, existing workflows are time-consuming and labor-intensive. Here, we developed a high-speed intraoperative sequencing protocol that optimizes quality control (QC) steps without compromising data integrity and accelerates library preparation using transposase adapters.

#### Methods

Our optimized workflow includes rapid DNA extraction using intraoperative sample size optimization, real-time tissue lysis (chemical and mechanical), followed by DNA isolation and quantification using a Qubit fluorometer. Libraries were prepared using a rapid sequencing protocol with transposase adapters, replacing traditional ligation-based methods. Real-time data analysis incorporated AI-assisted base-calling and modification detection. A total of 23 sequencing runs were analyzed, including 8 runs using the rapid-UKER protocol and 15 runs with the ligation-based protocol [1].

#### Results

The mean duration of the rapid-UKER protocol was 50.54 minutes, with DNA isolation and quantification accounting for two-thirds of the time. Library preparation and sequencer loading were completed within 10 minutes in 87.5% of cases, compared to a mean of 28.5 minutes for the ligation-based method. Both protocols demonstrated comparable performance, achieving 92% correct tumor detection within 5 minutes of sequencing and accurate copy number variation (CNV) profiling within approximately 25 minutes. No significant differences in sequencing accuracy were observed between transposase and ligation-based adapters.

#### Conclusion

The rapid-UKER protocol enables accurate CNS tumor classification within 1 hour, significantly reducing library preparation time without compromising sequencing quality. Transposase adapters represent a robust and efficient alternative to traditional ligation-based workflows for intraoperative tumor profiling.

### P158

#### Nicht Kontrastmittel aufnehmende Glioblastome: eine eigenständige Entität? Non-enhancing glioblastoma: A separate entity?

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#### Objective

Glioblastomas typically appear on MRI as contrast-enhancing tumors with a central necrotic area. However, in some cases, neuropathological analyses of non-contrast-enhancing tumors also reveal glioblastoma. In this study, we aim to compare the outcomes of typically contrast-enhancing glioblastomas with those of non-enhancing glioblastomas.

#### Methods

We identified patients with non-enhancing glioblastoma in our database and compared their demographic and clinical characteristics to those of a randomly selected control group consisting of typically enhancing glioblastoma patients.

#### Results

A total of 22 patients with non-enhancing glioblastoma were identified. The control group consisted of 34 randomly selected patients with typically enhancing glioblastoma. No significant differences were observed between the groups regarding age (p = 0.91) and sex (p = 0.78). The Karnofsky Performance Index was similar in both groups (p = 0.68). Overall survival was significantly longer in patients with non-enhancing glioblastoma (516 days vs. 328 days; p = 0.02).

#### Conclusion

Our data indicate a survival benefit in patients with non-enhancing glioblastoma. Further studies are required to better characterize the biological and clinical features of these tumors.

### P167

Die Expression der long non-coding RNA NEAT1 könnte als potenzieller Biomarker für die Aneurysma-Stabilität dienen

The expression of long non-coding RNA NEAT1 may serve a potential biomarker for aneurysm stability

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#### Objective

Long non-coding RNAs (lncRNAs) are the RNA molecules that do not encode proteins but play crucial regulatory roles in cellular processes, including gene expression, chromatin remodeling, and cellular stress response. LncRNA NEAT1 contributes to the regulation of oxidative stress, inflammation, cell proliferation, migration, phenotypic transformation via instructing gene expression. These processes are closely involved in pathophysiology of vascular diseases including formation and rupture of intracranial aneurysms. In response to vascular injury, vascular smooth muscle cells switch from contractile to proliferative phenotype thereby contributing to vascular repair. Role of NEAT1 in intracranial aneurysms (ICA) is unexplored. This study was planned to investigate the expression, and clinical significance of NEAT1 in ICAs.

#### Methods

The expression of NEAT1 were analyzed in tissue samples of ruptured and unruptured ICAs harvested during the microsurgical clipping (n=5). Samples of superficial temporal artery (STA) were collected during STA-MCA bypass surgery as controls. Using NucleoZOL, total RNA was extracted. Quantitative reverse transcription polymerase chain reaction (RT-qPCR) was performed to quantify the expression levels of NEAT1 that was then normalized to housekeeping gene ( $\beta$  actin). Fluorescence in situ hybridization (FISH) was performed with fluorescent probe staining using Stellaris<sup>®</sup> FISH Probes, Human NEAT1\_5 with CAL Fluor<sup>®</sup> Red 590 Dye to confirm RT-qPCR. SPSS software was used to analyze the data.

#### Results

Our data demonstrate that NEAT1 expression was slightly increased in unruptured intracranial aneurysms as compared to healthy STA showing probably a measure of enhanced proliferative activity after vascular injury. Interestingly, NEAT1 expression analyzed with qPCR and FISH was significantly lower in samples from ruptured ICAs as compared to unruptured ICAs (Fig.1). The relative expression to housekeeping gene ( $\beta$ -actin) was quantified (mean±SE) in three groups and compared using one way ANOVA (control=1.15±0.54 fold, ruptured ICAs=0.40±0.17 fold, unruptured ICAs=1.81±0.85 fold, p<0.05).

#### Conclusion

NEAT1 modulates critical cellular processes such as apoptosis, cell proliferation, and migration. NEAT1 may play a role during formation, growth and rupture of intracranial aneurysms. These findings suggest that NEAT1 could act as a potential diagnostic marker for aneurysm stability that need further investigations.

### P168

Auswirkungen einer frühzeitigen hochdosierten Vasopressoren-Therapie bei Patienten nach aneurysmatischer Subarachnoidalblutung: Eine retrospektive Single-Center-Studie Effects of early high-dose vasopressor administration in patients after aneurysmal subarachnoid hemorrhage: A single-center retrospective study

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#### Objective

Although the use of vasopressors after aneurysmal subarachnoid hemorrhage (aSAH) is recommended to maintain adequate cerebral perfusion pressure, data on potential adverse effects on delayed cerebral ischemia (DCI) are lacking. The aim of this study was to evaluate the effects of early high-dose vasopressor therapy on the subsequent occurrence of DCI, DCI-related infarction and functional outcome.

#### Methods

We performed a retrospective evaluation of aSAH patients admitted to our institution between January 2010 and December 2022. Demographic, clinical and outcome data as well as daily norepinephrine equivalent (NEE) scores were collected. Potential risk factors for DCI, DCI-related infarction and functional outcome 3 months after discharge were assessed by logistic regression analysis.

#### Results

A total of 288 patients with a median age of 55 years were included. 204 were female (71%). WFNS grades 1-3 were recorded in 180 patients (62%) and grades 4-5 in 108 patients (38%). 208 patients (72%) received vasopressor therapy during the first 14 postictal days with a mean NEE score of 3.8  $\mu$ g/kgBW/h. The highest NEE scores were seen in the acute post-hemorrhage period and in poor-grade patients (Fig. 1). The mean NEE score during the postictal days 1-4 was significantly higher in patients who developed DCI (p=0.004, Fig. 2A) or DCI-related infarction (p=0.002, Fig. 2B) and who had an unfavorable functional outcome (p<0.001, Fig. 2C). A dose threshold above a NEE score of 5.16  $\mu$ g/kgBW/h was identified in patients who were more likely to have an unfavorable outcome. Multivariable logistic regression analysis identified a high NEE score on postictal days 1-4 as an independent predictor of DCI (OR 1.06, p=0.013) and unfavorable functional outcome (OR 1.29, p<0.001).

#### Conclusion

Vasopressor use is common in aSAH patients in the acute phase after hemorrhage. Our results suggest that high NEE scores during the first 4 days after ictus are an independent prognostic factor and may aggravate the complex cerebral sequelae associated with the disease, so clinicians should consider strict indications. Prospective randomised controlled trials are needed to validate these findings and to further evaluate the effects of different vasopressors in aSAH patients.













### P169

Laborwerte, die bei Patienten nach aneurysmatischer Subarachnoidalblutung eine Shuntpflichtigkeit vorhersagen

Laboratory parameters as predictors of shunt dependency after aneurysmal subarachnoid hemorrhage

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#### Objective

Shunt-dependent chronic hydrocephalus is a common complication following aneurysmal subarachnoid hemorrhage (aSAH), particularly in patients requiring an external ventricular drain (EVD) due to acute hydrocephalus. The timely prediction of shunt dependency could facilitate shorter weaning periods, thereby reducing infection risks and the duration of hospitalisation. In this study, we assessed the diagnostic value of laboratory parameters in blood and cerebrospinal fluid (CSF) for predicting shunt dependency after aSAH.

#### Methods

All consecutive aSAH patients treated between January 2003 and June 2016 who had an EVD at admission and completed the weaning phase were included. Admission values and 14-day mean values for various laboratory parameters from blood and CSF were recorded. The development of shunt dependency after aSAH was the primary endpoint of this study. Data collection also encompassed demographic, clinical, and radiographic baseline characteristics of aSAH to adjust study results in multivariate analysis.

#### Results

Shunt-dependent chronic hydrocephalus developed in 242 of 526 patients (46%) in the final cohort. Among over 60 laboratory parameters evaluated in the univariate analysis, five markers were included in the final multivariate assessment: 14-day mean serum levels of white blood cell count, potassium and total protein, and 14-day mean CSF levels of lactate and total protein. Multivariate backward conditional regression analysis confirmed the independent predictive value of three laboratory parameters: mean serum white blood cell count (>10.5 ×  $10^{9}$ /L, aOR = 2.18, p = 0.002), mean serum potassium (>4.4 mmol/L, aOR = 1.88, p = 0.006), and mean CSF total protein (>89.15 mg/dL, aOR = 1.84, p = 0.011). Shunt dependency rates in the cohort were 25.8%, 36.9%, 49.4%, and 75.3% among patients with none, one, two, or all three laboratory predictors, respectively.

#### Conclusion

Our findings demonstrate that laboratory parameters are robust predictors of shunt dependency after aSAH. These results are relevant not only for refining prediction models for post-aSAH shunt dependency but also for advancing the understanding of the pathophysiological mechanisms underlying chronic hydrocephalus development in aSAH patients.

### P170

Flow-Diverter-Behandlung für sakkuläre, unrupturierte intrakranielle Aneurysmen: Eine systematische Übersichtsarbeit und Meta-Analyse Flow Diverter Treatment for Saccular Unruptured Intracranial Aneurysms: A Systematic Review and Meta-Analysis

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#### Objective

Flow diverter stents are used for occlusion of unruptured intracranial aneurysms, but sound data on complications and clinical outcome for aneurysms that can also be treated with clipping or coiling are limited. We evaluated short-term neurological outcomes and assessed the quality of existing literature.

#### Methods

We systematically searched the literature via PubMed, Embase, and the Cochrane Library up to November 15, 2023, for studies on flow diverter treatment for unruptured saccular aneurysms. The primary outcome measure was the clinical outcome according to a validated outcome scale at 1-3 months after the procedure. Secondary outcomes were worsening of mRS from pre-treatment to short-term follow-up, proportions of complications, and complete occlusion at 12 months. We assessed methodological quality using the Methodological Index for Non-Randomised Studies (poor:0-9, moderate:10-13, good:14-16) and financial interests.

#### Results

Ten studies with 397 patients and 436 aneurysms met the inclusion criteria. The proportion of patients with mRS≥1 was 19.2% (95%CI:13.7%-24.7%), with mRS≥2 8.6% (95%CI:4.7%-12.5%) and with mRS≥3 2.5% (95%CI:0.3%-4.7%). Clinical worsening occurred in 3.5% (95%CI:1.2%-5.7%), complications in 16,4% (95%CI:12.7%-20.0%) and complete aneurysm occlusion in 73.7% (95%CI:68.5%-78.8%). All studies were uncontrolled, of poor or moderate quality and 4 contained significant financial conflicts of interest.

#### Conclusion

Flow diverter treatment for unruptured aneurysms is associated with relevant proportions of complications, occlusion failures and post-treatment morbidity. The insufficient quality and potential bias by financial interests of the available studies do not support recommending flow diverters for unruptured intracranial saccular aneurysms that can be treated by coiling or clipping.

Figure 1: Flow chart, mRS: modified Rankin Scale, GOS: Glasgow Outcome Scale

#### Abb. 1



### P171

Molekulare Alterung sowie die Aktivierung von mTOR und NF-kB werden im rupturierten und nicht rupturierten intrakraniellen aneurysmatischen Gefäßgewebe beschleunigt Tissue analysis revealed enhanced molecular aging and activation of mTOR and NF-kB Pathway in ruptured and unruptured brain aneurysms

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#### Objective

The risk for cardiovascular diseases increases with age. Various markers for vascular aging have been suggested. However, these markers are not a direct measure of aging in vessels. Telomere length quantification can directly measure vascular aging. The current study aimed to investigate aging in aneurysm tissue by quantifying telomere length.

#### Methods

Telomere length was quantified by performing qPCR. Immunofluorescence staining was performed to observe the expression of mTOR, NF-κB, Lamin B1, P21, and oxidative stress-induced DNA damage marker 8-OHDG. Data were analyzed using GraphPad Prism by performing One-Way ANOVA followed by post hoc Tukey"s test.

#### Results

We recruited 67 patients (51 women, 16 men), which are divided into non-diseased control vessels (n=20), ruptured (n=20) and unruptured (n=27) intracranial aneurysm vessels to this study. Telomere length in intracranial aneurysm tissue shorter than in the non-diseased control vessel (Control vessel =  $5.182\pm2.01$  Kbs, unruptured aneurysm =  $3.246\pm1.60$  Kbs, ruptured aneurysm =  $2.541\pm1.33$  Kbs, p=0.0001). The difference in telomere length between non-diseased control vessels and intracranial aneurysm tissue remained significant after normalizing for age (Control vessel  $8.914 = \pm 2.67$  Kbs, unruptured aneurysm =  $7.04 \pm 1.69$  Kbs, ruptured aneurysm =  $6.514 \pm 1.50$  Kbs, p= 0.0007). Moreover, the intracranial aneurysm tissue showed a lower expression of the aging marker Lamin B1 and a higher expression of the senescence marker P21. Additionally, intracranial aneurysm tissue exhibited higher activation of mTOR and NF- $\kappa$ B pathways, which are known to contribute to cellular inflammation and aging. The expression of oxidative stress-induced DNA damage marker 8-OHDG seemed higher in intracranial aneurysm tissue than in non-diseased control vessels.

#### Conclusion

Our data showed increased molecular aging, elevated oxidative stress, and the activation of aging- and inflammation-associated pathways NF-kB and mTOR in intracranial aneurysm tissue, providing a novel insight into the pathophysiology of brain aneurysms.

### P172

#### Risikofaktoren für verlängerte zerebrale Vasospasmen nach aneurysmatischer Subarachnoidalblutung Risk Factors for Prolonged Cerebral Vasospasms in aneurysmal Subarachnoid Hemorrhage (aSAH)

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#### Objective

Cerebral vasospasms (CVS) resulting in delayed cerebral ischemia are a critical outcome determinant after aneurysmal subarachnoid hemorrhage (aSAH). Symptomatic CVS are expected to rarely occur after day 14 after initial aSAH. This study aimed to analyze clinical and radiological risk factors associated with prolonged CVS occurring beyond this period.

#### Methods

We conducted a monocentric, retrospective cohort study at our tertiary care center and included all aSAH patients who received interventional treatment for neurologically symptomatic CVS from 2014 to 2024. The primary endpoint was the occurrence of symptomatic CVS requiring an interventional rescue therapy later than 14 days after the initial aSAH. Clinical and radiological factors and outcome parameters were statistically assessed in relation to prolonged CVS.

#### Results

Among 149 included patients, 26 (17%) required interventional treatment for prolonged CVS later than 14 days after initial aSAH. Patients with prolonged CVS underwent more chemical interventional rescue therapies (4 vs. 2, p << 0.05) over a longer duration (8.5 vs. 2 days, p << 0.05) and had longer hospital stays (28.5 vs. 22 days, p << 0.05) compared to those with non-prolonged CVS. Younger age was identified as a significant risk factor for prolonged CVS (OR 0.92, p = 0.02). Long-term functional outcome was assessed as modified Ranking Scale (mRS) grade. 99 (67%) patients presented with grades 0 - 2, 43 (29%) with grades 3 - 6, with no significant difference in outcomes (p = 0.62) between those with and without prolonged CVS.

#### Conclusion

Younger age is a significant risk factor for neurologically symptomatic CVS beyond 14 days after initial aSAH. Patients with prolonged CVS did not have worse long-term functional outcomes despite requiring more interventional rescue therapies. We recommend extended neuro-intensive care monitoring particularly for younger aSAH patients.



Patients with Prolonged Vasospasms > 14d Patients with Vasospasms </= 14d

Abb. 2

Abb. 1



# mRS at Follow-Up

### P173

Plättchenfaktor 4 (PF4) und Stromal cell-derived factor 1 (SDF1) sagen Komplikationen und die Krankenhausmortalität nach aneurysmatischer Subarachnoidalblutung (aSAH) vorher Systemic Platelet factor 4 (PF4) and stromal cell-derived factor 1 (SDF1) predicted post aneurysmal subarachnoid hemorrhage (aSAH) complications and in hospital mortality after aSAH

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#### Objective

Aneurysmal subarachnoid hemorrhage (aSAH) is a fatal and debilitating condition, with most patients experiencing life-threatening complications that impact clinical outcomes. Platelet aggregates are observed early in parenchymal vessels after experimental SAH, with platelets playing a key role in the development of post-SAH complications as the primary source of PF4 and SDF1.

#### Methods

To investigate the potential of PF4 and SDF1 as predictive markers for post-aSAH complications and outcome, the serum was collected at day 4 after aSAH from patients. The serum concentration of PF4 [pg/mL] and SDF1 [pg/mL] was measured with ELISA. T-Test, linear, and logistic regression were performed to analyze the differences in groups and to build predictive models. The data is presented as mean  $\pm$  standard deviation. The calculations were performed in GraphPad Prism and in Python.

#### Results

We recruited 60 patients (43 women, 17 men; 32 poor grade WFNS (4-5), 28 good grade WFNS (1-3)). Of the 60 patients, 22 patients presented cerebral vasospasm (CVS) and 38 patients had no CVS. PF4 was significantly increased in patients with CVS than in patients with no CVS (CVS=  $8122 \pm 2019$  vs. no CVS=  $6851 \pm 2358$ , p= 0.0417). PF4 was also associated with the mean transit time (MTT) (linear regression, b= 0.11, p= 0.02). SDF1 did not present a difference between patients with and without CVS (CVS=  $123 \pm 377$  vs. no CVS=  $51.53 \pm 51.79$ , p= 0.21). 10 patients developed delayed cerebral ischemia (DCI) and 47 patients had no DCI. PF4 and SDF1 were significantly increased in patients with DCI compared to patients without DCI, (PF4: no DCI= 7058  $\pm 2251$  vs DCI=  $8663 \pm 2276$ , p=0.041; SDF1: no DCI=  $42.90 \pm 49.07$  vs DCI=  $251.5 \pm 503$ , p=0.0085). SDF1 was increased in patients who died within 30 days compared to patients that survived first 30 days (patient died=  $240 \pm 610$  vs patient survived=  $50 \pm 60$ , p= 0.025). However, in-depth analysis showed that the difference is due to one outlier (1700 pg/mL, more than four times the next highest value and almost 40 times the median). Still, when removing the outlier, SDF1 was associated with the time to death for the deceased patients (linear regression, b= 0.01, p= 0.03). PF4 and SDF1 were not different in patients with good WFNS and modified Rankin Scale (mRS) scores compared to bad WFNS and mRS scores at discharge and after three months.

#### Conclusion

The current data suggests that PF4 and SDF1 can be potential markers for predicting CVS and in hospital mortality following aSAH.

Abb. 1







### P174

Die Rolle von Pneumonie bei zerebralem Vasospasmus und verzögerter zerebraler Ischämie bei aneurysmatischer Subarachnoidalblutung: Erkenntnisse aus der P/F ratio The Role of Pneumonia in Cerebral Vasospasm and Delayed Cerebral Ischemia in Aneurysmal Subarachnoid Hemorrhage: Insights from the P/F Ratio

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#### Objective

Aneurysmal subarachnoid hemorrhage (aSAH) leads to complex pathophysiological processes, such as cerebral vasospasm, which clinically manifests as delayed cerebral ischemia (DCI). There is evidence suggesting that pneumonia, a common comorbidity, may trigger cerebral vasospasms. Pulmonary deterioration can be detected early using the P/F ratio, which is utilized to classify the severity of acute respiratory distress syndrome (ARDS). This study aims to investigate the relationship between the early detection of pneumonia, using the P/F ratio, and its potential association with cerebral vasospasm and pneumonia in patients with aSAH.

#### Methods

A cohort of 200 aSAH patients was included in this study to analyze the connection between pneumonia (defined by microbial detection in tracheal secretion and radiographic infiltrates) and vasospasm, as well as DCI. The P/F ratio was measured preliminarily in 50 patients through standardized arterial blood gas analyses. A significant decline in the P/F ratio was defined as a value below 200 for more than 24 hours. Statistical analysis was performed using Chi-square tests.

#### Results

No significant difference was observed in the onset of vasospasm between patients with aSAH who developed pneumonia and those without pneumonia (p = 0.475). However, a significant difference was found when comparing the onset of DCI, with pneumonia patients more frequently experiencing DCI (p = 0.007). Pneumonia patients exhibited a significant drop in P/F ratio (p = 0.012), but this drop had no association with vasospasm (p = 0.696) or DCI (p = 0.668). The most common pathogen identified in tracheal secretion was Staphylococcus aureus, followed by numerous Gram-negative organisms (Figure 1).

#### Conclusion

Pulmonary infections, particularly pneumonia, have been linked in the literature to an increased risk of vasospasms and ischemic complications. In our cohort, pneumonia did not result in a higher incidence of vasospasm but may have contributed to more severe vasospasms, leading to a greater incidence of DCI. The P/F ratio, used as a marker for pulmonary deterioration, did not reflect these findings. However, since it was only preliminarily investigated in 50 patients, further studies will focus on exploring this relationship in greater detail and examining the cause-and-effect timeline between vasospasm and pneumonia.



Figure 1. Detection rates of various bacteria in tracheal secretions (blue gram +, red gram -)

Abb. 1

### P175

Diabetes Insipidus als Komplikation bei aneurysmatischen Subarachnoidalblutungen Diabetes insipidus as complication in aneurysmatic subarachnoid hemorrhage

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#### Objective

A reduced production of ADH due to dysfunction of the hypothalamus or pituitary gland leads to the clinical picture of central diabetes insipidus (DI), characterized by impaired water homeostasis, polyuria, and polydipsia. DI has been described in numerous publications as a complication of traumatic brain injury, associated with increased morbidity and mortality. However, to date, no systematically investigated data exists regarding a possible analogous occurrence in the context of aneurysmal subarachnoid hemorrhage (aSAH).

#### Methods

Retrospective analysis of a propectively designed database of 853 patients with aSAH treated at out deparment between 2008-2021. DI was defined according to established criteria: serum sodium >145 mmol/L, polyuria (>200 ml/hour or >3 l/24 hours), and urine osmolality <300 mosm/kg. Outcomes in survivors were assessed using the modified Rankin Scale (mRS), and prognostic factors for a fatal outcome in DI were analyzed using multivariate regression

#### Results

In total 26 patients, 14 women and 12 men, with a median age of 59 years (36–81) were included. There were 17 aneurysms in the anterior and 9 in the posterior circulation, most commonly in the Arteria communicans anterior (n=10). The median Hunt & Hess grade and Fisher score were 4. Surgical clipping was performed in 13 patients, 9 received interventional treatment, and 4 were untreated due to an infaust prognosis. DI developed on average 3 days after aSAH, with average sodium levels of 154 mmol/l, maximum urine output of 539 ml/h, and total output of 3076 ml/24h. Desmopressin was given to 23 patients. Mortality was 69%, primarily from malignant brain swelling (n=18), with an average time from DI onset to death of 8 days. Survivors had a median mRS score of 4. Multivariate analysis revealed no specific prognostic factors for survival or death in DI patients.

#### Conclusion

DI is a rare complication of aSAH, associated with high mortality and severe disability in surviving patients. DI appears to occur more frequently in patients with ruptured aneurysms of the anterior circulation and in cases of higher-grade aSAH. Further multicenter studies with larger patient cohorts are needed for a better understanding and treatment of DI and aSAH.
### Vaskuläre Neurochirurgie 2 | Vascular neurosurgery 2

### P176

Moyamoya Disease

Anatomie des knöchernen Kanals der Arteria meningea media für eine gefäßschonende Kraniotomie bei Moyamoya-Erkrankung Anatomy of the Bony Canal containing the Middle Meningeal Artery for a Vessel-sparing Craniotomy in

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#### Objective

The frontal branch of the middle meningeal artery (MMA) often traverses a bony canal, rendering it vulnerable during craniotomies. In Moyamoya disease (MMD), the MMA serves as an important collateral pathway for cerebral blood supply. Thus, anatomical variations of the bony canal are crucial for surgical planning, but data on Caucasian populations remain scarce. This study investigated the incidence, dimensions, and spatial location of MMA bony canals in anatomical specimens and MMD compared to atherosclerotic cerebrovascular disease (ACVD).

#### Methods

A total of 175 dry skulls of Caucasian origin and computed tomography (CT) scans of Caucasian MMD (n = 100) and ACVD (n = 50) patients were assessed. The anatomical relationship to the convergence of the coronal, sphenofrontal, and sphenoparietal sutures, serving as a landmark, was analyzed.

#### Results

In 91.2% of adult dry skulls ( $\geq$ 18 years), a bony canal of the frontal MMA branch was observed. In children <2 years, before fontanelle closure, the canal was present in only 1.8%, increasing to 47.7% in children  $\geq$ 2 years (p < 0.0001). The length of the canal was similar in adults (12 ± 5.9 mm) compared to children  $\geq$ 2 years (10.1 ± 4.5 mm) and those <2 years (7.5 ± 3.5 mm, p = 0.222). The mean distance of the canal's entry and exit points posterior to the anatomical landmark was 11.3 ± 4.8 mm and 13.8 ± 6.4 mm, respectively. Canals containing the parietal MMA branch were rare, present in 12.9% of adults, 2.3% of children  $\geq$ 2 years and 0% of children <2 years (p < 0.0001), and were typically located below the squamous suture. Regarding clinical data, MMD patients were younger (41.6 ± 12.0 vs. 59.5 ± 10.2 years, p < 0.0001) and had a lower prevalence of frontal branch bony canals than ACVD patients (80.0% vs. 89.0%, p = 0.05). Parietal branch canals were rare in both groups (6.5% vs. 4.0%, p = 0.38). Notably, the length of the frontal canal was similar (15.8 ± 9.8 vs. 13.8 ± 6.7 mm, p = 0.16), but canals exhibited larger diameters in MMD compared to ACVD patients (1.6 ± 0.4 vs. 1.4 ± 0.5 mm, p = 0.05), although not reaching statistical significance.

#### Conclusion

Comprehensive knowledge of the MMA anatomy near the pterion is crucial for preserving its anterior branch during bypass surgery for MMD. This study highlights significant anatomical variations of MMA bony canals, emphasizing that after fontanelle closure, the likelihood of the MMA traversing a bony canal approximately one thumb-width posterior to the pterion increases with age.

### Vaskuläre Neurochirurgie 2 | Vascular neurosurgery 2

### P177

Der Einfluss eines ungesunden Lebensstils auf das Risiko der Ruptur intrakranieller Aneurysmen und die klinischen Ergebnisse: Eine retrospektive Untersuchung Linking Unhealthy Lifestyles to Intracranial Aneurysm Rupture Risk and Clinical Prognosis: A Retrospective Analysis

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#### Objective

The increasing prevalence of modifiable lifestyle risk factors and cardiovascular diseases, driven by poor diet, physical inactivity, excessive alcohol consumption, and smoking, may contribute to the development and rupture of intracranial aneurysms (IA). This study aimed to assess the influence of lifestyle-related and cardiovascular risk factors on IA rupture and patient outcomes.

#### Methods

We introduced the "MARVIN" model (Metabolic and Adverse Risk Factors and Vices Influencing Intracranial Aneurysms) (Figure 1) and conducted a retrospective analysis of 303 patients with 517 IAs treated between 2007 and 2020. Of these, 225 patients were evaluated for rupture status and 221 for clinical outcomes. The analysis included hypertension, diabetes, hypercholesterolemia, vascular diseases, nicotine and alcohol abuse, obesity, aneurysm rupture status, and clinical outcomes. Logistic regression was used to determine the impact of these risk factors.

#### Results

Among patients, 24.9%/25.3% had one risk factor, 30.8%/32.0% had two, 20.0%/20.4% had three, 12.0%/12.2% had four, 4.0%/4.1% had five, 0.9% had six, and 0.4%/0.5% had seven risk factors in the rupture and outcome analyses, respectively (Figure 1). Strong correlations were observed between lifestyle-related vascular risk factors, indicating that patients with unhealthy habits often had multiple comorbidities. Smokers with ruptured aneurysms presented higher WFNS Scores, but nicotine abuse did not significantly affect long-term outcomes. WFNS score and age emerged as the strongest predictors of poor outcomes, while age and a history of vascular diseases were protective against rupture. Despite the high prevalence of modifiable risk factors, the factors included in the "MARVIN" model did not significantly influence rupture risk.

#### Conclusion

This study highlights the importance of a multifactorial risk assessment approach in managing IA patients. Although modifiable risk factors were prevalent, they did not significantly affect rupture risk, emphasizing the complexity of IA progression. Larger cohort studies are needed to validate these findings and provide deeper insights into the role of lifestyle and cardiovascular risk factors in IA management.



**Figure 1.** (A) distribution of the number of risk factors. (B) schematic representation of the "MARVIN" concept, highlighting the accumulation of seven established risk factors in patients with unhealthy lifestyle habits.

#### Abb. 1

### Vaskuläre Neurochirurgie 2 | Vascular neurosurgery 2

### P178

Die Anwendbarkeit der intra-arteriellen ICG-Fluoreszenzangiografie in der Neurochirurgie. Intra-arterial ICG fluorescence video-angiography in neurosurgery – a proof of concept study.

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#### Objective

Intraoperative indocyanine green (ICG) video-angiography allows for real-time assessment of cerebral blood flow. Typically administered intravenously, ICG is diluted after passing through the lungs, which reduces sensitivity in detecting perfusion deficits. Intra-arterial ICG application may enable a more precise evaluation of cerebral blood flow. This study assesses the feasibility of intra-arterial ICG video angiography compared to the established intravenous method.

#### Methods

To perform ICG video-angiography, the abdominal aorta in n=20 eight-week-old female Wistar rats was exposed. Surgery was performed while animals were under anesthesia and continuous monitoring. Measurements were conducted using an adapted Carl Zeiss Meditec Pico surgical microscope with an incorporated IR800 filter. The Pico microscope was coupled with a highly sensitive infrared camera (150 frames/ second). Fluorescence angiography was performed after both intra-venous and intra-arterial ICG bolus. A micro clip was placed on the respective vessel to mimic clip-stenosis. All video data were analyzed using Fiji. Fluorescence intensities were calculated in predefined ROI in arbitrary intensity units. Rise time was evaluated in predefined ROIs. Rise times were compared between two modalities using unpaired t-tests.

#### Results

Rise time after inter-arterial ICG application was significantly shorter compared with the established gold standard. The average rise time after inter-arterial ICG application was 5.47 sec compared to 7.8 sec after i.v. application. As determined by arbitrary intensity units, fluorescence intensity was more robust after inter-arterial ICG application. Turbulent clip stenosis could be visualized in detail.

#### Conclusion

Our results show the feasibility of inter-arterial ICG application for neurovascular surgery. Fluorescence intensity after inter-arterial ICG application is more robust, and the time of rise is significantly shorter, which may allow more sensitive blood flow assessment. In particular, hemodynamic phenomena in stenoses can be excellently observed.

### P179

# Geografische Erreichbarkeit und Fallverteilung zertifizierter neuroonkologischer Zentren in Deutschland Geographical Accessibility and Case Distribution of Certified Neuro-Oncology Centers in Germany

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#### Objective

Neuro-oncology centers (NOZ) certified by the German Cancer Society (DKG) are integral components of the three-tier oncology care system outlined in the National Cancer Plan. Certification serves as a key quality indicator for high-standard neuro-oncological care. This study aimed to assess the geographical accessibility of NOZ and analyze the proportion of neuro-oncological hospital cases treated within these certified centers.

#### Methods

As of December 31, 2022, certified NOZ were identified using the OncoMap. Management and operational data were sourced from the §136b SGB V database, encompassing NOZ and all hospitals in Germany. Neuro-oncology cases were defined based on the ICD-10-GM codes C70, C71, C72, C75.1–3, D32, D33, D35.2–4, D42, D43, D44.3–5, in alignment with the DKG's primary case definition. Using the "trinovis VISION" tool (trinovis GmbH, Hanover, Germany), weighted average travel times from individual towns in Germany to the nearest NOZ were calculated. Travel times were computed based on HERE Technologies" navigation datasets and RW Net (Routeware) routing software, which accounted for varying traffic infrastructure, topography, and average traffic conditions.

#### Results

In 2022, German hospitals treated 41,242 cases with the defined neuro-oncological diagnoses. The most common diagnoses included brain malignancies (ICD-10-GM C71: 8,520 cases), benign meningeal tumors (D32: 3,848 cases), and benign brain/CNS tumors (D33: 2,002 cases). As of December 31, 2022, there were 51 hospitals with 52 DKG-certified NOZ locations. These centers managed 17,812 cases, accounting for 43.2% of all neuro-oncological cases.

The mean weighted travel time to an NOZ was 35.5 minutes (range: 6.1–1,383 minutes, SD 34,4 min, with the longest travel time recorded in Helgoland). Accessibility analyses revealed that 20% of the adult population could reach an NOZ within 15 minutes, 48% within 30 minutes, 69% within 45 minutes, and 86% within 60 minutes.

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#### Conclusion

The mean weighted travel time to NOZ for the population is 35 minutes , with over 30% requiring more than 45 minutes. Planning efforts should focus on improving access to inpatient neuro-oncological care and avoiding additional barriers to timely treatment. Currently, slightly over 40% of all neuro-oncology cases are treated within DKG-certified centers, highlighting the need for broader integration into the specialized care network.

### P180

Einfluss regionaler Radonkonzentration auf Meningeompatienten: Ergebnisse einer zehnjährigen monozentrischen retrospektiven Studie Impact of Regional Radon Concentration on Meningioma Patients: Insights from a Decade Monocentric Retrospective Study

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#### Objective

Radon-222 exposure has been implicated in the development of various malignancies, including central nervous system tumors. This study investigates the potential relationship between regional residential radon conventration (RRC) and the clinical and pathological characteristics of meningioma (MNG).

#### Methods

A retrospective analysis was conducted of 4435 patient files, identifying 1025 cases of histologically confirmed meningiomas treated with partial or total resection between January 2012 and December 2022. Demographic data, histological subtypes, tumor location, tumor characteristics, survival outcome, and RRC data (obtained from the Geoportal of the Federal Office for Radiation Protection) were analyzed. Patients were stratified into four groups based on RRC levels: Group 1 (0–50 kBq/m<sup>3</sup>; n=179), Group 2 (51–100 kBq/m<sup>3</sup>; n=537), Group 3 (101–150 kBq/m<sup>3</sup>; n=202), and Group 4 (>151 kBq/m<sup>3</sup>; n=107). Statistical analyses included the Pearson chi-square test, Kruskal-Wallis test, and Kaplan-Meier survival analysis.

#### Results

The median age of the cohort was 66.7 years (standard deviation (SD) 13.6 years, range 14.7-95 years), with a female predominance (73.6%; female ratio of 3:1). Gender and age were evenly distributed across all RRC groups (p=0.908 and p=0.969, respectively). The mean age across all groups ranged from 62.1 to 62.8 years, having no significant difference among the RRC groups (p=0.978). Meningothelial MNG WHO-Grad 1 was the most common histological subtype (n=428), with 53% of cases in group 2. Tumor were most frequently located at the convexity (58% of all cases), with group 2 also comprising the highest proportion (n=309). Skull base MNGs accounted for 332 cases, with 54.5% occurring in group 2 (p=0.767). Kaplan-Meier analysis revealed no statistical significant association between RRC and overall survival (p=0.651).

#### Conclusion

This study found no significant impact of residential radon exposure on the clinical characteristics or overall survival of MNG patients. Limitations include the use of averaged radon concentrations with a spatial resolution of 1 square kilometer, without direct measurements in patients' homes and unknown residence duration. Future studies should incorporate direct household measurements and residence duration to better understand the relationship between radon exposure and meningioma characteristics. Whether there is a correlation between MNG recurrence and MNG size with radon exposure is yet to be determined.

### P181

Metformin und Carnosine inhibieren das Wachstum primär kultivierter Meningeomzellen Metformin and Carnosine inhibit the growth of primary cultured meningioma cells

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#### Objective

There are currently no pharmacological therapies established as standard treatment for meningiomas. Given that higher-grade meningiomas have a recurrence rate of 40% (grade II) to 78% (grade III) within 5 years, pharmacological intervention is of clinical interest. For this reason, we asked whether the naturally occurring dipeptide carnosine (Car), whose anti-neoplastic effect has been demonstrated under experimental conditions in the case of glioblastomas, also affects the growth of cultured meningioma cells. In addition, we investigated the effect of metformin (Met), whose potential anti-neoplastic effect is currently studied in numerous clinical trials in other tumor entities.

#### Methods

In this study, we investigated the effects of Met, Car, and a combination of both on meningioma cells. We treated 11 primary meningeal cell cultures of different grades with 5 mM Met, 50 mM Car, or a mixture of both. We then quantified cell viability using the CellTiter-Glo assay (CTG) after 48 and 72 hours and measured cell confluence by live-cell imaging at 4-hour intervals. We also performed cell staining with Hoechst 33343 and propidium iodide to count cell nuclei and dead cells after 24h, 72h, and 144h.

#### Results

Live cell imaging revealed reduced cell growth in the presence of each substance. Both substances reduced proliferation within 144 hours by up to 75% (Met: 8 of 11 cultures; Car: 11 cultures). Six cultures responded to a combination of the compounds with a combined effect: For example, one Grade II culture responded to Met with a 48.5% reduction of proliferation and to Car with 45.5%, but to a combination of the compounds with 58.1% (live cell imaging at 72h). In addition, viability at 48h, as revealed by CTG, was significantly reduced to 71.2±19.7% in Met (7 of 11 cultures) and 74.3±12.4% in Car (5 of 11 cultures). After 72h exposure, CTG was further reduced to 61.8±19.1% (Met; 8 of 11) and 64.4±19.1% (Car; 9 of 11). Microscopy confirmed reduced confluence and viability caused by reduced proliferation, and there was no necrosis. At the current stage of the ongoing experiments, making a statistically clear statement about whether meningiomas of different grades respond differently to the substances is impossible.

#### Conclusion

Car and Met, alone or in combination, should be considered potential therapeutics for treating meningiomas. Since neither produces critical side effects in patients, they would also be suitable for continuous administration over an extended period.

### P182

Psycho-onkologische Belastung bei Meningeom-Patienten Psycho-oncological burden in patients with meningioma

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#### Objective

Meningiomas are the most frequent intracranial tumors. Complete surgical resection is curative in the majority of the cases. Despite the benign biology, meningiomas can cause symptom burden and possibly significant psycho-oncological distress. The aim of our study is to show the importance of psycho-oncological burden in patients with meningioma and the necessary support.

#### Methods

We screened 529 patients (400 female, 129 male) with a median age of 59.3 years (range: 23.9 – 90.6 years) who were planned to undergo surgical resection of a meningioma. In 158 cases (29.9%), the tumor was located on the skull base; the median pre-surgical Karnofsky Index (KPI) was 90 (range: 50-100); 125 patients presented with extensive bone invasion (25.1%), large edema was present in 33.3%. Psycho-oncological screening was performed on the day of admission using the Hornheider screening instrument (hsi) in 63.1% and the distress thermometer in the remaining 36.9% of all patients.

#### Results

In 79 cases, the screened patients failed to fill out the questionnaire (14.9%). Those patients were characterized by a poorer KPI (p=0.0001). The score exceeded the predefined threshold in 234 cases (52%), indicating the need for psycho-oncological treatment. The threshold was more frequently surpassed in younger patients (p=0.0002). There was a negative correlation between age and the hsi and the distress thermometer scores (p=0.039 and p=0.016, respectively). Female patients showed a higher distress thermometer score (p=0.015), while patients with bone invasion and large edema scored significantly higher in the hsi (p=0.027 and p=0.019, respectively). Patients with focal neurological deficits scored higher in the hsi and the distress thermometer (p=0.042 and p=0.034, respectively).

#### Conclusion

These results show that a large fraction of patients with meningiomas show significant psycho–oncological distress. This highlights the importance of an early psycho-oncological support especially in female and younger patients.

### P184

Analyse nummerischer Chromosomenaberrationen von 17p13 und 17q22 in Meningeomen – Ein Verlust des Genlocus von p53 auf 17p13 korreliert mit dem radiologisch ermittelten Tumorvolumen Analysis of numeric aberrations of the chromosomal regions 17p13 and 17q22 in meningiomas – Monosomy of p53 gene locus 17p13 correlates witch radiological measured tumor volume

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#### Objective

The investigation of chromosomal aberrations on chromosome 17p and 17q in meningiomas remains interesting because of various encoded tumor suppressor genes such as TP53 (17p13) or the serine/threonine kinases RPS6KB1 (17q23). Moreover a loss of heterozygosity of 17p13 is described in literature as a rare event, seen in atypic or anaplastic meningiomas. The loss of 17p22 occurs in recurrent meningiomas and has prognostic value.

#### Methods

In this trial 31 primary and 10 recurrent meningioma tumor samples of 37 patients that underwent surgical treatment were analyzed regarding numeric aberrations of 17p13 and 17q22 by fluorescent in situ hybridization (FISH).

#### Results

Numeric losses of 17p13 and 17q22 were rare over all WHO-grades (median: 3,7% range: 0% - 15% per case). Concerning losses of 17p13 and tumor volume a highly significant correlation was detected (r= 0.477; p= 0.002) and described by linear regression: 14.092+3,51\*x (p= 0.006). Apart of numeric losses, also numeric gains were seen (median: 8,8% range: 0% - 75%). But only two patients had meningiomas with high chromosomal gains between 58% - 75%. The tumors of these two patients were a WHO-grade I meningioma and a multiple WHO-grade III meningioma with 4 different cerebral lesions.

#### Conclusion

Chromosomal gains and losses of 17p13 and 17q22 remain rare in meningiomas. Nevertheless, aberrations were not only seen in high-grade tumors, as often described in literature but also as sporadic aberrations occurring in benign meningiomas. The linear regression showed that losses of TP53 (17p13) went along with greater tumor volumes, suggesting that even slight losses of TP53 work as a molecular mechanism that leads to tumor growth in meningioma. Apart of chromosomal losses, chromosomal gains of 17p13 and 17q22 were rare.

### P186

#### Implementierung der integrierten molekular-morphologischen Analyse und DOTA-TATE-PET im Meningiom-Management: Auswirkungen auf Behandlungskonzepte Implementation of Integrated Molecular-Morphologic Analysis and DOTA-TATE PET in Meningioma Management: Impact on Treatment Paradigms

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#### Objective

Meningiomas are the most common primary intracranial tumors, and their management is continuously evolving with advancements in molecular and imaging technologies. We present our internal guidelines implemented from January 2023, emphasizing integrated molecular and histopathological analysis and the use of DOTA TATE PET post-resection to enhance patient management strategies.

#### Methods

This study involves 213 patients who underwent meningioma surgery between January 2023 and August 2024. These patients received an extended molecular analysis including methylation status, mutations, and copy number variations (CNV). The cohort included 31 recurrent tumors and 182 primary tumors, classified as WHO Grades I (163), II (44), and III (6). Postoperative DOTA TATE PET scans were performed on 133 patients (62%) three months after surgery to identify tumor remnants.

#### Results

A critical question was addressed: for how many patients do these advanced analyses shift the therapeutic paradigm, specifically concerning WHO Grade I meningiomas in the context of suggesting adjuvant radiation rather than conventional follow-up? Out of the Grade I primary meningiomas, 21 patients (9.9%) were recommended adjuvant radiation therapy. This recommendation was based on increased mitotic activity in one patient, anomalies in CNV suggesting high risk in five patients, and definitive tumor residue indicated by positive PET results in 15 patients.

#### Conclusion

The integration of molecular diagnostic and advanced imaging techniques into routine practice significantly impacts the treatment approach for meningioma patients. It allows for more tailored treatment recommendations, especially in cases where traditional criteria might not reflect the underlying aggressive potential of the tumor.

### P187

Der potenzielle Einfluss von drei ausgewählten, auf Chromosom 17 lokalisierten miRNAs für die Aggressivität und das Rezidivverhalten in Meningeomen - p53-target miRNA-22 als potenzielle Tumorsupressor-miRNA in Meningeomen

The potential influence of three selected chromosome 17 encoded miRNAs for meningioma aggressivity and recurrence - p53-transcriptional target miRNA-22 as a candidate tumor suppressor miRNA in meningiomas

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#### Objective

Epigenetic investigations in meningioma is an upcoming issue: miRNAs are small non-coding RNA molecules, that represent new promising biomarkers in meningioma. The analysis in this study focuses on the expression of miRNA-22 (17p13), miR-657 (17q25) and miR-4737 (17q23) in meningioma tumor tissues.

#### Methods

The tumor samples of 31 primary and 10 recurrent meningioma of 37 patients that underwent surgical treatment were analyzed regarding miRNA expression levels. Measurement of the three miRNAs expressions was performed by real-time-PCR.

#### Results

Of the three candidate miRNAs only miR-22 expression correlated strongly negative with WHO-grades, (r = -0.659; p= <0.001). The inter-paired comparison of WHO-grades differed strongly (p= <0.001). With respect to proliferation rates, correlation of miR-22 expression and KI-67 expression (r= -0.497; p= 0.002) and mitotic-rate in high-power-field microscopy (r= -0.618; p= <0.001) were found. Comparing miR-22 expression levels in primary and recurrent meningiomas a significantly lower expression was found in the group of recurrent meningiomas (p= 0.042).

#### Conclusion

Only miR-22 correlated significantly negative with WHO-grades while miR-657 and miR-4737 showed no correlation. This study revealed decreasing expression levels of miR-22 in benign (WHO-grade I) to anaplastic meningiomas (WHO-grade III) on the one hand and different expressions comparing primary and recurrent meningiomas on the one hand. This strongly suggests the influence of miR-22 in tumor malignancy and its potential as a marker for high-grade meningiomas and recurrence behavior.

### P188

Verhalten eines neuen Somatostatin Rezeptor Typ 2 (SSTR II) zielgerichteten Nahinfrarotfluoreszenzfarbstoff im Schwein sowie in einem chirurgischen Bildgebungssystem Performance of a Novel Somatostatin Receptor Type 2 (SSTR II)-Targeted Near Infrared (NIR)-Fluorescent Probe in Healthy Pigs and a Surgical Imaging System

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#### Objective

We aim to develop a highly specific and sensitive optical method for intraoperative meningioma imaging to enable tumor visualization and improve the resection completeness by targeting the reliably overexpressed somatostatin receptor type 2 (SSTR2). We have already shown the proof of concept in a meningioma cell model and mouse model. To determine the full potential on its way to clinical translation, we aim to applicate the dye in healthy pigs and measure the uptake of TATE-sNIR in physiological SSTR2 expressing organs by using a custom-built imaging system as well as an established clinical surgical imaging system.

#### Methods

Female pigs were intravenously bolus injected with TATE-sNIR (10 and 30 nmol/kg). Blood samples were collected at different time points and were imaged to measure fluorescence intensity. At 5.6 h and 2.3 h post-injection, the animals were euthanized, and the organs were imaged *ex vivo* using a custom-built imaging setup and the Da Vinci surgical system (Firefly Sensitive mode). Another pigs' organs were imaged under same conditions without application of the dye to determine tissue autofluorescence.

#### Results

We observed a blood half-life of 7 minutes. A high tracer uptake was observed in the pancreas and stomach (**Fig. 1**) and succeeded to visualize the pituitary stalk and gland given their physiological SSTR2 expression. In contrast, the uptake of TATE-sNIR in the liver as a non-target tissue was low, giving a pancreas-to-liver ratio of 3.6. The visualization of uptake was feasible in the Da Vinci surgical system (**Fig. 2**). Fluorescence intensities in the pituitary, pancreas and gastric corpus of the injected animal were 64, 83 and 26 times higher compared to the autofluorescence control.

#### Conclusion

The proof-of-concept study in healthy pigs confirmed the physiological uptake of TATE-sNIR in expected target organs and the visualization was feasible in a custom-built imaging system as well as a clinically established surgical imaging system, underlining the translational potential of our novel SSTR2-targeted fluorescence dye for meningioma surgery in the future.



Abb. 2



### P190

Berufliche Wiedereingliederung von Patienten nach Resektion eines atypischen intrakraniellen Meningeoms Work-Life Reintegration of patients after resection of atypical intracranial meningioma

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#### Objective

Atypical meningiomas are rare intracranial tumours that tend to a higher recurrence rate and a more invasive growth than grade 1 meningiomas. Extended therapy and psychosomatic adverse events often hinder smooth re-integration into work and consequently reduce quality of life. The objective of this study was to bring out predictive factors for work return of patients after atypical meningioma surgery.

#### Methods

We conducted a single center retrospective study including n=102 adult patients who underwent surgery for atypical meningioma between 2016 and 2023. Data were acquired from patient files on record at our institution i. e. discharge letters, operative reports, MRI-Scans, pathological reports and radiation protocols. Additionally, work-related data were gathered by searching for relevant occupational aspects of social history taken upon regular follow up.

#### Results

55/102 (53.9 %) operated patients were surveyed upon follow up (mdn FU = 38 mo). Primary end point was reintegration into work life. 41/55 (74.5 %) returned to work, 33 (80.5 %) within 1 year of surgery (Fig. 1). Secondary end points were factors favoring or preventing work return. 13/24 patients (54.2 %) older than 50 returned to work, 20/23 (87.0 %) aged 36 to 50 and 8/8 (100.0 %) aged younger. Age was identified as an independent predictive factor for work return (p=0.009). 19/27 (70.4 %) patients with postop. radiation returned to work, 39/51 (76.5 %) did so after gross total resection (Simpson  $^{\circ}1+2$ ). 17/41 (41.5 %) patients returned to work despite cranial nerve palsy or motor deficit. 7/14 (50.%) of patients not returning to work presented with no deficit at all. Differences were not statistically significant.

#### Conclusion

Age is a predictive factor to assess whether a patient may not reintegrate into work life after atypical meningioma surgery. Other parameters were not conclusive, even though tendencies could be observed. Multi-centric prospective studies with more patients should be realized to pin down relevant prognostic factors and identify patients at risk of not being able to work and secure their income. This could lead to a more targeted perioperative socio-economic management.



Return to work 100 ••• All Percentage not returned to work (%) Women 90 Men 80 70 60 50 40 30 20 . . . . 10 0 ż 0 1 6 12 or more Months after surgery

Abb. 2



### P191

DCD10 ist ein entscheidender Vermittler der Temozolomid-Resistenz, der an mehreren Mechanismen in Glioblastomzellen beteiligt ist.

PDCD10 is a crucial mediator of temozolomide-resistance involving multiple mechanisms in glioblastoma

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#### Objective

Glioblastoma (GB) remains one of the most lethal primary brain tumors, largely due to resistance to temozolomide (TMZ). This study aims to investigate the role of PDCD10 in acquired TMZ resistance and its underlying molecular mechanisms in GB cells.

#### Methods

The present study was performed in PDCD10-knockdown cells (shPDCD10) and -overexpression GB cell lines (oxPDCD10). Using a previously established acquired TMZ-resistance model [1], cell viability and regrowth capacity were detected in TMZ-treatment phase and post-treatment phase by MTT assay. The expression of DNA damage response (DDR) gene including MGMT, MSH2, MSH6 and PMS2 was detected by RT<sup>2</sup>-PCR and Western blotting. Cell cycle was examined by flow cytometry. To evaluate the plasticity of TMZ-resistant shPDCD10 cells, neurosphere formation and the expression of stem cell markers were detected.

#### Results

Knockdown of PDCD10 significantly enhanced cell viability in TMZ-treatment and post-treatment phase, accompanied by upregulation of MGMT and downregulation of mismatch repair (MMR) gene MSH2, MSH6 and PMS2. shPDCD10 in GB cell resulted in evading from cell cycle arrest at the G2/M checkpoint. Furthermore, PDCD10 knockdown caused cellular reprogramming toward a glioma stem cell-like phenotype and genotype, characterized by increased sphere formation, upregulation of GSC marker Nestin and KLF4. These shPDCD10-GSCs exhibited higher TMZ-resistance. Conversely, overexpression of PDCD10 restored the sensitivity to TMZ treatment, suppressed MGMT expression, upregulated MMR gene and normalized cell cycle.

#### Conclusion

PDCD10 serves as a critical modulator of TMZ resistance in GB involving regulation of DDR pathways, cell cycle and stemness. These findings highlight PDCD10 as a promising therapeutic target for overcoming TMZ resistance and mitigating tumor recurrence in glioblastoma.

### P192

Longitudinale Immunzellphänotypisierung in peripherem Blut während der Erstlinientherapie von Glioblastom-Patientinnen und -Patienten

## Longitudinal immune cell phenotyping in peripheral blood of patients with newly diagnosed glioblastoma during standard of care

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#### Objective

Therapeutic options for newly diagnosed Glioblastoma (GB) consist of maximal safe resection, radiation therapy plus alkylating chemotherapy including temozolomide (TMZ) and tumor-treating fields. Still, overall survival remains in the range of 1.5 - 2 years. Several immunotherapeutic strategies are currently applied in clinical trials including therapeutic vaccines that are often administered in addition to standard of care (SOC). Here, we aimed to characterize the peripheral immune cell composition during SOC.

#### Methods

This is a longitudinal, prospective, single-center observational study. Patients with newly diagnosed GB were enrolled between 2017 and 2019. Longitudinal blood samples were collected at four predefined time points during SOC. We defined 1<sup>st</sup> time point after initial surgery, 2<sup>nd</sup> after radiochemotherapy, 3<sup>rd</sup> before finalization of the 4<sup>th</sup> TMZ cycle and 4<sup>th</sup> time point after finalization of the 4<sup>th</sup> TMZ cycle. Immune cell composition was analyzed via multiparametric flow cytometry and correlated with clinical data.

#### Results

We included 18 GB patients in this analysis. Flow cytometry revealed stable proportions of major T cell subsets across all four time points. However, regulatory T cells were significantly enriched in later stages. The immune marker programmed cell death protein-1 (PD-1) was upregulated in CD4<sup>+</sup> T cells at the end of SOC. In contrast, CD8<sup>+</sup> T cells either expressing HLA-DR or PD1 were elevated following radiochemotherapy. Of note, we noticed increased presence of CD8<sup>+</sup> effector memory T cells (CD45RA<sup>-</sup>, CCR7<sup>-</sup>) after radiochemotherapy. Moreover, we found elevated levels of myeloid-derived suppressor cells (MDSCs) and reduced monocyte numbers in GB in comparison to healthy donors.

#### Conclusion

Longitudinal peripheral immune cell profiling revealed increased presence of regulatory T cells at later time points during SOC. Distinct memory T cell states and CD8<sup>+</sup>T cells expressing HLA-DR were more prominent in patients with favorable prognosis and following radiotherapy. These findings might advocate for the integration of immunotherapeutic approaches, including tumor vaccines, at an early time point during SOC.

### P193

EVA und der PAM Signalweg: Rapamycin vs. Dactolisib als eine Erweiterung einer neuartigen Therapie-Strategie des Glioblastoms EVA and the Key to the PAM Pathway: Rapamycin vs. Dactolisib as an Extension of a Novel Rationale for Glioblastoma Therapy

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#### Objective

Glioblastomas (GB) are highly malignant brain tumors whose treatment is limited due to diverse resistance mechanisms, leading to rapid disease progression and fatal outcomes. In previous publications, we demonstrated the in vitro efficacy of a novel therapeutic combination comprising inhibitors of XPO1, Bcl-2, and Mcl-1 (Eltanexor, Venetoclax, and A1210477; EVA). In the present study, we analyze the dependency of GB cells on the PI3K/AKT/mTOR (PAM) signaling pathway and evaluate the efficacy of the therapeutics Dactolisib and Rapamycin as potential additions to EVA.

#### Methods

Expression of genes involved in the PAM pathway in GB tumor tissue was analyzed using the TCGA and GTEx databases. Viability and apoptosis assays were conducted following treatment with TMZ, MTX, Ara-C, and 5-Aza in combination with EVA and either Dactolisib or Rapamycin. Dose-response curves were generated for GB cell lines U87 and U251 and for glioblastoma stem-like cells (GSCs). Expression of apoptosis-regulating genes (Bcl-2, Mcl-1, XPO1) and PAM signaling pathway genes (PIK3CA, AKT2, mTOR) was analyzed by qPCR and Western blot. Cell cycle analyses were performed using flow cytometry. The toxicity of the drugs on healthy tissue was evaluated in vivo using cultured mouse brain slices.

#### Results

PIK3CA and AKT are overexpressed in GB tissue. Compared to established cell lines, mTOR and AKT2 are particularly elevated in GSCs. Dactolisib exhibited up to 100-fold lower IC50 values compared to Rapamycin across all tested GB cell lines. In combination with EVA, Dactolisib was significantly more effective than Rapamycin in reducing cell viability and inducing apoptosis. On the mRNA level, Dactolisib treatment resulted in a reduction in the expression of mTOR, AKT2, PIK3CA, Mcl-1, and XPO1, whereas Rapamycin induced upregulation of AKT2 and PIK3CA in GSCs. EVA treatment led to a significant induction of PAM signaling pathway genes. Dactolisib caused a more pronounced G1-phase cell cycle arrest than Rapamycin. Both substances showed no signs of toxicity in healthy tissue in mouse brain slices.

#### Conclusion

The PAM signaling pathway appears to represent a critical survival mechanism for GB cells, particularly when challenged with EVA. Dactolisib proved to be superior to Rapamycin overall, especially in combination with EVA, and suggests a non-harmful safety profile. The combination of EVA and Dactolisib as a novel therapeutic option for GB justifies further investigation in future preclinical and clinical studies.

### P194

#### BRAF- und PTPN11-mutierte Glioblastome: Gut oder schlecht? BRAF- and PTPN11-altered glioblastomas: Good or Bad?

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#### Objective

The classical oncogenic BRAF/PTPN11 driver mutation is observed frequently in lower grade and epilepsy associated tumors and occur in approximately 5% in glioblastoma (GB). Target therapy including BRAF and MEK inhibition demonstrate prolonged outcome in lower grade tumors but no therapeutic effect in GBs. Here we investigated the molecular landscape of MAPK-altered GBs.

#### Methods

We performed multi-omic analysis including mutational, epigenetic and transcriptional profiling data of BRAFmutated (n=29) and PTPN11-mutated (n=25) glioblastoma and propensity matched GBs. Using spatially resolved transcriptomics and single cell RNA-sequencing, we explored the effect of a BRAF mutated cell line and the neuronal environment and therapeutic effect of BRAF and MAK inhibition in a human neocortical slice model.

#### Results

Clinical data analysis demonstrated no difference in overall or progression free survival of BRAF/PTPN11 mutated GBs. Co-mutation analysis and differentially gene expression analysis demonstrated a strong link between BRAF mutated GBs and enriched neuronal signatures (synaptogenesis p<0.001 and cholinergic synapse p<0.001). The epigenetic neural-score is significantly increased in BRAF mutated GBs along with decreased abundance of macrophages in the spatial transcriptomic data. BRAF and MEK inhibition increased the invasive capacity and pro-inflammatory neuronal environment in the human neocortical slice model.

#### Conclusion

Our study highlights distinct molecular phenotype of BRAF mutated GBs with enhanced neuronal features linking them to similar behavior compared to lower grade glioma. Enhanced proinflammatory ecosystems in BRAF mutated tumors may explain the recent response to immune therapy.

### P195

#### Tumornetzwerkreaktion auf Temozolomid Tumor-Network response to temozolomide

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#### Objective

Glioblastoma (GB) is conventionally treated with surgery followed by radiotherapy and temozolomide (TMZ), but resistance often causes recurrence within two years. A key factor in relapse is the ability of GB cells to communicate with their microenvironment, forming extensive cellular networks to enhance proliferation and invasiveness. This project aims to investigate TMZ effects on tumor networks, interactions with neurons, and their underlying dynamics.

#### Methods

To investigate the effect of TMZ of transcellular signaling, we used a human neocortical slice model injected by primary GB cells expressing the calcium reporter GCaMP6 (+/- TMZ). Following live-imaging slices were processed by spatially resolved transcriptomics using MERFISH and integrated with the single cell calcium signal.

#### Results

We found profoundly altered tumor network dynamics and diminished tumor cell viability after TMZ treatment. TMZ significantly change intracellular calcium signaling with increased cellular activity suggesting cellular communication of TMZ-induced stress. stRNA-seq and imaging analysis revealed heterogeneous response in cell cycle alterations with a subset of cells increasing mitosis marker (*MKI67 TOP2A*).

#### Conclusion

These findings reveal the dynamic interplay between GB cells and their network, offering insights into glioblastoma resilience and potential therapeutic targets to enhance treatment.

### P196

Einfluss der Pyruvat-Carboxylase auf die antineoplastische Wirkung von Metaformin beim Glioblastom Influence of pyruvate carboxylase on metformin's antineoplastic effects in glioblastoma

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#### Objective

Metformin exhibits antineoplastic effects in various cancers, including glioblastoma (GBM), a highly malignant brain tumor in adults. However, the exact mechanisms and molecular targets underlying these effects remain unclear. In addition, it cannot be ruled out that tumors may differ in sensitivity toward the drug. Therefore, we explored pyruvate carboxylase (PC) and transporters involved in metformin metabolism as responsible for metformin"s efficacy as an anticancer drug.

#### Methods

RT-qPCR and Western blotting were used to quantify the expression of PC and the efflux transporters MATE1, MATE2, OCT1, OCT2, and OCT3 in ten different GBM cell lines. In addition, the effect of metformin on cell viability was explored by cell-based assays, and live cell imaging was employed to monitor growth under the influence of metformin using different media, each containing distinct combinations of essential nutrients (glucose, pyruvate, and glutamine). Furthermore, siRNA knockout experiments targeting PC were conducted to get further insights into its role in mediating metformin's effects on the cells.

#### Results

Our analysis of ten GBM cell lines revealed significant variability in nutrient preferences and impaired cell growth in the presence of metformin, regardless of nutrient composition. Cells with robust mitochondrial function, such as LN229 and 1321N1, favored conditions with pyruvate and/or glutamine, which fuel the TCA cycle and oxidative phosphorylation. In contrast, highly adaptable cell lines like MZ18 and MZ54 thrived in various nutrient conditions, while those with more rigid metabolic dependencies, such as U251 and U87, struggled when deprived of their preferred substrates.

Additionally, there were significant differences in PC expression at the mRNA level, with T98G showing the highest gene copy number ( $1.6 \times 10^3$  per 12.5 ng RNA) and U343 showing the lowest ( $0.2 \times 10^3$  per 12.5 ng RNA). Variations were also observed in the expression of the efflux transporters MATE1 and OCT1 across the cell lines.

#### Conclusion

Given the variation in metformin's antineoplastic effects across different cell lines, we anticipate that a more comprehensive understanding of the underlying mechanisms and cellular targets will enhance metformin's potential for use in stratified tumor therapies.

### P197

#### Intraoperative Strategien zur Gewinnung von Immunzellen aus dem Schädelknochen bei Glioblastom-Patienten Intraoperative Strategies for Sampling Immune Cells from the Cranial Bone in Glioblastoma Patients

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#### Objective

Glioblastoma (GB), the most common malignant brain tumor in adults, remains incurable despite extensive research. Recent discoveries revealed the skull bone marrow as a reservoir of tumor-reactive CD8+ effector/memory T cells (Dobersalske et al., *Nat. Medicine*, 2024). This study aims to refine immune cell isolation techniques from skull bone marrow, facilitating translational research during neurosurgical procedures.

#### Methods

To streamline and standardize the process, we collected cranial bone meal from treatment-naïve GB patients during craniotomy, replacing the previously used solid bone fragments. A robust protocol was developed to isolate and analyze immune cells, focusing on T cell subpopulations. A flow cytometry panel was established to identify and characterize these cells.

#### Results

So far, 14 consecutive patients were enrolled in this prospective study. Using our optimized method, immune cells were successfully isolated from bone meal, achieving an average cell yield of  $3.89 \times 10^5 \pm 3.95 \times 10^5$  following erythrocyte removal via density gradient centrifugation. The procedure preserved cell viability, enabling detailed analysis of T cell composition. Preliminary data indicate the feasibility of cultivating and conserving these cells for future therapeutic applications. Additional findings will be presented at the annual conference.

#### Conclusion

This study establishes a streamlined intraoperative approach for isolating immune cells from cranial bone meal, offering a more efficient alternative to solid bone fragment extraction. By leveraging this novel method, we provide a foundation for further exploration of the skull bone marrow as an immune niche in GB patients. These advances accelerate planned multicenter clinical trials and hold promise for future cell-based immunotherapeutic strategies.

### P198

Entschlüsselung der Chordom-Tumormikroumgebung: Erkenntnisse aus multiomischen Einzelzell- und räumlichen Transkriptomdaten für klinische Handlungsempfehlungen Deciphering the Chordoma Tumor Microenvironment: Multiomic Single-Cell and Spatial Transcriptomics Insights Guiding Systematic Clinical Trials

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#### Objective

Chordomas are rare, locally aggressive malignancies with limited standard treatment options and high recurrence rates. Current clinical decision-making is hindered by scarce patient numbers and insufficiently characterized tumor biology. This study aimed to leverage an integrated multiomic approach—encompassing single-cell sequencing, spatial transcriptomics, and computational modeling—to elucidate the chordoma tumor microenvironment (TME) and identify immunosuppressive networks. Using advanced computational methods, we aim propose testable immunotherapeutic targets guiding systematic clinical trials and with a data-driven rationale for targeted interventions in this orphan diseas.

#### Methods

Freshly resected sacral chordoma samples were profiled using single-cell RNA sequencing and T cell receptor (TCR) analyses to characterize cellular heterogeneity and antigen specificity. Spatial transcriptomics (10x Visium) mapped these immune populations and their states onto distinct histological tumor regions. Multiplex immunofluorescence provided spatial validation. To model patient response in vitro, we integrated laboratory-based immune profiling with computational tools: (1) single-cell latent variable models (scVI, scGen) to harmonize and interpret single-cell data, (2) Cell2location and CytoSPACE to refine spatial cell assignments, and (3) CellAgentChat, an agent-based modeling framework, to simulate in silico checkpoint blockade (CTLA4, PDCD1, TIM3) and predict transcriptional changes. These combined lab and computational methodologies enabled us to model therapeutic responses and prioritize promising targets for prospective systematic clinical trials.

#### Results

The integrated multiomic analysis revealed a spatially organized immune microenvironment, including regions enriched with regulatory B cells and exhausted T cells that reinforce immunosuppression. T cell pseudotime trajectories indicated progressive exhaustion, while in silico receptor perturbation highlighted TIM3 blockade as a promising avenue to enhance antigen presentation and T cell activation.

#### Conclusion

These computational multiomic analysis allowed us to identify candidate immunomodulatory strategies suitable for systematic clinical testing in this rare cancer entity.







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### P199

MRT-gestützte Radiomics zur Unterscheidung zwischen perifokalem Ödem und nicht kontrastmittelaufnehmenden Glioblastomanteilen *MRI-based radiomics for differentiation between perifocal edema and non-contrast-enhancing glioblastoma foci* 

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#### Objective

Various intracranial tumors can lead to the development of perifocal edema. Differentiating edema from tumor on MRI might be easy in metastases and meningiomas but can be challenging or near impossible in patients with glioblastoma. We set out to compare and characterize perifocal edema and non-contrast-enhancing glioblastoma foci by means of radiomic feature analysis to potentially guide further treatment planning and possibly supramarginal resection borders.

#### Methods

A retrospective study of 60 patients (glioblastoma, meningioma, metastases; n=20 each) was conducted using preoperative T2-weighted and contrast-enhanced T1-weighted MRI to identify T2 hyperintense and contrast-enhancing lesions. Brain extraction was performed with HD-BET, followed by manual segmentation and spatial normalization using ANTs. Radiomic features were extracted from T2 hyperintense lesions with PyRadiomics. Statistical analysis included Shapiro-Wilk for normality, followed by ANOVA for normal and Kruskal-Wallis for non-normal features (p < 0.01). Significant features were further analyzed using Tukey''s HSD to compare glioblastoma with other tumor types.

#### Results

We analyzed 107 radiomic features analyzed across shape, texture, and intensity categories. Among these, 29 significant features (27% total) were identified for differentiating T2 of the hyperintense perifocal regions around glioblastoma from those around meningiomas and metastases. Significant features mainly comprised measures of shape, texture and intensity distribution, e.g., sphericity (p<0.01), surface/volume (p<0.01), entropy (p<0.01), skewness (p<0.01) and kurtosis (p<0.01), showed no significant difference between metastases and meningiomas but differed significantly from the T2-hyperintensity of glioblastoma. The textual complexity of glioblastoma was significantly higher (p<0.01).

#### Conclusion

Radiomic feature analysis of T2 hyperintense lesions effectively differentiates perifocal T2 hyperintense lesions associated with glioblastoma from the perifocal edema of meningiomas and metastases. These findings may aid in more precise tumor margin delineation, potentially guiding surgical planning for supramaximal resection and improving patient outcomes through more targeted therapeutic strategies.

### P201

Adultes Pilozytisches Astrozytom: Eine Single-Center Analyse klinischer Merkmale, Behandlungsoutcomes und Prognostischer Faktoren Adult Pilocytic Astrocytoma: A Single-Center Analysis of Clinical Characteristics, Treatment Outcomes, and Prognostic Factors

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#### Objective

Pilocytic astrocytoma (PA) in adults is a rare entity with distinct clinical features compared to pediatric cases. While PAs are low-grade tumors with generally favorable outcomes, recurrence rates vary widely based on tumor characteristics and surgical approaches. Limited literature exists on the impact of tumor volume, location, and patient age on resectability and survival. This study aims to address these gaps by analyzing how these factors collectively influence prognosis and management in adult PA.

#### Methods

We retrospectively analyzed 32 adult patients with PA who underwent surgery at our institution between 2014 and 2023. Patient demographics, histological and imaging data, and outcomes were systematically reviewed.

#### Results

The mean age was 35.8 years (range: 18–71), with a slight male predominance (59.4%, n=19). The mean Karnofsky Performance Score (KPS) on admission was 90.6%. Infratentorial tumors predominated (68.8%, n=22) over supratentorial locations (43.8%, n=14). Headache was the most common presenting symptom (50.0%, n=16), followed by signs of hydrocephalus (46.9%, n=15) and visual disturbances (25.0%, n=8). Gross total resection (GTR) was achieved in 43.8% (n=14), while subtotal resection (STR) was performed in 46.9% (n=15). Recurrence occurred in 50.0% (n=16) with an average time to recurrence of 19.4 months. Tumor mass was significantly correlated with GTR likelihood (p = 0.0699), but no significant associations were found between age and recurrence (p = 0.4368) or tumor location and resectability (p = 0.0975). The five-year survival rate was 93.8%, with two fatalities during follow-up.

#### Conclusion

This study highlights the critical role of tumor volume in achieving GTR and demonstrates that neither age nor tumor location alone significantly impacts recurrence or resectability. The high five-year survival rate reinforces the value of aggressive surgical management when feasible. These findings provide novel insights into the management of adult PA, emphasizing the importance of tumor mass in surgical planning and follow-up. This study offers a foundation for future research and contributes to a more personalized approach to treating this rare tumor.

### P202

Die Hemmung von Bcl-xL fuehrt zu einer ueberwiegend synergistischen Verstaerkung der Wirkung von Photodynamischer Therapie und zu einer Umprogrammirung des Tumorzellmetabolismus in Medulloblastomzellen *in vitro*.

Bcl-xL inhibition enhances photodynamic therapy in a predominantly synergistic manner and reprograms the tumor cell metabolism of medulloblastoma cells in vitro

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#### Objective

Medulloblastoma represents one of the most common brain tumors in children. Photodynamic therapy has gained substantial interest as a therapeutic measure for brain tumors. In this study, we performed a preclinical testing of a combined treatment with 5-ALA-based photodynamic therapy (PDT) and the Bcl-xL inhibitor A-1331852 *in vitro*.

#### Methods

The combination therapy was tested on established, primary cultured and stem-like medulloblastoma cells using MTT assays. BLISS analysis was performed for thorough evaluation of the nature of the interaction of both treatment modalities. Spheroids were used to examine the effects of the combination therapy in a 3-dimensional setting. Annexin V/PI staining followed by flowcytometric analysis was used to detect pro-apoptotic effects. Western blot analyses were performed to examine mechanistic effects on the molecular level. Extracellular flux analyses served at examining effects on the tumor cell metabolism. AI-based analysis was performed to examine antimigratory effects.

#### Results

Treatment with PDT in combination with Bcl-xL inhibition led to a predominantly synergistic anti-proliferative effect on established, primary cultured and stem-like medulloblastoma cells. The nature of the response towards this combinatorial approach was independent of baseline c-myc expression. In the 3-dimensional setting, this multi-modal therapy resulted in a significantly enhanced inhibitory effect on medulloblastoma spheroids. On the molecular level, PDT and Bcl-xL inhibition combined led to enhanced cleavage of caspases 9 and 3. On the metabolic level, the combination therapy led to a reduction in both, oxidative phosphorylation and the glycolytic rate. In line with this finding, a reduced expression of respiratory chain proteins was found. Moreover, the velocity and the total distance of migrating cells was significantly impaired by the combination treatment.

#### Conclusion

PDT in combination with Bcl-xL inhibition had a predominantly synergistic inhibitory effect on the cell viability of a broad panel of medulloblastoma cells. This effect was associated with enhanced cleavage of caspases and energy depletion. Further studies are warranted.

### P203

Klinische Ergebnisse von Carbon Fiber-Reinforced PEEK-Implantaten bei zervikaler Spondylodiszitis: Eine retrospektive Studie Clinical Outcomes of Carbon Fiber-Reinforced PEEK Implants in Cervical Spondylodiscitis: A Retrospective Study

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#### Objective

The aim of this study was to evaluate the clinical and radiological outcomes of patients with cervical spondylodiscitis treated surgically with anterior surgery using carbon fiber-reinforced polyether ether ketone (CFR-PEEK) implants.

#### Methods

A retrospective analysis of electronic medical records from 2013 to 2024 was conducted, identifying 15 patients with cervical spondylodiscitis who underwent surgical debridement and stabilization using only CFR-PEEK implants. Data analysis included patient age, BMI, clinical presentation, MRI and CT findings, ASA risk classification, CRP dynamics, microbiological results, and the occurrence of complications or repeat surgeries.

#### Results

The cohort included 15 patients (mean age 64.5  $\pm$  10.8 years) with a gender distribution of 67% male and 33% female. The most common preoperative symptom was neck pain (93.3%), and focal neurological deficits were observed in 43.3% of patients. The majority of patients (80%) had cardiovascular comorbidities, and the severity of the condition was classified as ASA II in 53.3%, ASA III in 30%, and ASA IV in 16.7%. Preoperative MRI and CT scans showed spondylodiscitis in one segment in 80% of patients and in two segments in 16.7%. Epidural empyema was present in 80% of cases. The average time from admission to surgery was 1.63  $\pm$  1.94 days. Antibiotic therapy was initiated empirically and continued for an average of 58.32  $\pm$  34.1 days. Reoperation was required in three cases. The average hospital stay was 15.3  $\pm$  20 days. At discharge, the majority of patients reported significant improvements in clinical outcomes, with 36.84% achieving Odom Score 1 (excellent results). At the final follow-up, 52.63% of patients had Odom Score 1, indicating good recovery, while 42.11% had Odom Score 2 (fair results). Neurological deficits persisted in a minority of patients, including neck pain (10.53%) and paresis (21.05%). The reoperation rate was 20% due to re-infection at the same level. In one case instability occurred and a posterior stabilisation was performed. CFR-PEEK implants achieved optimal quality for MRI images for follow-up in 100% of cases.

#### Conclusion

The use of CFR-PEEK implants for anterior cervical surgery in patients with spondylodiscitis provides promising clinical and radiological outcomes. Surgical stabilization with CFR-PEEK implants resulted in favorable clinical recovery, with a relatively low incidence of complications and reoperations.

### P204

Einfluss von Sarkopenie auf das Verletzungsmuster bei Patienten mit Verletzungen der oberen Halswirbelsäule. Impact of Sarcopenia on Injury Patterns in Patients with Upper Cervical Spine Injury

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#### Objective

Upper cervical spine trauma is common in elderly patients. Frailty and associated sarcopenia are known to largely influence spinal pathologies, disease progression, treatments' curse and outcome. This study focuses on the impact of cervical sarcopenia on trauma pattern of upper cervical spine segments C1/C2 and C2/C3.

#### Methods

Spinal MRIs of patients with upper cervical spine trauma were evaluated following a standardized protocol. T2weighted sequences in axial view on level C4 were analyzed to measure the fatty degeneration of semispinalis muscles, according to the classification by Goutallier. Trauma pattern were captured using the established classifications for upper cervical spine injuries. The study was approved by the local ethics committee and covered the period 2021 to 2024.

#### Results

Of 146 patients with trauma of the upper cervical spine, 59 patients met the criteria for subgroup analysis (male N=31, female N=28, mean age 73,5  $\pm$  13). Consistent with the distribution of age in this cohort, the vast majority exhibited significant sarcopenia and was thus allocated to sarcopenia index 3 and 4 (high, N= 47, 80%). In line with this, the age of patients with index 1 and 2 (low) was significantly lower than of those with high index (64.5 $\pm$ 16.9 vs 75.8 $\pm$ 11.4, p=0.0076). There were no significant differences in patients with low and high index, regarding the distribution of odontoid fractures (Anderson d'Alonzo Type II; p=0.34) and C2 body fractures (Anderson d'Alonzo Type III, Benzel, other, p=0.75) as predominant trauma pattern (N=52, 88%). In the sense of mutually dependent cause and effect, the number of minor trauma increased with rising sarcopenia index (low high 68%).

#### Conclusion

Our data show a close link between age, frailty and the trauma mechanism in patients with upper cervical spine injuries. However for trauma pattern, sarcopenia of the neck muscles appears to be of minor importance. The extent to which this phenomenon influences postoperative course and treatment success remains subject of ongoing studies.

### P205

Knochendichtebestimmung mit intraoperativer Cone-Beam-CT - eine präliminäre Analyse und Vergleich mit präoperativer qCT Bone Mineral Density Assessment Using Intraoperative Cone-Beam CT – A Preliminary Analysis and Comparison with preoperarive qCT

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#### Objective

This study investigated the feasibility of predicting bone mineral density (BMD) using intraoperative cone-beam computed tomography (CBCT) compared to quantitative computed tomography (qCT).

#### Methods

Data from 16 vertebral bodies across 7 subjects were analyzed. Preoperative qCT measured BMD, and intraoperative CBCT images were acquired using the Brainlab LoopX system during navigated spinal surgery. The CBCT and qCT datasets were coregistered using rigid fusion to allow direct comparison of region of interest (ROI) intensities. ROIs were placed in the spongious bone, qCT phantom, psoas muscle, and spinal canal. Each bone ROI was divided into 10 sub-regions, yielding 160 ROIs for comparison. Subject-specific normalization methods were tested using average muscle and spinal canal intensities.

#### Results

The direct correlation between CBCT intensity and qCT-derived BMD showed a moderate correlation (R = 0.4934, p < 0.0001), improving to R = 0.7665 after applying subject-specific normalization in a ridge regression model. The most important predictor was the difference between bone ROI intensity and spinal canal intensity, followed by muscle-normalized bone intensity.

#### Conclusion

This preliminary analysis shows that BMD prediction from CBCT is feasible with reasonable accuracy when applying subject-specific normalization. Intraoperative CBCT could provide valuable insights on bone quality, aiding surgical decision-making. Further validation with a larger cohort is ongoing at our institution.

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### P206

Technische Aspekte anteriorer zervikaler Verplattung und ihre Rolle bei der Plattenlockerung *Technical Aspects of Anterior Cervical Plating and Their Role in Plate Loosening.* 

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#### Objective

Anterior plating is commonly employed alongside cage implantation in patients undergoing anterior cervical corpectomy and fusion (ACCF). While various patient- and hardware-related factors contributing to fusion failure have been previously reported, this retrospective study emphasizes the technical aspects of hardware implantation that influence the risk of anterior plate loosening (APL) following ACCF.

#### Methods

All consecutive ACCF cases with anterior plating performed at our institution between August 2008 and May 2024 were included. Preoperative and postoperative computed tomography (CT) imaging was evaluated to investigate technical factors during hardware implantation and their association with APL during follow-up. Baseline characteristics relevant to the endpoint and secondary complications were documented as potential confounders for multivariable analysis.

#### Results

Among 225 patients undergoing ACCF with anterior plating, radiographic evidence of APL was observed in 29 cases (12.9%), with concomitant cage subsidence reported in six of these cases (20.7%). Independent risk factors for APL included lordosis angle of  $\geq$ 2.5<sup>o</sup> between the upper and lower vertebral bodies (adjusted odds ratio [aOR]=4.01, p=0.005), cage subsidence (aOR=6.64, p=0.005), and screw positioning in both sagittal (parallel to the endplates: aOR=0.33, p=0.015) and transverse planes (diverging orientation: aOR=2.59, p=0.042). In contrast, the length of the hardware and the timing of dorsal stabilization showed no significant association with APL.

#### Conclusion

APL is a common complication following ACCF with anterior plating, necessitating revision surgery. The technical aspects of hardware implantation significantly influence the risk of postoperative fusion failure, underscoring the importance of meticulous intraoperative technique to optimize patient outcomes.

### P207

# Prädiktoren der Wundheilungsstörungen nach stabilisierenden Wirbelsäulenoperationen bei spinalen Metastasen

#### Predictors of Impaired Wound Healing Following Stabilisation Surgery for Spinal Metastases

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#### Objective

Wound infections are a significant complication of stabilisation surgery for spinal metastases, leading to increased morbidity and the need for reoperation. Despite their clinical importance, predictors of impaired wound healing remain underexplored. This study aimed to identify independent factors associated with wound infections in spinal metastases surgery.

#### Methods

A retrospective cohort of 149 patients undergoing stabilisation surgery for spinal metastases between 2010 and 2020 was analysed. Statistical methods included chi-square tests, t-tests, univariate regression, covariate boosting (ElasticNet, LASSO, ridge regression), and stepwise logistic regression.

#### Results

Intraoperative cerebrospinal fluid (CSF) leakage was the most significant predictor of wound infections (OR: 77.11, 95% CI: 2.74–2171.68, p=0.011). Thyroid malignancies were also associated with an increased risk (OR: 44.18, 95% CI: 1.31–1486.50, p=0.035). Thoracic spine interventions demonstrated a tendency toward increased wound infections in the univariate analysis (OR: 7.41, 95% CI: 0.59–92.80, p=0.120), although not statistically significant in the final model. Elevated blood pressure (OR: 4.60, 95% CI: 0.85–24.76, p=0.076) showed a similar trend. Factors traditionally considered critical, such as diabetes, smoking, or advanced age, were not significant predictors in this cohort. The type of stabilisation technique employed also showed no significant association with wound infections (p>0.05).

#### Conclusion

Intraoperative CSF leakage and thyroid malignancies are critical predictors of wound infections in spinal metastases surgery. Thoracic interventions showed a tendency toward higher infection rates and warrant further investigation. Larger multicentre studies are needed to validate these findings and refine preventive strategies to improve patient outcomes.





#### Abb. 2


### P208

*In vitro* Vergleich von Wirbelsäulenimplantaten aus Polyetheretherketon (PEEK) und Titan hinsichtlich der Bakterienanheftung durch *Escherichia coli* im Falle osteodestruktiver Spondylodiszitis. *In vitro comparison of spinal implants consisting of Polyetheretherketone (PEEK) and Titanium regarding bacterial attachment by Escherichia coli in the case of osteodestructive spondylodiscitis.* 

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#### Objective

The most common gram-negative pathogen causing spondylodiscitis is *E. coli (1)*. When the destructed tissue is removed surgically, a spinal implant will usually be inserted (1, 2). Cages consisting of PEEK or Titanium are frequently used, but there is no consensus on which material should be preferred (3). Therapy failure can be caused by biofilm formation on the implants (2). The aim of this experimental study was to analyze if there is a difference in the bacterial attachment of *E. coli* on implants made of PEEK or Titanium.

#### Methods

Four implants of each, PEEK and Titanium, were coated with human plasma. Whereas three cages of each material were incubated with *E. coli* (ATCC 25.922, a standard laboratory strain), one cage of each material served as a negative control. The implants were washed twice with 1X PBS after 24h of incubation. Then the cages were sonicated to dislodge the biofilm. A 1:10 serial dilution was performed with the obtained liquid and plated on Luria-Bertani-agar. After a further 24h incubation, the colony-forming units (CFU) were counted. The mean CFU was calculated per mm<sup>2</sup> and per implant. The mean and the standard deviation were included in the analysis.

#### Results

The PEEK implants have a surface area of 679 mm<sup>2</sup>, while the Titanium implants have 677.1 mm<sup>2</sup>. After 24h incubation, there was no significant difference (p>0.05) regarding the CFU per mm<sup>2</sup> (Figure 1) and the CFU per implant (Figure 2).

#### Conclusion

Regarding the attachment of *E. coli*, neither of the materials analyzed was found to be superior to the other. Thus, PEEK and Titanium seem to be equally suitable for intervertebral disc replacement in case of spondylodiscitis caused by *E. coli*. Further assessments will include prolongation of incubation and comparing biofilm formation on intervertebral cages through other pathogen species.

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	Implant 1	Implant 2	Implant 3
Titan	51000	70600	86200
PEEK	15000	27200	7110

CFU/mm<sup>2</sup>

Abb. 2



	Implant 1	Implant 2	Implant 3
Titan	34500000	47833333	58333333
PEEK	10166667	18500000	4825000

CFU/Implant

### P209

Einfluss der Behandlungsmodalitäten auf das Überleben und die progressionsfreie Überlebenszeit bei primärem Glioblastom des Rückenmarks: Eine systematische Überprüfung und Meta-Analyse Influence of treatment modalities on survival and progression free survival in primary spinal cord glioblastoma: A systematic review and meta-analysis

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#### Objective

Glioblastoma (GBM) is the most common primary malignant tumor of the central nervous system, predominantly affecting the brain and rarely the spinal cord, where it accounts for approximately 1.5% of all spinal cord tumors. Primary spinal cord GBM (sGBM) has a poor prognosis, with a median overall survival (OS) of 12 to 15 months and a progression-free survival (PFS) of 11.5 months. This study conducted a systematic review and meta-analysis to assess the impact of different therapeutic strategies on OS and PFS in this population.

#### Methods

Following the PRISMA guidelines, data from 222 patients extracted from 107 studies were analyzed. The search was conducted in December 2024 using the PubMed and Mendeley platforms. Statistical analyses included Kaplan-Meier survival curves, the log-rank test, and univariate and multivariate Cox regression models.

#### Results

The average age was 28.3 years, with a predominance of males (57.6%). Most patients underwent subtotal resection (STR) (63.2%), chemotherapy (QT) (63.6%), and radiotherapy (RT) (79.3%). The mean OS was 15.7 months, while the mean PFS was 12 months. QT and RT were associated with a better prognosis, with QT reducing the risk of progression (HR 0.49) and mortality (HR 0.62). Additionally, patients who underwent gross total resection (GTR) had a lower risk of mortality compared to those who underwent subtotal resection (HR 1.61) or biopsy (HR 2.12).

#### Conclusion

Chemotherapy, Radiotherapy, and total resection demonstrated significant benefits for OS. However, only QT showed a significant benefit for PFS. These findings emphasize the importance of adjuvant therapies and surgical extent in the management of primary spinal GBM. Limitations regarding the impact of tumor genetic profile on OS and PFS should be addressed in future studies.

### P210

Der Einfluss von Hemilaminektomie versus Laminektomie auf das Resektionsausmaß intraduraler juxtamedullärer Spinaltumoren: Eine europäische retrospektive multizentrische Studie. *The effect of hemilaminectomy versus laminectomy on the extent of resection of intradural juxtamedullary spinal tumors: A European retrospective multicenter study.* 

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#### Objective

Spinaltumoren machen bis zu 15 % aller Neoplasien des zentralen Nervensystems aus. Das Resektionsausmaß und der postoperative neurologische Status sind entscheidende prognostische Faktoren für ein gutes funktionelles Ergebnis. Minimalinvasive chirurgische Verfahren wurden eingeführt, um die klinischen Ergebnisse zu verbessern. Ziel der vorliegenden multizentrischen Studie ist es, zu untersuchen, ob die Hemilaminektomie eine zuverlässige Alternative zur konventionellen Laminektomie darstellt.

#### Methods

Daten aus einem multizentrischen Patientenregister wurden retrospektiv analysiert. Bewertet wurden operative Ansätze, Bildgebung, Resektionsausmaß, Krankenhausaufenthaltsdauer (LOS), geschätzter Blutverlust und unerwünschte Ereignisse. Der Fisher's exact test wurde durchgeführt, um festzustellen, ob der minimalinvasive Zugangsweg das Resektionsausmaß beeinflusste. Der t-Test wurde verwendet, um die Krankenhausaufenthaltsdauer zwischen den Kohorten zu vergleichen.

#### Results

Laminektomie wurde in 198 von 452 Fällen (43,80 %) durchgeführt, Hemilaminektomie in 254 von 452 Fällen (56,20 %). Es gab keinen statistisch signifikanten Unterschied zwischen den beiden chirurgischen Ansätzen (p = 0,716), wobei eine GTR in 93,43 % der Laminektomie-Gruppe und in 92,13 % der Hemilaminektomie-Gruppe erreicht wurde. Die Krankenhausaufenthaltsdauer in der Hemilaminektomie-Kohorte war signifikant kürzer (8 ± 5 Tage) im Vergleich zur Laminektomie-Kohorte (9 ± 7 Tage) (p = 0,0413).

#### Conclusion

Die minimalinvasive Hemilaminektomie ist hinsichtlich des Resektionsausmaßes der konventionellen Laminektomie nicht unterlegen und ist zudem mit einer kürzeren Krankenhausaufenthaltsdauer verbunden.

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### P211

Sicherheit und Ergebnisse der dorsalen Stabilisierung nach Goel-Harms in sitzender Position bei Densfrakturen ohne Navigation

Safety and Outcomes of Goel-Harms Dorsal Stabilization in Sitting Position for Dens Fractures Without Navigation

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#### Objective

Fractures of odontoid account for about 10–15% of all cervical spine fractures. Type II fractures are unstable and carry a morbidity and mortality rate of roughly 6%. Numerous techniques exist for C1/C2 stabilization, but the goal of this paper is to evaluate the safety and effectiveness of a modified Goel-Harms procedure performed freehand under lateral fluoroscopy in the sitting position.

#### Methods

This retrospective study describes 161 consecutive patients between 2014 and 2023 who underwent C1–C2 fixation using a modified Goel-Harms technique in the sitting position, without navigation. Postoperative CT scans confirmed screw positioning. Screw placement was graded according to Gertzbein and Robbins. Surgery-related complications were recorded. Bony fusion was evaluated at 3 and 6 months.

#### Results

A total of 161 patients (72 men [44.7%], 89 women [55.3%];mean age 77 years) underwent surgery with 644 screws placed. Seven patients with a persistent foramen ovale were operated in prone position and were therefore excluded. Preoperatively 116 patients (72.0%) reported neck pain, 10 (6.2%) radicular pain and 33 (20) patients had neurological deficits. In 53 cases (32.9%), extension to C3 was performed due to associated pars or pedicle fractures. 624 screws (96.8%) were Grade A and B, 16 (2.4%) Grade C, and 4 (0.6%) Grade D and E. Only these four screws required revision for misplacement. Dorsal decompression with a C1 laminectomy was performed in 21 patients (13%), and 6 (3.7%) underwent revision for wound healing disorder. Four C2 screws breached the vertebral artery canal but did not compress the artery (0,6%). Two patients experienced vertebral artery injuries with total occlusion on CTA due to screw misplacement (0,3%), however without resulting neurological deficits and therefore the screws were not revised. None of the patients experienced an intraoperative air embolism or developed new neurological deficits. The pain rate and intensity improved over time, but we did not have a reported pain scale to quantify the changes. Fusion rates reached 29.8% at 3 months and 62.1% at 6 months.

#### Conclusion

The modified Goel-Harms C1-C2 dorsal fixation performed in the sitting position under lateral fluoroscopy without navigation is a safe and straightforward technique with low complication rates. It should be considered a viable option in the surgical treatment of C1-C2 fractures. The surgeon's experience plays a critical role in the success of this procedure.

Abb. 1



Abb. 2



### P212

Reduktion der Mortalität der pyogenen Spondylodiszitis durch eine frühe operative Behandlung Early treatment of pyogenic spondylodiscitis leads to reduced long-term mortality

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#### Objective

The decision making about the indication and timing of surgery in patients with pyogenic spondylodiscitis (SD) is still under discussion. Recent studies indicate an advantage of early surgical therapy in terms of early functional outcome. However, there is still a lack of reliable data on long-term mortality. The aim of this study was to evaluate the treatment-dependent mortality.

#### Methods

This retrospective single-center study includes 229 consecutive patients who were treated at our department from 01/2012 until 12/2022. Beside demographic data, clinical and treatment data were assessed during hospital stay and follow-up. The initially conservative treated group (n=105, 46%) was compared to the surgically treated group (n=124, 54%). The primary endpoint was the 1-year mortality. A multivariable analysis was performed to analyze risk and prognostic factors.

#### Results

The mean age was 69 (range 1-90), while 95 patients were female (41%). The median follow-up was 5,3 months. 1-year-mortality was significantly higher (p=0.008) in the conservatively treated group (34/105, 32%) than in the early surgically treated group (21/124, 17%). This difference was already evident after 30 days (0.0019) and also after 3 months (0.016). The multivariable logistic regression analysis showed that initial conservative treatment is an independent risk factor for 1-year mortality (p=0.038). Other risk factors include advanced age (p=0.013) and the presence of multiple pre-existing diseases defined as Charlson comorbidity Index (CCI) > 3 (0.009). Moreover the conservatively treated patients showed a significant higher rate of recurrence (18% vs. 9%; p=0.049).

#### Conclusion

Our study can confirm the recently published results on the benefit of early surgical treatment of SD in the longterm follow-up. Surgery for SD should therefore be considered early in the course of the disease in order to reduce the mortality.

### P213

3D Navigation in der dorsalen Instrumentierung der HWS in sitzender Positionierung 3D Navigation in Cervical Dorsal Instrumentation in the sitting position

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#### Objective

Spinal navigation is popular among spine surgeons. Most of the published studies used spinal navigation in cervical spine surgery in the prone position. Spinal navigation in the sitting position is less popular among spine surgeons due to several challenges regarding operating room setup and the navigation process itself. Furthermore, the sitting position may increase the risk for venous air embolism. Advantages of the sitting position to prone positioning are a dry surgical field, easier evaluation of spinal alignment prior to instrumentation as well as a better set-up of camera, reference arc and therefore an overall easier and more accurate reference process. We present our experience, including technical notes, in the management of cervical fractures, dislocations and degenerative diseases using spinal navigation in the sitting position

#### Methods

All patients with elective and trauma surgeries of the dorsal cervical spine who had a surgical treatment with 3D navigated dorsal instrumentation in semi-seated positioning between 2022 and 2024 were evaluated retrospectively. All patients underwent the surgery without preoperative transesophageal echocardiography. We examined these patients due to outcomes of screw misplacement, neurological outcome and postoperative air embolism events occurred within a 30-day postoperative time window. All patients underwent the surgery with arterial lines, central venous catheters but without preoperative transesophageal echocardiography. All screws were graded according to the Gertzbein Robbins grading system.

#### Results

8 patients were identified. 5 Trauma cases with dislocated fractures and 3 cases with severe degenerative spondylolisthesis and facet joint degeneration of the cervicothoracic junction. All screws were positioned correctly according to the Gertzbein Robbins grading system grades A and B. No patient had VAE complications within 30 day of the surgery. No new postoperative neurological deficit occurred in any of these patients. Overall Complication-rate equated to a 0%.

#### Conclusion

The use of intraoperative navigation in the sitting position in the standrad setup in our clinic is safe, efficiant and accurate. The sitting position also offers advantages in the oftentimes challenging navigation process of 3D navigation in the cervical spine by far better visualitation of the surgical field.

### P214

Geschlechtsspezifische Unterschiede in Schmerzempfinden und soziodemografischen Faktoren bei lumbalem Facettensyndrom Gender disparities in pain perception and sociodemographic factors in lumbar facet syndrome

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#### Objective

This prospective study was conducted to explore potential differences in pain perception between men and women. Patients with suspected lumbar facet syndrome underwent test anesthesia of the medial branch nerves of lumbar facet joints under fluoroscopic guidance. In this study, we evaluate sociodemographic data and the associated differences between men and women.

#### Methods

Prior to test infiltration, data collection included demographic information, a pain questionnaire (covering duration, type, quality, and intensity of pain), the type and number of previous treatments and healthcare providers, a pain sensitivity questionnaire (Ruscheweyh), clinical neurological status, Hamilton Depression Scale, Mini Mental State Examination, and the Mainz Pain Staging System (MPSS). Post-intervention, all of the patients were surveyed about procedural pain intensity, current pain severity, and pain improvement.

#### Results

In this interim analysis we included 70 patients (41 women, 29 men). Test infiltration at L4/5 and L5/S1 was performed in 78 % of women and 79 % of men. Median age was 60.5 years (women: 60, men: 62), with an average BMI of 29.48 (women: 29.04, men: 30.12). Educational levels: 14 % high school, 37 % secondary school, 33 % middle school, 8.6 % no degree, and 10 % college/community college). Most patients were German (women: 75.6 %, men: 75.9 %).

Two women were immobile, and 14.6 % required assistance; however all men were mobile and independent. Stabbing pain was reported by 78.5 % of women and by 51.7 % of men, pulling pain by 68.3 % of women and 58.6 % of men. Prior lumbar spine surgery was reported by 29.3 % of women and by 44.8 % of men.

Depression and cognitive scores were similar (women: 7.7/29.1, men: 7.9/28.8). Women had a mean Hamilton Depression Scale score of 7.7, and men 7.9. In the Mini Mental State, women scored a mean of 29.1 points, and men 28.83. Of the 41 women, 36 had given birth (1–7 times), with 6 attending childbirth preparation courses.

#### Conclusion

This study reveals gender-specific differences in sociodemographic factors and in pain perception among patients with lumbar facet syndrome. Women reported more stabbing and pulling pain and required more assistance with mobility, while men had more prior lumbar surgeries. These findings underscore the need for gender-tailored pain management approaches.

## P215

Endoskopisch-unterstützte retrofaciale vs. mikrosurgische anterofaciale Route: Eine anatomische Studie zum Vergleich des Zugangs zur lateralen Fossa Jugularis Endoscopic-Assisted Retrofacial vs. Microsurgical Anterofacial Route: An Anatomical Study Comparing Access to the Lateral Jugular Fossa

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#### Objective

Tumors involving the jugular fossa (JF), typically benign, often extend to its lateral aspect, posing significant surgical challenges. This study compares the endoscopic-assisted retrofacial and microsurgical anterofacial techniques for gaining additional access to the lateral aspect of the JF via the transmastoid infralabyrinthine approach.

#### Methods

Ten formalin-fixed human head specimens (20 sides) were dissected to evaluate both techniques. Accessibility to critical anatomical structures, including the lateral border of the jugular bulb, the vertical segment of the internal carotid artery (ICA), and the posterior canal wall of the external auditory canal (EAC), was assessed. Approach depth and surgical freedom were measured image-guided to quantify precision and range of motion.

#### Results

Both techniques provided comparable access to critical anatomical structures. The endoscopic-assisted retrofacial technique demonstrated significant advantages, including a greater field of surgical freedom (10,888.8  $\pm$  3,773.8 mm<sup>2</sup> vs. 3,618.4  $\pm$  497.1 mm<sup>2</sup>; P < .01) while maintaining a similar approach depth (11.6  $\pm$  0.5 mm vs. 9.6  $\pm$  0.6 mm; P < .01). Additionally, the endoscopic retrofacial route avoided the extensive bone removal and soft-tissue dissection required for microsurgical anterofacial access, thereby reducing invasiveness and associated surgical risks.

#### Conclusion

The endoscopic-assisted retrofacial route offers a safe, minimally invasive, and effective alternative to microsurgical anterofacial access. By avoiding extensive bone removal and soft-tissue dissection, it reduces surgical risks and enhances surgical freedom. These findings highlight the potential of the endoscopic-assisted approach as a superior option in appropriate clinical cases. Further clinical studies are necessary to validate these findings.

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Abb. 1
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## P217

Einfluss von Metformin und Statinen auf das Tumorzellwachstum und die Immunzellen im Vestibularisschwannom Influence of metformin and statins on tumor cell growth and immune cells in vestibular schwannoma

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#### Objective

Vestibular schwannoma (VS) is the most common tumor in the cerebellopontine angle. Treatment options of VS are limited to 'wait and scan', surgery and radiation. However, the use of radiation and surgery is associated with a significant risk of complications, including hearing loss. The favorable 'wait and scan' approach has its limitations due to the variability in the growth behavior of VS, which complicates the prediction of VS growth. To date, no drug treatment against the growth of sporadic VS is available. Previous research has demonstrated a correlation between immune cell infiltration and VS growth. Our research aims to identify immune markers that can predict VS growth behavior and to investigate the efficacy of drug treatments inhibiting tumor progression.

#### Methods

VS tissue was cut into 350µm thick slices using a compresstome. These slices were cultivated on semipermeable membranes for one week and then treated with metformin, simvastatin or atorvastatin for 3 weeks. After treatment, the slices were fixed with 4% formalin, embedded in paraffin and stained with several antibodies specific for apoptosis, immune cells and VS tumor markers. In addition, VS primary cell cultures were isolated from VS tissue. VS cells were transferred to a 96 well plate. Then treated with statins or metformin for 4 days and apoptosis was determined using impedance measurement.

#### Results

The impedance measurement revealed a 2-fold higher relative apoptosis rate in treated VS cells compared to untreated cells. Analysis of treated VS slices showed a reduction in tumor proliferation and an increased number of apoptotic cells compared to untreated slices. The microscopic images showed a positive correlation of immune cell infiltration, especially tumor-associated macrophages (CD68+ CD163+), and tumor volume.

#### Conclusion

Our results showed that a higher tumor volume is associated with increased immune cell infiltration. Furthermore, it was demonstrated targeting the interaction between immune cells and tumor cells with drugs such as metformin and statins increased the rate of apoptosis. The results suggest that the drug treatment approach could possibly reduce the tumor progression in VS.

### P219

Unterschiede in der Tumorinflammation und im Ausmaß der Resektion in Abhängigkeit von früheren Behandlungen bei primären, sporadischen Vestibularisschwannomen. Differences in tumor tissue inflammation and the extent of resection due to prior treatment in primary, sporadic vestibular schwannomas.

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#### Objective

Recurrent vestibular schwannomas (VS) after prior surgery or radiation therapy (RT) are more difficult to reoperate radically. The inflammatory microenvironment of vestibular schwannomas is involved in pathogenesis and growth. It is unclear whether inflammatory changes are different in prior irradiated and resected VS and may also play a role in the extent of resection in recurrent VS.

#### Methods

We analyzed clinical data, tumor extension, cystic characteristics, prior treatments and immunohistochemical markers for inflammation (CD68, CD163, CD3, CD8), combined in an inflammatory score (IS), and proliferation (MIB-1) as potential factors associated with prior RT and resection in 1131 surgically treated sporadic VS. Univariate analyses were performed which considered, how the mentioned factors differed regarding prior treatments (resection and radiation therapy). A multivariate analysis was performed for the EOR.

#### Results

A total of 27 (2.5%) cases received prior RT and 31 (2.8%) underwent prior surgery. Prior irradiation was associated with female sex (p=0.0019), larger tumor size (0.0221), less radical surgery (p<0.0001), increased CD163 expression (p=0.0109) and a high IS (p=0.0053). For prior resected VS, no differences were observed except for more frequent cystic characteristics (p=0.0006). In multivariate analysis, larger size (p<0.0001), older age (p=0.0056), prior irradiation (p=0.0011), cystic characteristics (p=0.0014) and increased tissue inflammation (p=0.0218) were independently significant factors for partial resection.

#### Conclusion

Prior irradiated tumors are larger in size and show increased tumor tissue inflammation suggesting post radiation reaction and tumor associated macrophage activity. Advanced age, greater tumor extension, cystic growth and prior irradiation are independent factors for a less radical extent of resection.

## P220

Eine erhöhte Tumorinflammation in primären, sporadischen Vestibularisschwannomen ist mit einer postoperativen Beeinträchtigung des N. facialis assoziiert. Increased tumor tissue inflammation in primary, sporadic vestibular schwannomas is associated with postoperative facial nerve impairment.

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#### Objective

Preservation of the facial nerve (FN) in vestibular schwannoma (VS) surgery is critical for adequate postoperative mimic function and is a determinant of quality of life. Tissue inflammation in VS is discussed as a possible factor for pre- and postoperative cranial nerve dysfunction. Identification of clinical factors and inflammatory markers for perioperative facial nerve impairment may guide treatment decisions in the future.

#### Methods

We analyzed clinical factors, radiographic data, the extent of resection, pre- and postoperative facial nerve function according to the House and Brackman classification (HB) and immunohistochemical markers for inflammation (CD3, CD8, CD68 and CD163) and proliferation (MIB1) in 333 primary, sporadic and totally resected VS. A postoperative decrease in the HB grade of more than one was considered as a cutoff value for FN impairment. With CART specified cut-offs for each inflammation marker, an inflammatory score from 0 to 2 was determined. Univariate and multivariate analyses were performed for the impairment of FN function.

#### Results

The highest preoperative HB of 2 was overserved in 6 cases (1.8%). A postoperative decrease of the HB of more than one grade was seen in 93 (27.9%) patients. A worsening of the FN function was associated with larger tumor size (p=0.0012), a higher expression of CD163 (p=0.0009) and CD3 (p=0.0116) and an increased inflammatory score (p=0.0014). In the multivariate analysis, larger tumor size (p=0.0381) and an inflammatory score of 2 (p=0.0005) were independently significant for a postoperative impairment of FN function.

#### Conclusion

Postoperative facial nerve function impairment in totally resected, primary and sporadic VS is independently associated with larger tumor size and increased tumor-associated macrophage and lymphocyte infiltration of the tumor microenvironment.

## P221

Endoskopische transnasal-transethmoidale Resektion von Kavernomen der Orbita Endoscopic Transnasal-transethmoidal Resection of Intraorbital Cavernomas

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#### Objective

The objective of this study is to demonstrate our series and evaluate the feasibility and efficacy of transnasal resection of cavernomas, focusing on the potential advantages of this minimally invasive interdisciplinary approach compared to traditional open surgery. Orbital tumors present challenges in terms of treatment due to the complicated anatomical location and the potential for visual or neurological impairment. Transnasal resection offers a minimal invasive route for tumor excision, minimizing morbidity and potentially improving recovery times.

#### Methods

A retrospective study was conducted involving patients who underwent endoscopic transnasal resection of orbital cavernomas between 2016 and 2023. Data were collected from medical records, including demographic information, tumor characteristics, surgical approach, complications, and outcomes.

#### Results

A total of 4 patients were included in the study, with a median age of 48 years. In each case we performed an interdisciplinary transnasal-transethmoidal approach. Histological results showed a cavernoma. All tumors were localised at the inferomedial retrobulbar space. Complete resection was achieved in all cases. We did not observe major intraoperative or perioperative complications. Transient nasal bleeding was seldom and resolved on its own. No significant long-term complications or recurrences were noted during the follow-up (up to 8 years). Visual outcomes were favorable, with all of patients maintaining or improving their preoperative visual acuity.

#### Conclusion

The transnasal resection of cavernomas is a safe and effective alternative to transcranial approaches, offering several benefits, including reduced morbidity, fast recovery times, and preservation of ocular function. Our data of a small series emphasizes that the technique is particularly advantageous for tumors located in the inferomedial orbit, where access via the transethmoidal route provides direct visualization and precision in excision. Further prospective studies with larger sample sizes are needed to refine patient selection criteria and optimize surgical techniques.

### P226

Pipeline-Vantage-Flow-Diverter der vierten Generation zur Behandlung sakkulärer Aneurysmen im posterioren Hirnkreislauf

Safety and feasibility of the new fourth-generation Pipeline Vantage Flow Diverter for the treatment of saccular aneurysms in the posterior cerebral circulation

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#### Objective

Posterior circulation aneurysms are particularly challenging to treat due to their anatomical complexity and high perforator density within this region. The Pipeline Vantage Flow Diverter (PVFD), a fourth-generation flow diversion device, has shown promising results in treating anterior circulation aneurysms. However, its efficacy and safety in treating posterior circulation saccular aneurysms is not well investigated.

#### Methods

This single-center study retrospectively reviewed patients with posterior circulation aneurysms treated with PVFD between September 2021 and November 2024. Patients and aneurysm characteristics, clinical and radiological results were documented.

#### Results

22 patients harboring 24 aneurysms were identified. All of the aneurysms were of saccular morphology. PVFD implantation was successful in all cases. Complications included ischemic events in two patients (8.3%), one reversible and one leading to a mRS shift from 0 to 3 as well as one cerebral hemorrhage leading to mRS shift from 0 to 1. At the latest follow up available (median 14.3 months), complete aneurysm occlusion (RROC Class I) was documented in 50% of the cases, residual neck (Class II) in 41.7%, and residual aneurysm (Class III) in 8.3%. Basilar bifurcation aneurysms exhibited low occlusion rates (RROC I: 33.3%) and higher complication rates compared to other locations. An asymptomatic moderate In-stent stenosis occurred in one case (4.5 %) and resolved spontaneously. No mortality was documented.

#### Conclusion

The PVFD demonstrates high occlusion rates and a favorable safety profile in the treatment of saccular aneurysms in the posterior circulation. However, treatment of basilar bifurcation aneurysms with FD remain challenging due to the complex anatomy and high flow dynamics in this location. Tailored treatment approaches and further studies are needed to optimize treatment outcomes for aneurysms at the basilar bifurcation.

### P227

Der prädiktive und diagnostische Wert des kontinuierlichen Monitorings von S100 bei aneurysmatischer Subarachnoidalblutung Revisiting S100: the predictive and diagnostic value of continuous monitoring of S100 in aneurysmal subarachnoid hemorrhage

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#### Objective

Aneurysmal subarachnoid hemorrhage (SAH) is a severe neurological condition with high mortality and morbidity. Vasospasm and delayed ischemic neurological deficits (DIND) are major complications affecting patient outcomes. Reliable biomarkers for early detection and management of ischemia remain lacking. S100, a protein associated with astrocytic damage and blood-brain barrier disruption, has shown potential as a predictive and monitoring tool.

#### Methods

This retrospective study included 100 SAH patients admitted to a neurosurgical intensive care unit. Daily S100 serum levels were measured from admission until discharge, and their trends were correlated with angiographic vasospasm, infarction, and neurological outcomes. Clinical data, including Hunt and Hess scores, modified Fisher scores, and imaging findings, were analyzed. S100 thresholds for predicting ischemia and outcome were evaluated using ROC analysis.

#### Results

: Elevated S100 levels showed two distinct peaks: an initial rise post-hemorrhage and a secondary elevation linked to vasospasm-related ischemia, starting on day 7 and peaking by day 10. A threshold of 0.12  $\mu$ g/L on the day of vasospasm showed 92% specificity and a positive predictive value of 94% for ischemic injury, while 0.17  $\mu$ g/L had 100% specificity. Patients with infarction had significantly elevated S100 levels compared to those without infarction (mean levels of 0.13  $\mu$ g/L vs. 0.08  $\mu$ g/L, p<0.05). Mortality was observed in 20% of patients. Patients with poor outcome consistently exhibited higher S100 levels, particularly in the first five days after vasospasm detection. Higher S100 levels were also associated with the need for more invasive interventions, including ventriculoperitoneal shunting (28%), external ventricular drainage (71%), and decompressive hemicraniectomy (4%).

#### Conclusion

Continuous S100 monitoring provides valuable predictive and diagnostic insights into vasospasm-related ischemia in SAH patients. Elevated S100 levels correlate with infarction, clinical severity, and poor outcome.

### P228

# Entzündungsreaktionen in zerebralen kavernösen Malformationen: Unterschiede zwischen malformationsbedingter Epilepsie und symptomatischer Blutung. Inflammation in cerebral cavernous malformations: Differences between malformation related epilepsy vs. symptomatic hemorrhage

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#### Objective

Cerebral cavernous malformation (CCM) is a vascular disorder causing seizures, neurological deficits, and hemorrhagic stroke. It can be sporadic or inherited via CCM1, CCM2, or CCM3 gene mutations. Inflammation is broadly recognized as a promotor of cerebral vascular malformations. This study explores inflammatory mechanisms and differences behind CCM-related hemorrhage and epilepsy.

#### Methods

The study group comprised 28 patients, ten patients with CCM-related epilepsy, and 18 patients who clinically presented with a cerebral hemorrhage at diagnosis. All patients underwent microsurgical resection of the CCMs. Formaldehyde-fixed, paraffin-embedded tissue samples were immunohistochemically stained using a monoclonal antibody against Cyclooxygenase 2 (COX-2) (Dako, Santa Clara, CA; Clone: CX-294) and NOD-, LRR-, and pyrin domain-containing protein 3 (NLRP3) (ABCAM, Cambridge, MA; ab214185). MRI and clinical data were correlated with immunohistochemical findings, and the analysis was performed using the Trainable Weka Segmentation algorithm.

#### Results

The median CCM volume was 1.68 cm<sup>3</sup> (IQR: 0.85-3.07 cm<sup>3</sup>). The proportion of NLRP3 positive cells was significantly higher (32.56% to 91.98%; mean: 65.82%, median: 68.34%; SD: ±17.70%), compared to COX-2 positive cells (1.82% to 79.69%; mean: 45.87%, median: 49.06%; SD: ±22.56%). No correlation was shown between the volume of CCMs and a hemorrhage event (p = 0.13, 95% CI: 0.99-1.02). Symptomatic brain hemorrhage showed a significantly increased inflammatory enzyme upregulation from both COX-2 (p<0.001) and NLRP3 (p=0.009) against patients with symptomatic CCM-related epilepsy at first diagnosis.

#### Conclusion

Inflammatory processes in CCMs seem to be driven by broad and multiple pathways because both anticipatory pathways of mechanical (COX-2) and ischemic (NLRP3) driven inflammatory pathways are consistently activated. Patients with symptomatic hemorrhage showed upregulated inflammatory enzyme activity against patients with CCM-related epilepsy. No direct associations between NLRP3 and COX-2 expression and radiological, pathological, or patients' preexisting conditions were found in this cohort.

### P229

Einfluss der Fördermenge und Dauer der Liquordrainage auf die Shuntpflichtigkeit nach einer aneurysmatischen Subarachnoidalblutung

Impact of the Volume and Duration of Cerebrospinal Fluid Drainage on Shunt Dependency After Aneurysmal Subarachnoid Hemorrhage

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#### Objective

While various risk scores exist to facilitate early recognition of shunt dependency following aneurysmal subarachnoid hemorrhage (aSAH), accurately predicting this outcome in patients requiring external ventricular drain (EVD) for acute hydrocephalus remains a significant challenge. This study aimed to evaluate the predictive utility of existing shunt dependency scores in aSAH patients with EVD, with a specific focus on the impact of drainage duration and total volume.

#### Methods

In this retrospective, single-center cohort study (January 2003 to June 2016), all consecutive aSAH cases requiring EVD, with completed weaning processes, were included. Intensive care unit records were analyzed to determine the total duration and volume of cerebrospinal fluid drainage (CSFD). Additional data included baseline clinical and radiographic features, necessary to calculate three shunt dependency scores—CHESS, CHESS-Huckman, and SDASH—as well as the occurrence of chronic hydrocephalus requiring shunt placement.

#### Results

The final cohort consisted of 526 aSAH patients requiring EVD at admission, of whom 46% ultimately required shunt placement. The median CSFD duration was 12 days, and the median drainage volume was 2152 mL. Analysis revealed that CSFD characteristics demonstrated superior diagnostic accuracy for predicting shunt dependency compared to the SDASH (AUC: 0.56), CHESS (AUC: 0.59), and CHESS-Huckman (AUC: 0.65) scores. Clinically significant cut-offs were identified as > 12 days for duration and > 2250 mL for drainage volume. Shunt surgery rates were 22.6%, 45.6%, and 73.5% for individuals with none, one, or both of these CSFD characteristics, respectively. A combined prediction model incorporating the CHESS-Huckman score and CSFD parameters (+2 points per parameter) exhibited the highest diagnostic performance (AUC: 0.77).

#### Conclusion

The total duration and volume of CSFD are critical predictors of shunt dependency after aSAH, with clinically relevant thresholds of > 12 days and > 2250 mL. Including these characteristics in prediction models significantly enhances diagnostic accuracy, potentially reducing weaning time. External validation of these findings is essential to confirm their utility in clinical practice.

### P230

### Karotiskalzifizierung und der Einfluss auf den Schweregrad von Vasospasmen nach aneurysmatischen Subarachnoidalblutungen

# Calcification of the internal carotid artery and the influence on the severity of cerebral vasospasm in aneurysmal subarachnoid hemorrhage

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#### Objective

Cerebral vasospasm (CV) is a critical complication following aneurysmal subarachnoid hemorrhage (aSAH), contributing significantly to delayed cerebral ischemia (DCI) and poor neurological outcomes. While carotid siphon calcification (CSC) has been identified as protective against CV, its association with increased DCI risk and impaired outcomes highlights a complex interplay between atherosclerosis, arterial stiffness, and cerebral blood flow regulation. This study aimed to evaluate the impact of CSC on CV severity, transcranial Doppler (TCD) findings, delayed ischemic neurological deficits (DIND), and long-term functional outcomes in aSAH patients.

#### Methods

A retrospective analysis of 475 aSAH patients treated between 2008 and 2016 was conducted. CSC was graded using the Woodcock scale on non-contrast CT, while CV severity was assessed using the scale of Merkel et. al. on digital subtraction angiography (DSA). Daily TCD measurements and clinical evaluations were performed to monitor CV and DIND. Statistical analyses included multivariable logistic regression and linear regression, adjusting for confounders such as age, sex, smoking, bleeding severity, and treatment modality.

#### Results

CSC was absent in 40% of patients, while 41.6% exhibited CSC grades  $\geq 2$ . Higher CSC grades were inversely correlated with angiographic CV occurrence (aOR 0.76; 95% CI 0.60 – 0.97; p=0.025) and severity (RC -0.14; 95% CI -0.24 to -0.04; p=0.006). Patients with higher CSC grades experienced fewer days of TCD-detected CV (RC - 0.43; 95% CI -0.77 to -0.10; p=0.010). Despite the reduced CV incidence, increased CSC grades were independently associated with poorer functional outcomes at six months (RC +0.12; 95% CI +0.05 to +0.18; p<0.001). No significant correlation was detected regarding the TCD-detected CV, neither for the occurrence (aOR 0.87; 95% CI 0.69 – 1.11; 0=0.265; p=0.265) nor the maximum cerebral blood flow velocity (RC -4.47; 95% CI -24.61 to +15.68; p=0.651).

#### Conclusion

CSC demonstrates a protective role against CV and DIND in aSAH patients, reducing angiographic CV severity and TCD-detected CV duration. However, higher CSC levels are associated with unfavorable long-term outcomes, likely due to multifactorial atherosclerosis-related mechanisms. These findings underscore the importance of incorporating CSC evaluation into aSAH management to stratify CV risk and improve patient-specific therapeutic strategies.

### P231

Extrakranielle-zu-intrakranielle Bypass-Chirurgie bei atherosklerotischer Gefäßokklusion mit reduzierter Reservekapazität und rezidivierenden TIAs: Erfahrungen eines einzelnen Zentrums Extracranial to intracranial bypass surgery for atherosclerotic vessel occlusion with reduced reserve capacity and recurrent TIAs: a single center experience

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#### Objective

Controversy surrounds the application of flow augmentation bypasses for steno-occlusive atherosclerotic cerebrovascular disease, particularly following the divisive Carotid Occlusion Surgery Study (COSS) and CMOSS. The selection of patients who benefit from ECIC bypass and perioperative complications remain critical factors. For example the COSS trial showed very high complication rates and the recent trial (CMOSS) included much younger and clinically much stable patients yielding overall negative trial. Despite conflicting evidence, authors argue for the procedure's continued relevance, supported by reduced perioperative complication rates and a distinct contemporary patient cohort. This study contributes to the discourse by presenting our center's experience.

#### Methods

Data from our EC-IC bypass registry (2007-2024) was analyzed for patients with flow augmentation bypasses for steno-occlusive atherosclerotic cerebrovascular disease with reduced reserve capacity and recurrent TIAs.

#### Results

Results cover 98 procedures in 89 patients with a mean follow-up of 22 months. Internal carotid artery (ICA) occlusion was most prevalent (88.8%), often coexisting with stenosis in additional intracranial arteries (27.6%). Isolated middle cerebral artery (MCA) occlusion/stenosis and anterior cerebral artery (ACA) stenosis were rare. Symptomatically, 14.3% had single transient ischemic attacks (TIAs), 44.9% experienced multiple TIAs, 26.5% had recurrent strokes, and 14.3% had progressive strokes. Hemodynamic assessments preoperatively showed 62.2% unilateral and 37.8% bilateral impairment cerebrovascular reserve capacity, with cases of ICA stenosis and additional intracranial artery involvement more likely to exhibit bilateral impairment. Postoperatively, the bypass patency rate was 96.9% within 30 days. Perioperative complications including stroke occurred in 4.1% and long-term follow-up revealed a 97.5% bypass patency rate, with 3.7% symptomatic for recurrent TIAs.

#### Conclusion

Our data show that flow augmentation bypass surgery is still beneficial in highly selected cases of progressive cerebrovascular disease under intensive medical management. Our center's experience supports the argument and underlines the currently much lower perioperative risk for patients with significantly reduced recurrent stroke.

### P233

Quantitative Evaluation der T1-gewichteten SPACE MRT zur Vorhersage des Krankheitsverlaufs bei Moyamoya-Angiopathie

Quantitative Evaluation of T1-weighted SPACE MRI for Predicting Disease Progression in Moyamoya Angiopathy

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#### Objective

Moyamoya Disease is an underdiagnosed condition where the internal carotid and cerebral arteries narrow, potentially leading to stroke or bleeding. As shown before, disease progression can be detected by high-resolution vessel wall contrast enhancement (VWCE) on T1-weighted SPACE MRI. However, this imaging approach is in need of standardization for signal intensity and longitudinal reproducibility of healthy and affected tissue.

#### Methods

Signal intensity of the vessel wall, pituitary stalk, and temporal lobe white matter was measured using manually selected regions of interest on the same MRI. Additionally, the clinical course regarding disease progression and timing of surgical interventions were correlated with the vessel wall enhancement data.

#### Results

In 60 patients, two or more MRIs (n=129) with median time between MRI of 14.8 months (range: 2-36 months) with T1 SPACE sequences on the same MR machine were available. Intraindividual variation of pituitary stalk enhancement (positive control with maximum contrast enhancement signal) and temporal lobe white matter enhancement (negative control with no contrast enhancement) showed median signal changes of 20.5% and 17.5%, respectively. Notably, the deviation always occurred in the same direction. Therefore, the ratio of pituitary gland to temporal lobe signal intensity did not significantly change (p=0.843) interindividual over time, with a mean change of 8.0%. With these findings, the signal intensity of the pituitary stalk can now be defined as maximum value and therefore used for intraindividual normalization of vessel wall contrast enhancement in affected arteries. In our cohort, 75% of patients had VWCE, with an in- and decreasing course of intensity (depicting disease activity) over approximately 15.9 months.

#### Conclusion

High resolution vessel wall imaging is an important method for depicting disease activity in Moyamoya patients. With these findings, normalization of signal intensity based on the pituitary stalk is proven to be a reliable for comparable intraindividual chronological evaluation of the course of the disease.

### P235

Vorhersage von Outcome und klinischem Outcome nach einer aneurysmatischen Subarachnoidalblutung (aSAH) mit Biomarkern des OLINK-Proteoms Predicting clinical Outcome and in hospital mortality after Aneurysmal Subarachnoid Hemorrhage (aSAH) with OLINK proteomics biomarkers

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#### Objective

Sterile inflammation is a critical factor following aneurysmal subarachnoid hemorrhage (aSAH). However, the role of specific inflammatory biomarkers in predicting clinical outcomes and survival remains unclear.

#### Methods

We collected serum from patients at day 4 after aSAH. The concentration of 92 inflammatory biomarkers was analyzed using OLINK inflammatory panel. Data was analyzed using GraphPad Prism by performing T-test for comparing two groups and One-Way ANOVA followed by post hoc Tukey"s test for multiple groups. The data is presented as mean $\pm$  standard deviation. The modified Rankin Scale (mRS) score were classified as good (mRS $\leq$  2) and poor ( $3 \leq$  mRS  $\leq$  5 and mRS= 6).

#### Results

In total we recruited 50 patients (36 women, 14 men; 29 poor grade WFNS (4-5), 21 good grade WFNS (1-3)). 23 patient had mRS≤ 2, 17 patients had 3≤mRS ≤5, and 10 patients were dead (mRS= 6). 7 inflammatory biomarkers were significantly different in patients with good and poor mRS scores; OPG (mRS≤ 2= 11.53±0.52 vs 3≤mRS ≤5= 12.16±0.64 vs mRS=6 = 12.29±0.53, p= 0.0005), IL6 (mRS ≤ 2= 6.40±1.36 vs 3≤mRS ≤5= 8.23±2.24 vs mRS=6 = 8.21±1.36, p= 0.0022), FGF-21 (mRS≤ 2= 7.66±1.5 vs 3≤mRS ≤5= 9.81±2.54 vs mRS=6 = 9.80±1.98, p= 0.0022), MMP10 (mRS≤ 2= 9.74±0.86 vs 3≤mRS ≤5= 10.61±0.87 vs mRS=6 = 10.62±0.84, p= 0.0034), IL10 (mRS≤ 2= 3.49±0.71 vs 3≤mRS ≤5= 4.20±1.00 vs mRS=6 = 4.35±0.94, p= 0.0115), CCL23 (mRS≤ 2= 12.44±0.60 vs 3≤mRS ≤5= 13.12±0.77 vs mRS=6 = 13.24±0.65, p= 0.0020), and CCL20 (mRS≤ 2= 8.12±1.23 vs 3 ≤mRS ≤5= 9.79±2.10 vs mRS=6 = 9.77±1.52, p= 0.0034). The patients were further categorized into two groups: the patients who survived the first 90 days (n=40) and the patients who did not survive (n=10). The concentration of 21 inflammatory biomarkers was significantly different between the patients who survived and the patients who died. The top 5 inflammatory biomarkers with the highest difference were IL-17A (survivors= 1.56±1.38 vs no survivors= 2.85±1.42, p= 0.011), IL-17C (survivors= 4.14±1.57 vs no survivors= 5.24±1.06, p= 0.039), CCL19 (survivors= 11.33±1.07 vs no survivors= 12.21±1.23, p= 0.026), CXCL10 (survivors= 7.53±0.92 vs no survivors= 8.37±1.30, p= 0.019) and MCP-3 (survivors= 4.24±0.98 vs no survivors= 4.99±1.15, p= 0.039).

#### Conclusion

The OLINK inflammatory panel identified potential biomarkers that were significantly higher in patients with poor outcome, offering valuable biomarkers for early risk stratification and treatment decisions.

### P236

Der Einfluss der Thrombektomie auf die Notwendigkeit einer chirurgischen dekompressiven Kraniektomie bei schweren Schlaganfällen: Eine vergleichende 10-Jahres-Analyse The influence of thrombectomy on the need for surgical decompressive craniectomy in major stroke: A 10-year comparative analysis

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#### Objective

Decompressive craniectomy (DC) is performed to treat refractory intracranial hypertension following traumatic brain injury and stroke-a life-saving measure. This study evaluates the incidence of craniectomy in stroke patients over a 10-year span, comparing data from 2010-2015 and 2020-2024. Our aim was to identify any significant changes in the frequency of craniectomy procedures, which may reflect shifts in clinical practice, technological advancements or patient management strategies. We hypothesized that the implementation of thrombectomy in routine stroke treatment following after 2015 has resulted in a reduction in the number of patients requiring or undergoing DC.

#### Methods

A retrospective observational study of stroke patients treated at our tertiary care center from 2010-2015 and 2020-2024 was conducted. We assessed the number of craniectomy procedures in relation to the total number of stroke cases in each period. The proportions of patients who recieved DC were calculated and compared between the periods. We also analysed the number of patients who underwent neurointerventional thrombectomy from 2020-2024.

#### Results

Between 2010 and 2015, a total of 3268 patients were treated for acute stroke with 86 of them (2.63%) undergoing DC. In the 2020-2024 period 466(13,72%) out of 3397 stroke patients underwent neurointerventional thrombectomy, and 73 (2.15%) underwent DC. The difference in the proportion of patients undergoing DC in both time periods was not statistically significant (P=0.20, Fisher''s exact test). The total number of DC prodcedures accross both periods was 159, representing 2.38% of all stroke patients.

#### Conclusion

Only a minority of stroke patients underwent DC in our institution. We did not observe a statistically significant reduction in the proportion of stroke patients undergoing DC between 2010-2015 and 2020-2024. This suggests that the implemention of neurointerventional thrombectomy, albeit improving stroke outcomes, has not led to a relevant decrease in the number of patients suffering from life-threatening major stroke.

### P237

Kontrastverstärkte Cone-Beam-CT: Ein unterschätztes Werkzeug in der Diagnostik und Therapie von kraniozervikalen duralen arteriovenösen Fisteln – Erkenntnisse aus einer Fallserie und einem systematischen Review

Contrast-Enhanced Cone-Beam CT: A Rarely Used Tool in Diagnosis and Management of Craniocervical Dural Arteriovenous Fistulas—Insights from a Case Series and Systematic Review

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#### Objective

Dural arteriovenous fistulas at the craniocervical junction (CCJ DAVF) pose diagnostic challenges due to their rarity and complex angioarchitecture. This study presents a case series of CCJ DAVFs, focusing on our treatment algorithm and experiences with contrast-enhanced cone-beam CT (CE-CBCT). A systematic review was conducted to emphasize neurological symptoms, diagnostic imaging techniques, obliteration rates, and neurological outcomes.

#### Methods

A retrospective case series included consecutive patients treated at our hospital from January 2010 to December 2023. Clinical and imaging data, including CE-CBCT, were collected. A systematic review following PRISMA Guidelines included original studies with  $\geq$ 5 cases and detailed clinical information from January 2020 to December 2023.

#### Results

The systematic review included 14 studies with 705 cases, predominantly male (79%). Mean age was 60,20  $\pm$  5,89 years. Progressive myelopathy (39%) and subarachnoid hemorrhage (40%) were common presenting symptoms. Diagnostic workup involved digital subtraction angiography in all cases, computed tomography angiography and magnetic resonance angiography in 34%. No study utilized CE-CBCT preoperatively. Most patients underwent microsurgery or a combined approach. Our series included seven consecutive patients; CE-CBCT was performed in all cases. Imaging and treatment strategies as well as clinical features are presented.

#### Conclusion

CCJ DAVFs present ongoing challenges. CE-CBCT enhances preoperative diagnostic workup and patient safety by improving anatomical orientation, as observed in our series. Despite its potential, the systematic review suggests limited widespread use of CE-CBCT in CCJ DAVF cases.

### P238

Die Arteria occipitalis (OA) im extrakraniellen-intrakraniellen Bypass: Erfahrungen aus 17 Fällen *The occipital artery (OA) in extracranial-intracranial bypass: experience on 17 cases* 

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#### Objective

The occipital artery (OA) represents the natural extracranial donor in posterior cranial fossa bypass procedures and an alternative to the STA in selected patients. In this series we analyze our retrospective experience.

#### Methods

A single surgeon experience of patients, surgically treated with cerebral revascularization in the time interval from 2016 to 2024 in 3 Hospitals was retrospectively analyzed, identifying patients in whom an OA dissection was performed.

#### Results

The surgical indication was Moyamoya vasculopathy in 3 cases, an aneurysm of the PICA in 7 cases, of the AICA in one patient and cerebrovascular insufficiency in the remaining 6. The type of incisions used were "cut down" in 7 patients, "Hockey Stick" in 6 cases and "Inverted Hockey Stick" type in the remaining 4 patients. Dissection of the OA was possible in 15 cases. In the remaining two, the extra-intracranial revascularization procedure was converted into "side-to-side" PICA-PICA bypass and end-to-end AICA-AICA anastomosis respectively. The OA was sutured with the middle cerebral artery in 6 cases, with the PICA in 9 patients. A double end-to-side bypass was performed in 2 patients, single in the remaining. The anastomosis was patent intraoperatively in 14 of the 15 patients treated with extra-intracranial bypass as well as in the two patients treated with in situ anastomosis. There were no complications of the surgical wound in 14 cases, in the other 3 there was a CSF fistula, requiring surgical revision and prolonged hospitalization.

#### Conclusion

The occipital artery proves to be a versatile extracranial donor for bypass surgery both in the posterior fossa where its caliber guarantees adequate flow for both flow augmentation and flow substitution interventions, while its length allows reaching the territories of the Middle cerebral artery sometimes for multiple anastomoses.

In addition to the intrinsic fragility of the vessel, the risk of CSF fistulas presents an important limitation to its use. For these reasons its use must be critically evaluated if an intra-intracranial bypass procedure is possible.

### P239

Onkolytische Aktivität von pseudotypisierten Zika-Virus E- Protein HIV-1gfp in primären Glioblastom-Zellkulturen Transduction Efficiency of Zika Virus E Protein Pseudotyped HIV-1gfp and Its Oncolytic Activity Tested in Primary Glioblastoma Cell Cultures

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#### Objective

Cells from the malignant brain tumor, glioblastoma multiforme (GBM) are highly heterogeneous. After tumor removal, some tumor cells remain at the tumor-brain boundary since in the brain, surgery cannot be performed with the normally required safety margin. Thus, it is of upmost importance to develop tools able to destroy remaining tumor cells. One strategy is to develop lentiviral vectors (LVs) with high specificity for GBM cells to transfer therapeutic genes into these cells. The Zika virus (ZIKV) provides an envelope with the protein E, which has a high specificity for GBM cells, making it a prime candidate for the development of LVs; so-called ZIKV protein E coated lentiviral particles. The study demonstrates that such LVs have an efficiency and high specificity for GBM tumor cells, leaving healthy cells mostly unharmed. These LVs open up new perspectives and therapeutic options for combating tumor cells that cannot be removed through surgery.

#### Methods

Primary GBM cell cultures were transduced with different Lentiviral vectors (LVs) encased with ZIKV envelope variants. LVs were generated by using the pNL*gfp*AM plasmid, which produces the lentiviral, HIV-1-based, core particle with GFP (green fluorescent protein) as a reporter (HIV*gfp*). For testing, we used five different GBM primary cell cultures and three laboratory-adapted GBM cell lines.

#### Results

For oncolytic virus therapy, the biggest hurdle is to transfer the relevant genetic material into a sufficient number of target cells and to avoid the transduction of non-target cells. It is important to design the gene transfer vector in such a way that it has the best possible specificity for the desired cells.

#### Conclusion

ZIKV envelope coated LVs provide prime tools for targeting GBM since they have a high specificity for these kind of tumor cells.

## P241

Charakteristika und klinische Ergebnisse von Glioblastom-Patienten mit schwacher Methylierung des MGMT-Genpromotors Characteristics and clinical outcomes of glioblastoma patients with weak methylation of the MGMT gene promoter

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#### Objective

A substantial body of research has demonstrated that silenced DNA repair gene O6-methylguanine-DNA methyltransferase (MGMT) by methylating the promoter in glioblastoma (GBM) enhance the efficacy of temozolomide chemotherapy. Current treatment guidelines for GBM require MGMT promoter methylation status. In nearly all cases, a methylated or non-methylated MGMT promoter can be distinctly identified and differentiated through routine neuropathological examinations. However, a subset of GBMs may exhibit weak methylation of the MGMT promoter. The objective of this study was to investigate the clinical features, disease progression, and treatment outcomes in GBM patients with weak methylation of the MGMT promoter in comparison to those with methylated and unmethylated MGMT promoter.

#### Methods

A quantitative analysis of MGMT promoter methylation was conducted on 140 of 190 samples from a cohort of adult patients with newly diagnosed GBM treated at our university hospital over the past decade. The MGMT promoter was stratified by methylation status (methylated, unmethylated, and weakly methylated) and standard treatment with chemoradiotherapy according to the Stupp protocol. A comparative analysis of the patients' medical records, including their treatment regimens and clinical outcomes, was then performed.

#### Results

Overall, the MGMT promoter was methylated in 66 samples, unmethylated in 57 samples and weakly methylated in 17 samples. 57 of the 140 patients received chemoradiotherapy. The progression-free interval (PFI) was 8, 10, and 12 months for patients with methylated, unmethylated, and weak methylated MGMT, respectively. The 2-year survival rates (SR) were 9.1%, 10.4% and 11.8%, and the overall survival (OS) were 19, 22 and 36 months, respectively. After stratification following chemoradiotherapy, patients with weak methylated MGMT continued to show better disease progression with a PFI of 10, 12 and 19 months, and 2-year SR were 19.2%, 26.9% and 20.0% for patients with methylated, unmethylated and weak methylated MGMT, respectively. All patients succumbed to their disease at the last follow-up. OS was 19, 22, and 36 months, respectively.

#### Conclusion

Despite the study's limitations, including the absence of statistical analysis and the modest patient sample size, our findings suggest that glioblastoma patients with weakly methylated MGMT promoters may experience higher rates of PFI and OS compared to those with methylated MGMT promoters, irrespective of chemoradiotherapy.

### P242

Fortschrittliches maschinelles Lernen zur Erkennung der Heterogenität von Zellzyklusveränderungen während einer TMZ-Chemotherapie auf Einzelzellebene Advanced machine learning to detect heterogeneity of cell cycle alterations during TMZ chemotherapy at single cell level

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#### Objective

Glioblastoma (GB) is the most aggressive tumor of the CNS, characterized by significant resistance to standard treatments, including Temozolomide (TMZ) and radiotherapy. TMZ alters the GB cell cycle, reducing cells in GO-G1 and increasing those in S/G2, suggesting a dual response: tumor cell re-entry into the cell cycle and cycle arrest, contributing to resistance and progression. Using Ki-67, a marker of cellular proliferation peaking during S/G2/M phases, we investigated TMZ's effects across primary cell lines, patient-derived organoids (PDOXs), and tissue samples.

#### Methods

We developed an image-based approach utilizing machine learning to reconstruct the cell cycle at the single-cell level. Primary cell lines (n=6) were characterized with whole-genome DNA, methylation, and RNA sequencing. Functional assays included time- and dose-dependent TMZ treatment in cell cultures and GB tissue slices. 3D Smart-seq of treated samples revealed transcriptional changes, while fluorescently labeled TMZ quantified drug uptake per cell, correlating it with EdU and Ki-67 staining for cell cycle analysis. Spatial transcriptomics was performed on PDOXs to evaluate proliferation changes, while paraffin-embedded GB samples from primary and relapsing tumors were assessed for cell cycle shifts in relation to the tumor microenvironment.

#### Results

Our machine learning-based analysis demonstrated accurate cell cycle reconstruction, with untreated cells predominantly in G0-G1. TMZ induced a significant shift to S/G2 phases (p < 0.02) in half of the tested cell lines. Pseudo-time analysis revealed dose-dependent cycle alterations, with changes observed at doses below 50  $\mu$ mol. Stem-like cell lines showed resistance to cycle changes even at >150  $\mu$ mol, irrespective of MGMT promoter methylation. TMZ uptake correlated with cell cycle re-entry, with low-uptake cells more likely to shift from quiescence to proliferation. Spatial transcriptomics in PDOXs revealed increased proliferation immediately after TMZ treatment, indicating dual effects: inducing cell damage and promoting proliferation in resistant cells. GB patient cohorts exhibited variable proliferation patterns depending on TMZ response.

#### Conclusion

TMZ induces complex cell cycle alterations, independent of MGMT methylation status but according to the active uptake of the drug. These findings underscore GB heterogeneity and highlight TMZ-induced cell cycle changes as a potential biomarker for treatment response, supporting personalized therapeutic strategies.

## P243

#### Kann FTY720 Glioblastom-Rezidive durch CDK1-Regulation verhindern? Can Glioblastoma-recurrences be prevented by regulating CDK1 through FTY720?

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#### Objective

In various studies the antiproliferative effect of fingolimod (FTY720) on glioblastoma cells, an approved spinghosin 1-phosphate-receptor-agonist (S1P-RA) in the treatment of multiple sclerosis, has been shown. Many different signalling pathways induce the development and have influence on the poor prognosis of glioblastoma multiforme (GBM). The epithelial-mesenchymal-like transition (EMT) in glioblastoma cells with the additional effect of surrounding astrocytes after a resection and the p53-signal pathway with highly CDK1-expression play key roles for the limited treatment success by inducing proliferation, chemoresistance and recurrence. The aim of this study was to search further targets of FTY720 beside the proven downregulation of S1P-R.

#### Methods

Human astrocytes, patient-derived primary GBM cells and cell-lines U87, A172 and U251 were treated with temozolomide (TMZ 150 $\mu$ M), FTY720 at the doses of 5 and 10 $\mu$ M, or a combination of both. In addition to the investigation of the antiproliferative effect of FTY720 using XTT and colony-forming assay, we investigated the gene and protein expression of the EMT-factors ZEB1, CDK1, N- and E-Cadherin as possible target molecules of FTY720 using PCR and Western blot. Statistical analysis was performed using the ANOVA test and the post-hoc test.

#### Results

PCR showed a cell-line-dependent down-expression of EMT-factors, both under TMZ and FTY720, while this effect prevailed under FTY720. In contrast, FTY therapy (10 $\mu$ M) achieved a significant down-expression of CDK1 in Western blot compared to TMZ therapy (p-value < 0.049). The main focus is on astrocytes which shows a lower gene and protein expressions under FTY therapy than under TMZ.

#### Conclusion

In addition to the antiproliferative effect, FTY720 seems to be a prognostically relevant therapeutic agent based not only on the regulation of EMT, but also on the G2/M phase, with the significant CDK-1 downregulation and the tendency of EMT-inhibiting effect. Moreover, the induction of GBM recurrence described by Okolie et al., 2016 can be positively influenced by the interaction of reactive astrocytes with tumor peripheral cells through downregulation of N-cadherin and ZEB1 after surgical resection. Therefore, further investigations of the FTY720 are necessary.

Okolie, O., Bago, J. R., Schmid, R. S., Irvin, D. M., Bash, R. E., Miller, C. R., & Hingtgen, S. D. (2016). Reactive astrocytes potentiate tumor aggressiveness in a murine glioma resection and recurrence model.

### P244

Nachweis von IDH-Mutationen in Liquor-cfDNA: Faktoren für die Detektierbarkeit und prognostische Bedeutung bei IDH-mutierten Gliomen

*IDH-mutation detection in CSF-cfDNA: factors influencing detectability and prognostic significance in IDH-mutant gliomas* 

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#### Objective

Detection of cell-free DNA (cfDNA) provides a non-invasive approach for glioma diagnosis and monitoring. Previous studies have demonstrated the feasibility of identifying *IDH* mutations in cerebrospinal fluid (CSF) from patients with *IDH*-mutant gliomas. However, detection rates vary widely, and the clinical relevance of a positive result remains unclear. This study aims to evaluate the factors influencing *IDH* mutation detection in CSF and to assess its prognostic implications for glioma patients.

#### Methods

Matched CSF and plasma samples were collected from 60 glioma patients during surgery prior to tumor manipulation. *IDH1/2* hotspot mutations were analyzed in cfDNA from CSF and blood plasma, as well as in corresponding tumor DNA, using quantitative real-time PCR and next-generation sequencing. Variant allele frequency (VAF) of *IDH* mutations in CSF-tDNA was correlated with tumor characteristics and patient outcomes.

#### Results

Among the cohort, 15 patients (25%; 10 male, 5 female) had *IDH*-mutant gliomas. Histological subtypes included eight WHO grade 3 astrocytomas, three WHO grade 2 astrocytomas, three WHO grade 3 oligodendrogliomas, and one WHO grade 2 oligodendroglioma. The median patient age was 44 years (range: 25–70 years). *IDH* mutations in CSF-tDNA were detected with 100% specificity (95% CI, 92.1–100%) and 75% sensitivity (95% CI, 50.9–91.3%).

Notably, preoperative MRI contrast-enhancing tumor volume was significantly associated with successful *IDH* mutation detection in CSF (mean 4.63 cm<sup>3</sup> [SD: 7.03] vs. 0.16 cm<sup>3</sup> [SD: 0.36], Mann-Whitney U-test, p=0.028). Conversely, FLAIR tumor volume showed no significant correlation with mutation detection (mean 48.69 cm<sup>3</sup> [SD: 47.17] vs. 16.71 cm<sup>3</sup> [SD: 18.98], Mann-Whitney U-test, p=0.129). Additionally, tumors located adjacent to the subventricular zone exhibited a higher rate of successful *IDH* mutation detection in CSF (Fisher's exact test, p=0.022). Kaplan-Meier analysis revealed significantly longer survival in patients without detectable *IDH* mutations in CSF (log-rank, p=0.04).

#### Conclusion

This study demonstrates that *IDH* mutations can be reliably detected in CSF-tDNA, with detection rates influenced by tumor characteristics such as contrast enhancement and proximity to the subventricular zone. Importantly, the presence of *IDH* mutations in CSF-cfDNA may serve as a prognostic surrogate, with positive detection correlating with poorer survival outcomes in patients with *IDH* mutant gliomas.





## P245

#### Einfluss des Resektionsausmaß bei IDH1/2-wt Astrozytomen (ZNS WHO Grad 4) The impact of surgery in IDH1/2-wildtype Astrocytomas (CNS WHO grade 4)

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#### Objective

Isocitrate dehydrogenase (IDH)1/2 wildtype astrocytomas have high recurrence rates and were classified as CNS WHO grade 4 tumors in the latest WHO classification of 2021. Uncertainty remains towards clinical implications and decision making- especially regarding the role of surgery.

#### Methods

Data acquisition was conducted as a multi-center retrospective analysis at 6 University Hospitals (2016-2020). Patients with IDH 1/2 wildtype diffuse astrocytoma (CNS WHO grade 2-4) were included in our study. Patients presenting with IDH wildtype glioblastoma from one institution served as controls. Primary outcome parameters were EOR according to the RANO 2.0 response assessment criteria and OS.

#### Results

160 patients with IDH-wildtype glioblastoma (CNS WHO grade 4) (45.6 % females) and 111 patients with IDH-wildtype diffuse astrocytoma (CNS WHO grade 2-4), (34.2 % females) were enrolled. The median age was 68 years (37-86 years) in the classic glioblastoma cohort and 59 years (20-87 years) in those with astrocytomas. GTR was achieved more often in patients with classic glioblastoma: 58.8% compared to those with diffuse astrocytoma 27.9% (p = 0.0001); STR (36.0%, p = 0.0048) and biopsy (36.0%, p = 0.0032) were more often in astrocytomas. The overall survival was 12.7++10.4 months in classic glioblastoma: 15.3++10.4 months, 95% Cl 13.13 - 17.40, p = <0.0001; diffuse astrocytoma: 26.7++17.9 months, 95% Cl 20.13 - 33.25, p = <0.0001). Further, also STR significantly increased OS in glioblastoma (11.46++11.03 months, 95% Cl 7.55 - 15.37, p = 0.0257) and astrocytoma (18.8++13.54 months, 95% Cl 14.47- 23.13, p = 0.0035). ROC analysis identified a residual cut-off tumor volume of >20% in the glioblastoma cohort and >60% in the difuse astrocytoma cohort to be associated with impaired OS. Multivariate logistic regression analysis identified age and EOR, not radio-chemotherapy, as independent predictors of OS in diffuse astrocytoma. MGMT methylation had no impact on OS (p = 0.11).

#### Conclusion

The presented data suggests that resection prolongs OS in patients with IDH-wildtype astrocytomas and is of higher value than radio-chemotherapy. Of note, STR also positively influences OS in these patients. These results underline the importance of surgical resection even if GTR is not achievable and thus mark a potential paradigm shift in clinical decision making.

### P246

# Mikrochirurgische Resektion versus Biopsie bei Glioblastom-Patienten ab 65 Jahren: eine retrospektive multizentrische Analyse und Entwicklung eines prognostischen Scoring-Systems On the value of microsurgical resection compared to biopsy in elderly glioblastoma patients: a retrospective multicenter analysis and scoring system proposal

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#### Objective

Benefits of tumor resection in elderly glioblastoma multiforme (GBM) patients within the framework of multimodal treatment remains a matter of debate. This retrospective, multicenter analysis aims at the identification of patients who are most likely to benefit from microsurgical resection, and the development of a scoring system to improve future decision-making.

#### Methods

Demographic and outcome data of GBM patients aged 65 years and older, who underwent resection or biopsy at three centers between 2003 and 2022, were analyzed. Frailty was assessed by the Modified 5-Item Frailty Index (mFI-5).

#### Results

We studied 537 patients (median age 73.4 years); 369 (68.7%) underwent resection and 168 (31.3%) underwent biopsy. Resected patients were younger, were preoperatively more commonly functionally independent, were less frail, and had larger tumor volumes (all p<0.001). The median overall survival was 9.1 (Cl95% 7.9- 10.5) months for resected and 2.8 (Cl 95% 2.1-4.3) months for biopsied patients (p<0.001). The strongest preoperatively determinable predictors for poor survival were older age, significant frailty (mFI-5≥2), and deep-seated tumor location for, both, resected and biopsied patients (p<0.001). Based on this, a score (0-5 points) incorporating these parameters was developed. Among patients with assumed favorable prognosis (score= $\leq$ 1) the median survival difference between resection and biopsy was 7.5 months, whereas in case of poor prognosis (score≥4) the difference was 2.1 months. No long-term survivors ≥24 months had a score of ≥3 points.

#### Conclusion

Selected elderly glioblastoma patients might benefit from microsurgical resection. A score to guide neurosurgical treatment decision-making and patient counseling was developed.
Abb. 1

Factor	Score		
Deep-seated	No = 0 points Yes = 2 point		
mFI-5	no/minor frailty (0,1) = 0 points significant frailty (>=2) = 1 point		
Age	≥65-70 years = 0 points >70-75 = 1 point >75 years = 2 points		
Sum score	min. 0 points, max. 5 points		

### P247

Postoperative Ischämien bei neu diagnostizierten Glioblastomen Postoperative ischemia in newly diagnosed glioblastoma

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### Objective

To investigate the incidence and risk factors of postoperative ischemia following resection of newly diagnosed glioblastoma as well as the associated impact on neurological function and long-term outcome.

### Methods

We retrospectively investigated pre- and postoperative MRI scans of patients previously included in a prospective register study of newly diagnosed glioblastoma. Postoperative diffusion-weighted imaging (DWI) and apparent diffusion coefficient maps were screened with regard to peritumoral ischemic changes. DWI changes with an axial diameter of less than 3 mm were assessed as non-specific postoperative changes. Ischemic lesions were classified according to shape (rim-/sector-shaped, distant to resection cavity) and localization. The volume of ischemic lesions was determined using ITK-SNAP. Additional characteristics (pre-/postoperative tumor volume, extent of resection, pre-/postoperative neurological function, KPS, molecular pathology, cerebrovascular risk factors, progression-free survival and long-term survival) were recorded and analyzed.

### Results

382 patients (150 female, 232 male) were included. New postoperative ischemic lesions were found in 100 patients (26,2%), of which 59 patients showed rim-shaped ischemic lesions and 41 patients showed sector- or distant ischemic lesions. The mean age among patients without ischemia was 62 years (SD +/- 12,6) and 64 years (SD +/- 11,8) among those with new ischemia (p=0.036). Larger volume of ischemic lesions was associated with occurrence of new aphasia (p=0.04), cranial nerve deficit (p=0.003), visual field deficit (p=0.0001) and new hemiparesis (p=0.0001). Patients with new ischemia showed shortened progression-free survival (p=0.038). No difference between groups was seen regarding overall survival (p=0.55) and the presence of cerebrovascular risk factors (p=0.60).

### Conclusion

New postoperative ischemic lesions were seen in 26,2% of all cases. Patients with new ischemic lesions showed to be older than those without ischemic changes. Larger infarct volumes were significantly associated with the occurrence of new neurological deficits. Patients with new ischemic lesions showed reduced progression-free survival but no reduced overall survival.





### P248

Die Rolle des Resektionsausmaßes in der Therapie von Gliosarkomen – Eine Volumetrische Analyse der Postoperativen Kontrastmittel Aufnehmenden Tumormasse im Frühen Postoperativen MRT und der Einfluss auf den Onkologischen Verlauf

The Role of Extent of Resection in Gliosarcoma – Volumetric Assessment of Residual Contrast-Enhancing Tumor Mass in Post-Surgical MRI and Association with Oncological Outcome

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### Objective

The extent of resection (EOR) of contrast-enhancing (CE) tumors significantly influences patient survival in glioblastoma (GBM) patients. However, evidence regarding the impact of EOR in the histopathologically well-defined subgroup of gliosarcomas (GS) remains scarce. The role of fluorescence-guided (5-Aminolevulinic acid, 5-ALA) and intraoperative MRI (ioMRI)-guided resection in maximizing EOR for GS is not yet established. This study evaluates how EOR affects patient survival in GS.

### Methods

In this retrospective study, we analyzed 50 consecutive patients (56.0 % male) who underwent surgery for histopathologically confirmed GS between Mai 2005 and December 2024. The mean age at diagnosis was 61.2 years (range: 26–86, standard deviation [SD] 13.4). Surgeons used the ioMRI in 40 % of cases, with additional resection after ioMRI in two-thirds of cases. 5-ALA was administered in 30 % of cases. We analyzed clinical, surgical, and survival data and performed preoperative and early postoperative MRI (epMRI, within 48 hours) volumetric analyses of the CE tumor. Additionally, we correlated residual tumor volume in epMRI with patient survival and outcomes.

### Results

The mean pre-operative CE volume was 39.3 ml (SD 24.9), and the mean postoperative residual tumor volume was 0.57 ml (SD 1.2). Although there was no statistical significance, for patients with ioMRI-guided resection the mean residual CE tumor volume was 0.85 ml (SD 1.7) vs. 0.38 ml in the 5-ALA group (SD 0.57). Cases with a residual CE tumor volume of less than 0.1 ml showed a mean overall survival (OS) of 12.6 months (SD 6.5) and a mean progression-free survival (PFS) of 8.4 months (SD 4.5). In patients with residual CE tumors greater than 0.1 ml, OS was 7.6 months (SD 5.9), and PFS was 4.3 months (SD 2.9). Differences in OS and PFS showed no statistical significance. In patients with residual CE tumor > 0.1 ml and < 0.1 ml, differences of tumor location and eloquence, MGMT-promotor methylation, and postoperative radiochemotherapy were not statistically significant.

### Conclusion

In this cohort of GS patients, a greater EOR of CE tumor seems to be associated with prolonged postoperative OS and PFS. Both intraoperative MRI and fluorescence-guided resection demonstrated sufficient utility in GS resection. Further, a matched-pair analysis of GS and GBM patients regarding the impact of EOR on outcomes will be conducted.

### P249

Funktionelle Ergebnisse und neuropsychologische Beurteilung im Rahmen der Resektion von insulären Gliomen Functional outcomes and neuropsychological assessment in patients undergoing insular glioma resection

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### Objective

Maximal safe resection in highly eloquent gliomas, preserving motor, language, and cognitive functions, is crucial to optimize patient outcomes. This study evaluates functional outcomes in patients undergoing resection of insular gliomas.

### Methods

All patients in this cohort underwent preoperative non-invasive mapping and function-based fiber tracking. Right-sided lesions were resected under general anesthesia, while left-sided lesions often required awake surgery, depending on the preoperative function-based mapping. Neuropsychological evaluations were conducted preoperatively, postoperatively, and at follow-up.

### Results

Fourteen patients with insular gliomas (seven left-sided, seven right-sided) aged 48.8±16.1 (30.4-74.8) years underwent microsurgical resection.

In **right-sided lesions**, **mild postoperative deficits** were observed in executive and cognitive tasks, with changes in the Controlled Oral Word Association Test (COWAT) (12 [5–18] to 12 [4–19][IS1] [MO2]) and Montreal Cognitive Assessment (MoCA) (28 [21–30] to 26 [18–30]). More significant declines were noted in the Trail Making Test B (TMT-B) (65 [45–96] sec to 89 [47–300] sec) and Nine-Hole Peg Test (NHPT) (23 [18–27] sec to 26 [18–28] sec).

In **left-sided lesions, significant postoperative impairments**, particularly in language functions, were identified, with declines in COWAT (11 [7–17] to 4 [0–8]) and MoCA (26 [24–29] to 20 [9–28]). Executive function, measured by TMT-B, also showed marked deterioration (54 [34–117] sec to 168 [41–300] sec), whereas NHPT deficits were less pronounced (23 [16–24] sec to 25 [12–34] sec). Four patients exhibited functional recovery at follow-up, particularly in language and cognitive tasks. Improvements were observed in COWAT (11 [8–17] to 2 [0–8] to 6 [3–19]), MoCA (26 [24–29] to 21 [9–28] to 25 [19–30]), and TMT-B (53 [34–60] sec to 142 [41–300] sec to 66 [28–300] sec).

### Conclusion

Postoperative impairments in right-sided lesions primarily affected executive functions, whereas left-sided lesions showed more pronounced declines in language-related tasks. Gradual recovery was observed at follow-up, highlighting the importance of tailored surgical approaches based on lesion laterality to optimize functional outcomes.

### P250

Der BLTT (Brain Lesion Tracking Test) bei Glioblastom Patienten - Durchführbarkeit einer neuen neurokognitiven Testbatterie

The BLTT (Brain Lesion Tracking Test) in Glioblastoma Patients – Feasibility of a Novel Neurocognitive Test Battery

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### Objective

Neurocognitive assessment in neuro-oncological patients presents challenges due to the limitations of conventional neuropsychological test batteries. These tests are often time-consuming and complex. We have previously developed the Brain Lesion Tracking Test (BLTT) as a time-efficient screening tool for patients with brain injuries and have demonstrated its feasibility and validity in larger cohorts of individuals undergoing neurological rehabilitation. The BLTT test addresses all important domains of neurocognition including episodic, sematic memory and executive functions, thereby neurological restrictions as visual or hemiparesis are not leading to exclusion. The aim of the present study was to evaluate the feasibility of the BLTT in glioblastoma patients and compare its performance to established neurocognitive test batteries.

### Methods

Between 2019 and 2022, we prospectively examined a total of 23 patients who underwent resection of an anterior temporal lobe glioblastoma (CNS WHO Grade 4, IDH wildtype) on the following day. The patients were assessed preoperatively using either the BLTT or a neuropsychological standard test battery commonly used in the evaluation of patients with temporomesial epilepsy. The BLTT total score is calculated as the sum of three subscores.

### Results

Thirteen patients (57%) performed the BLTT, while 10 (43%) attempted the standard neurocognitive test battery. The BLTT was successfully applied in all glioblastoma patients, whereas only 50% of patients were able to complete the neuropsychological standard test battery. The mean BLTT total score was 69.9 (SD 4.8), compared to 84.7 (SD 6.1) in healthy controls. While the standard neuropsychological test demonstrated limitations in assessment in general due to high dropout rate, the BLTT effectively assessed all three domains.

### Conclusion

This study suggests that the BLTT may represent a promising tool for neurocognitive assessment in glioblastoma patients, offering advantages over standard neurocognitive tests. Its high completion rate and superior sensitivity in detecting semantic and episodic memory impairments highlight its potential relevance in the neuro-oncological field. Based on these findings, the authors aim to evaluate the BLTT in larger cohorts to further explore its applicability, particularly its repeatability in long-term assessments.

### P251

Zusammenhang zwischen Krankheitsstadium sowie -symptomen und der physischen und psychischen Belastung von Patienten mit höhergradigen hirneigenen Tumoren The correlation between disease course and symptoms with physical and emotional distress in patients with high grade glioma

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### Objective

Patients with high grade glioma (HGG) may suffer from somatic and cognitive deficits and experience higher emotional distress compared to patients with other cancer diagnoses. As the disease progresses, symptoms can become more severe and psychological burden may increase. Psychological screening instruments can help to evaluate the level of distress.

### Methods

From March to May 2024 patients with HGG were interviewed in our outpatient department using MIDOS questionnaire and the Distress Thermometer (DT) to analyze distress and correlate it to the severity of disease (assessed with the Karnofsky Performance Index; KPI) and physical performance. Descriptive statistics and fisher"s exact test were used for analysis.

### Results

We assessed 50 patients, age ranged from 27-77 years (median 55). 14 patients were female (28%) and 36 male (72%). Mean follow up period was 47 months (median 17 months) after diagnosis of a HGG. We divided patients into two categories, primary and recurrent tumors, and differentiated the disease status (e.g. stable or progressive disease). 83.9 % of the patients have had stable primary HGG (26/31). Among patients with recurrent disease (19/50), 8 patients have suffered from progressive disease. Median MIDOS score was 4 (which means "feeling good") in all categories without relevant difference. DT separates physical and emotional stress level, whereas median physical distress level was 5 and median emotional distress 4 in all patients. The group of patients with progressive primary tumor (5 out of 31) showed higher level of emotional distress than all other categories (median of 6), with statistical significance correlated to primary and stable disease (p = 0,0067). HGG progression and recurrence was associated with a lower KPI (median 65). Epilepsy was the major symptom, presented in 28/50 patients (56%). Only in the subgroup of progressive primary tumors the most common symptom was motor deficit in 80% (4/5).

### Conclusion

Psychological screening tests should be used during the whole disease course of HGG patients to correlate emotional stress with clinical severity and can support disease monitoring. DT is a reliable screening tool in HGG patients and cut-off values > 4 should prompt psycho-oncological intervention.

### P252

Kognitive Leistungsfähigkeit bei Post-COVID-19-Patienten: Eine longitudinale neuropsychologische Untersuchung Cognitive Performance in Post-COVID-19 Patients: A Long-Term Neuropsychological Study

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### Objective

The COVID-19 pandemic has left a substantial number of individuals experiencing long-term symptoms. Among these, cognitive impairments such as memory deficits, reduced attention, and executive dysfunction have emerged as frequent and debilitating complaints. Understanding the trajectory of these impairments is crucial for developing effective interventions. The aim of this study was to quantify and evaluate longitudinal cognitive changes in patients with persistent cognitive symptoms after COVID-19.

### Methods

A cohort of 28 patients with persisting cognitive complaints Post-COVID-19 was assessed using a comprehensive battery of neuropsychological tests. The tests evaluated verbal short and long term memory (Digit Span forwards and backwards, WAIS Logical Memory I & II), executive functions (Trail Making Test B), attention (Trail Making Test A), visual constructive abilities and memory (Rey Osterrieth Complex Figure Test), and language fluency (RWAT letters B, K & S, categories animals & food). Assessments were conducted three times at intervals of three months. Test results were analyzed using the non-parametric Friedman test to assess changes over time.

### Results

Significant improvements were observed in several cognitive domains across the three assessments, especially in Logical Memory I (p < .001) an II (P < .01), Rey 30-minute recall (p < 0.01), and RWAT (B p < .05; S p < .01). Tasks assessing executive functions, such as the Trail Making Test B, showed a trend towards improvement (p = .069). In contrast, performance on tasks such as the Digit Span forward and backward as well as the Corsi Block Span Task remained stable over time.

### Conclusion

The results highlight a gradual recovery of cognitive functions in Post-COVID patients over time, though some domains, particularly related to working memory, may show persistent deficits. These findings underscore the importance of continuous monitoring and tailored rehabilitation strategies for Post-COVID patients with cognitive impairments. Further research is needed to explore long-term recovery patterns and underlying mechanisms.

### P253

Zwischen Klinikalltag und Forschung: Eine Analyse der Arbeitsbelastung und Rahmenbedingungen wissenschaftlicher Tätigkeiten von Neurochirurginnen und Neurochirurgen in Deutschland Between everyday clinical practice and research: An analysis of the workload and framework conditions of neurosurgeons' scientific activities in Germany

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### Objective

Reconciling patient care and scientific activites (SA) presents physicians with major challenges. According to an Germany-wide survey, more than 60% of neurosurgeons work between 60 and 80 hours a week. One reason for dissatisfaction is the lack of opportunity to conduct research. As part of a survey conditions of SA were examined. The aim of the study is to identify barriers and discuss approaches for improving working and research conditions.

### Methods

We conducted an anonymous survey at two university hospitals in Germany.

### Results

So far, 20 neurosurgeons have taken part in the survey. The majority of respondents were residents (60%). In terms of academic background, 70% had achieved a doctorate or habilitation. 35% had already been scientifically active for more than ten years. 90% of the participants stated that they are currently scientifically active.

25% had published more than 15 first or last authorships to date, while 40% had published up to five papers. Most of the respondents (50%) invest 1-5 hours per week in research, 30% stated that they invest even 6-10 hours. 65% stated that they do over 70% of their SA in their free time. The majority of them (45%) do all of their research in their free time. 75% stated that they have taken vacation to conduct SA. For the majority (75%), SA were either poorly integrated or not integrated at all into their daily work. 80% perceived SA as a burden and negative in terms of work-life balance. Nevertheless, 60% stated that conducting science improves their personal satisfaction.

While 47.4% positively emphasized mentoring or collaboration with experienced researchers, 47.4% stated that they did not receive specific support. Financial issues also play a role for 55%.

35% of the respondents stated that patient care is negatively affected by SA. 75% stated that their clinical skills have improved as a result of their SA. On the other hand, 15% stated that the clinical skills of their colleagues who conduct research are poorer than of those who do not. Most respondents stated that SA have no influence on their training in the OR (60%).

### Conclusion

The survey highlights challenges in integrating SA into the clinical routine. Despite these obstacles, many physicians value the personal satisfaction gained through scientific engagement, which reflects the high motivation of the surveyed neurosurgeons and thus great potential. The survey is to be conducted throughout Germany by the time of the annual conference.

### P254

Das Offenlegen medizinischer Behandlungsfehler - gibt es innerhalb der letzten Jahrzehnte eine Entwicklung zugunsten geschädigter Patient:innen?

The disclosure of medical treatment errors - has there been a development in favor of damaged patients in the past few decades?

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### Objective

Treatment errors are not uncommon in medicine. Open communication of these errors has been advocated in the German-speaking and Anglo-American public since the turn of the millennium. A main argument was that mistakes are not always avoidable and open discussion could serve to learn from them in order to make medicine safer. In addition, it was observed that open communication prevented physicians from beeing sued.

In the work presented, it was investigated whether a change in communication between physician and patient about treatment errors can actually be observed in recent decades.

#### Methods

In addition to a detailed literature analysis on treatment errors, 6 experienced neurosurgeons, 2 lawyers who mainly deal with medical law, as well as a leading representative of the "Aktionsbündnis Patientensicherheit" were interviewed. These interviews were evaluated as part of a thematic analysis. Furthermore, criteria for and against the communication of treatment errors were also discussed from an ethical point of view.

#### Results

According to the literature, it is evident that an open communication of treatment errors helps both patients and physicians. Compared to the end of the last millenium, complications were reported more frankly.

However, an increasing communication of mistakes in the dialogue between physicians and patients could not be proven. Additionally, the interview partners observed an increasing critical attitude of patients towards their physician.

### Conclusion

In particular on the basis of concerns of legal nature, there is still a reluctance to open treatment errors openly and to apologize. As a consequence, special emphasis should be placed to improve knowledge about treatment errors. They cannot be always avoided. Mostly there is no single resposible person. Similar to aviation, the handling of errors should be a part of the medical education.

### P255

Sexuelle Belästigung in deutschsprachigen neurochirurgischen Kliniken Sexual Harassment in German-speaking Neurosurgical Clinics

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### Objective

Sexual harassment in the workplace plays a significant role as it can have substantial negative consequences for physical and mental health 1. The purpose of this survey is to assess the prevalence of sexual harassment in neurosurgery in the German-speaking region and identify the groups at highest risk. 1 Benzil, D.L., et al., *Toward an understanding of sexual harassment in neurosurgery*. Journal of Neurosurgery JNS, 2020: p. 1-10.

#### Methods

A questionnaire was developed to collect basic information and included scenarios about three forms of sexual harassment, as well as questions about the perpetrator and responses to sexual harassment. In addition, information was gathered about reporting mechanisms in the clinics and participants' awareness of them. The survey was conducted by "umfragenonline.com" and completed from December 2020 to June 2021. Data analysis was performed using IBM SPSS Statistics and Microsoft Excel 2020.

### Results

An individual link to the survey was sent to 850 neurosurgeons from 135 hospitals in Germany, Austria, and Switzerland. 154 respondents (22.3%) completed the survey. 43.5% of respondents reported witnessing sexual harassment, including 54% of women and 36.7% of men. Thus, 47.6% of women and 11.1% of men reported being victims of sexual harassment. 83% of the offenders were male, and 17% were female. The most common forms of harassment were inappropriate comments (79%) and physical contact (64%). 83.3% of sexual harassment took place at the workplace. Hierarchical structures played a role, with 70.7% of perpetrators being supervisors.36.6% of respondents reported that they did not take action or file a complaint. 38.8% of respondents indicated that their department does not have a diversity officer.

Figure 1: Representation of Victims of Sexual Harassment

### Conclusion

This study shows that sexual harassment remains a relevant issue in neurosurgical clinics and affects both female and male neurosurgeons, with only 31% of cases being officially reported. Male dominance and rigid hierarchies have been identified as risk factors. To reduce sexual harassment, preventive measures should be developed and a network for victims to report their experiences should be established. An important goal should be to create a diverse and gender-neutral work environment in neurosurgery.





### P256

Die Auswirkungen der Arbeitszeiterfassung auf Chirurgen: Eine hierarchische Analyse in einem Universitätsklinikum The Impact of Working Time Recording on Surgeons: A Hierarchical Analysis in a University Hospital Setting

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### Objective

Efficient workforce management is essential in surgical settings to maintain high standards of care. This study examines the impact of working time recording on surgeons" satisfaction and team dynamics across different hierarchical levels in a university neurosurgery department. Following Germany's 2023 legislation mandating time recording, we conducted a mixed-method study involving 20 surgeons to assess its implications.

### Methods

A structured 12-item questionnaire was employed, operationalized according to COREQ standards, and complemented by pretests. Responses were analyzed using ANOVA and Tukey HSD tests, with assistant physicians and specialists combined into one group for comparative purposes against senior physicians. Quantitative data covered three years of recorded working hours.

### Results

The analysis revealed significant differences in perceptions of working time recording between junior physicians (assistant and specialists) and senior physicians. Senior physicians rated the system's transparency significantly higher (p = 0.004), likely due to their greater administrative experience. Junior physicians found the system to improve flexibility (p = 0.021) but viewed it as more burdensome (p = 0.008), possibly due to added documentation. They also showed a stronger preference for digital solutions (p = 0.015), reflecting a need for streamlined processes.

No significant differences were found in perceptions of fairness (p = 0.387), workload management (p = 0.452), or teamwork (p = 0.678), suggesting these aspects are consistently viewed across hierarchical levels.

### Conclusion

The findings highlight differing perceptions of working time recording across hierarchical levels. While senior physicians view the system as more transparent and less burdensome, assistant and specialists advocate for digital solutions to reduce the perceived burden. Areas such as fairness and teamwork show consistent perceptions across all groups, suggesting these aspects are less influenced by hierarchical roles. Tailored measures, including digital implementation and enhanced communication strategies, could address these differences and improve overall satisfaction and efficiency in surgical teams.

### P257

Hürden und Chancen bei der Nutzung digitaler Qualitätsmanagementhandbücher: Erkenntnisse aus einer Mixed-Methods-Studie in einem Krankenhaus

Barriers and Opportunities in Utilizing Digital Quality Management Manuals: Insights from a Mixed-Methods Study in a Hospital Setting

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### Objective

Quality management (QM) in healthcare ensures high standards of patient care and operational efficiency. Digital quality management manuals (QMMs) centralize guidelines and protocols to streamline workflows and enhance compliance. However, QMMs are underutilized in routine practice, often due to usability barriers. This study investigates QMM usage patterns, identifies obstacles, and suggests strategies for improved adoption.

#### Methods

A mixed-methods approach was used. Quantitative data on QMM usage were collected over two years using Matomo, analyzing metrics like visits, actions, and search queries. Statistical tests included ANOVA and t-tests. Qualitative data were obtained via semi-structured interviews with diverse healthcare staff to explore usage behaviors, barriers, and potential improvements.

### Results

The QMM was accessed an average of 64 times per month, with usage peaking during audit periods (e.g., 117 visits in June 2023, p = 0.011). Monthly actions averaged 775, peaking at 1,835 in May 2023 (p = 0.018). Document downloads averaged 207 per month but rose significantly during audits, with 553 downloads in January 2022 (p = 0.015). Search queries averaged 24 per month, with the majority focused on standard operating procedures (45%) and administrative forms (39%). Despite a six-year implementation and rigorous external (four annually) and internal (one annually) audits, qualitative interviews revealed key barriers: inefficient search functionality, complex navigation, and limited awareness of the QMM's content. Staff frequently relied on alternative resources, such as colleagues or internet searches, due to these challenges. While some participants used the QMM weekly or daily, others reported rare or no use, reflecting variability in engagement. The qualitative analysis emphasized the need for a more intuitive user interface, natural language search capabilities, and regular training programs to increase staff engagement and usability.

### Conclusion

Despite rigorous certifications, QMMs are primarily used for audits rather than daily clinical workflows. Addressing usability and awareness issues can improve QMM integration, supporting standardized processes and better patient care. Future efforts should explore AI and other advanced technologies to optimize functionality and adoption.

### P258

Weniger ist mehr: Verringerung des ökologischen Fußabdrucks in der Neurochirurgie durch Optimierung von Instrumentensieben Less is More: Reducing the Neurosurgical Eco-Footprint through Optimization of Operating Instrument Sets

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### Objective

The healthcare sector significantly contributes to environmental pollution. Hospitals in Germany generate 6 kg of waste per patient per day. Operating rooms (ORs) are among the most resource-intensive hospital units, producing 24.5 kg CO<sub>2</sub>e per neurosurgical case. While sterilization processes are essential for infection control, they substantially impact carbon emissions and costs. This study quantifies the environmental and financial benefits of streamlining neurosurgical instrument sets.

### Methods

A comparative process-based analysis was performed on two cranial surgery sets (Full Set: 130 instruments, 10.864 kg; Streamlined Set: 70 instruments, 5.703 kg). A Gate-to-Gate Life Cycle Assessment (LCA) quantified CO<sub>2</sub> emissions from cleaning, desinfection and sterilization, including energy, water and detergent use. Costs analyzed included resource consumption, instrument purchasing, sterilization, and labor expenses

### Results

Reducing instruments in a single operating set by 46% decreased the annual carbon footprint by 0.84 to 0.88 metric tons of  $CO_2e$  and annual costs by  $\leq 248,400 - \leq 258,600$ . A staff survey reported 88.9% satisfaction, confirming no compromise in procedural efficiency.

### Conclusion

Optimizing neurosurgical instrument sets reduces carbon emissions, resource use, and costs without compromising efficiency. Annual carbon savings equate to the planting of 40 trees, highlighting the need for sustainable practices in neurosurgery.

### P259

Periphere Nervenstimulation – unsere Erfahrungen mit dem drahtlosen Hochfrequenz-System *Peripheral Nerve Stimulation – Our Experiences with the Wireless High-Frequency System* 

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### Objective

PNS using wireless systems offers a potential alternative to IPG implantation. This approach has the potential to reduce the risk profile of treatment and improve overall quality of life

### Methods

From 1/21-10/24, 21 patients (7m,14f) were treated in our clinic with a wireless system for PNS. It is implanted under local anesthesia, guided by ultrasound, through a Tuohy needle puncture. All patients had chronic pain (8-90, mean 44 mo) and had previously undergone multimodal pain therapy. The underlying causes of pain were previous surgeries in 8 patients, trauma in 9, and nerve tumors in 3 patients. The nerves targeted for stimulation included: ulnar, peroneal, tibial, median, infrapatellar, medial cut. nerve of the forearm, and occipital nerve. Preoperatively, all patients reported neuropathic pain NRS 10-7/10 (mean 7.9/10)

#### Results

Pain reduction was achieved in 17/21 patients (NRS 8 - 4/10; mean 5.2/10), and 14/21 patients experienced a reduction in medication or a complete stop. However, no positive effect was observed in 3 patients with partial nerve transplants, despite correct pain area coverage. 19/21 patients would choose PNS again, but even patients with negative outcomes generally supported the attempt at therapy. Stimulation was applied twice daily for approximately 30 min in most patients (16/17). No infection or wound healing problems were reported in any patient.

### Conclusion

PNS, particularly for sites far from the nerve root, has rarely been an option due to the need for extensions and the bridging of joints. More invasive therapies, were often preferred. This procedure, due to its simple application, is a viable option for patients with pain clearly linked to the territory of a specific nerve. However, in patients with prior partial nerve transplants, this peripheral stimulation seems to be ineffective, despite correct coverage of the pain area.

### P260

Periphere Nervenstimulation – Erfahrungen mit der Stimulation peripherer Nerven als eine neue Therapieoption bei chronischen neuropathischen Schmerz.

*Neuromodulatory peripheral stimulation – Experiences with pain stimulation of the peripheral nerve as a new treatment option for chronic neuropathic pain* 

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### Objective

A common cause of peripheral neuropathic pain syndrome is a peripheral nerve lesion. With a new technology for stimulating a damaged nerve that has only been available since 2017, very good, long-term pain reduction can be achieved.

### Methods

In the period from 2018 to 2024, 26 patients were surgically treated with a peripheral pain electrode on the peripheral nerve. This is a new technological innovation with an active component in the electrode. This is implanted on the nerves. The energy supply and stimulation takes place externally via the skin.

### Results

In 16 (61,5%) of 26 patients, a pain reduction of 70% was achieved. In 5 patients, a pain reduction of 50% was achieved and in 2 (7,7%) of the patients at least 30%. In 3 patients, no pain reduction was observed (non-The for responders). need pain medication was reduced by 58%. Conclusion: The new technology of peripheral pain stimulation represents a very good therapy option in the treatment of neuropathic chronic pain originating from a nerve. With a narrow indication and careful preoperative diagnostics, unusually high therapeutic success rates can be measured.

### Conclusion

The new technology of peripheral pain stimulation represents a very good therapy option in the treatment of neuropathic chronic pain originating from a nerve. With a narrow indication and careful preoperative diagnostics, unusually high therapeutic success rates can be measured.

### P261

### Chirurgie peripherer Nerventumoren in Deutschland: Daten aus dem multizentrischen Register für periphere Nerventumoren (PNTR)

Peripheral Nerve Tumor Surgery in Germany: Data from the Multicentric Peripheral Nerve Tumor Registry (PNTR)

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#### Objective

Peripheral nerve tumors are rare and diverse. They often mimic other pathologies and lead to misdiagnoses with potential iatrogenic nerve damage. This study evaluates peripheral nerve tumors and rare lesions based on data from five centers in Germany and one in Austria, establishing one of the largest registries worldwide.

#### Methods

The Peripheral Nerve Tumor Registry includes 467 surgically treated patients. Data analysis covered demographics, histopathology, tumor locations, surgical strategies, and pre- and postoperative outcomes. Tumors were categorized as benign (Group 1), malignant (Group 2), and rare (Group 3).

### Results

The average patient age was 48 years (range: 10–88), with 50.5% female. Group 1 (79%) predominantly included schwannomas (n=271, mean age 49.7 years), neurofibromas (n=73, 43.7 years), and hybrid nerve sheath tumors (n=28). Group 2 (6%) primarily comprised malignant peripheral nerve sheath tumors (n=20, 45.6 years). Group 3 (14%) included perineuriomas (n=25), hemangiomas (n=4), lymphangiomas (n=2), and other rare entities (mean age 31.3 years). The most frequent tumor locations were the brachial plexus (13%), median nerve (12%), and sciatic nerve (12%), with rare tumors more common in the median and sciatic nerves. Schwannomas were often fully resected with favorable outcomes. Malignant and rare tumors required advanced microsurgical techniques, including open biopsies, partial resections, epineurotomy, nerve grafting, or end-to-end suturing. Preoperative symptoms included stress-related pain (75%), rest pain (33%), motor deficits (21%), and sensory deficits (36%). Postoperatively, pain decreased to 21%, while motor and sensory deficits initially slightly increased to 27% and 47%, respectively, before improving to 21% and 31%. Group 2 patients exhibited worse outcomes, with persistent pain (47%), permanent paresis (53%), and sensory deficits (70%) compared to Groups 1 and 3. Group 1 showed the best recovery, while Group 3 had intermediate results.

### Conclusion

While benign tumors yield favorable surgical outcomes, malignant and rare tumors necessitate complex surgical interventions. Despite initial increases in postoperative deficits, most were transient, and patients experienced significant pain relief and functional improvement. These findings highlight the importance of early surgery, even before neurological deficits occur, and precise surgical strategies tailored to each tumor type to optimize outcomes.



Abb. 2



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### P262

Einfluss von laborchemischen und radiologischen Parametern auf die klinische Präsentation und das Outcome von chirurgisch behandelten Patienten mit einem primären Hirnabszess Influence of laboratory and radiographic parameters on the clinical presentation and outcome of surgically treated patients with primary brain abscesses

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### Objective

Brain abscesses are potentially life-threatening. Most studies analyzed heterogenous cohorts including postsurgical/posttraumatic abscesses or patients receiving conservative treatment only. This study aimed to evaluate the clinical presentation and postoperative outcomes in a homogeneous group of patients with primary, pyogenic brain abscesses who underwent surgical intervention.

### Methods

We retrospectively analyzed consecutive patients with pyogenic brain abscesses who were surgically treated at our center between 2008 and 2023. The primary endpoint was a modified Rankin Scale (mRS) score of  $\geq$  3 at discharge. Secondary endpoints included preoperative disturbance of consciousness (DOC), defined as a Glasgow Coma Scale (GCS) score of < 13, and preoperative clinical status (mRS  $\geq$  3). We statistically correlated clinical, radiological (including 3-D volumetric assessments of the abscess and surrounding edema), and microbiological parameters to the endpoints.

### Results

60 patients were included in the study. Of these, 22 (36.7%) underwent open surgery, while 38 (63.3%) had pus aspiration through navigated burr holes with catheter placement. Eighteen patients presented with an mRS score of  $\geq$  3 upon admission. Elevated leukocytes were identified as risk factor for poor preoperative status (p=0.007). Six patients had unfavorable short-term outcomes (mRS  $\geq$  3), two of whom died. Risk factors for unfavorable outcomes included preoperative DOC (p=0.012) and elevated C-reactive protein levels (CRP) (p=0.002). Patients with poor outcomes had a longer length of stay in the intensive care unit (p=0.001). Abscesses in patients with unfavorable outcomes tended to be closer to the ventricles (mean distance of 3 mm vs. 11.42 mm, p=0.086) and larger (37.4 ml vs. 16.1 ml, p=0.065). Other radiological parameters did not influence the pre- and postoperative status.

### Conclusion

Preoperative DOC and elevated CRP levels were significant predictors of unfavorable outcomes and elevated leukocytes were identified as risk factor for poor preoperative status.

### P263

Einfluss verschiedener Erreger auf die radiologische und klinische Präsentation sowie das Ergebnis der chirurgischen Behandlung von Patienten mit primären Hirnabszessen Influence of different pathogens on the radiographic and clinical presentation as well as the outcome of surgically treated patients with primary brain abscesses

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### Objective

Brain abscesses are a severe condition with high morbidity and often poor outcomes. Existing studies often analyze heterogeneous patient populations without focusing on the clinical course of specific pathogens. This study aimed to compare the radiographic, clinical presentations, and outcomes of different pathogens isolated from surgically treated patients to identify pathogen-specific features.

### Methods

A retrospective study was conducted on consecutive patients with primary pyogenic brain abscesses who underwent surgical treatment at our center between 2008 and 2023. We analyzed demographic data, medical records, clinical progression, and imaging studies. The primary endpoint was defined as poor clinical status at hospital admission, defined by a modified Rankin Scale (mRS) score of  $\geq$ 3. We statistically correlated different isolated pathogens with clinical, radiological (including 3-D volumetric assessments of the abscess and surrounding edema) and laboratory parameters.

### Results

Sixty patients (36.7% female, mean age  $48.5 \pm 20.8$  years) were included in the study. Pathogens were isolated in 88.3% of cases (53/60), more frequently in patients with mRS  $\geq$  3 (100% vs. 83.3%, p=0.1). Streptococci were the most common pathogens (38.3%), followed by Fusobacterium spp. (10%), and 30% had multiple pathogens. Patients with Fusobacterium spp. had the highest rate of poor preoperative clinical status (50%), followed by mixed infections (33.3%) and streptococci (30.4%). Streptococci were linked to higher CRP levels (p=0.04). Fusobacterium spp. was associated with larger edema volumes (p=0.037), increased midline shift (p=0.023), and closer proximity to the ventricles (p=0.025). No differences were found in abscess volumes (p=0.053) or location (p=0.5) by pathogen type.

### Conclusion

Our findings suggest pathogen-specific characteristics in brain abscesses. Abscesses caused by Fusobacterium spp. showed larger edema volumes, closer proximity to the ventricle, and poorer preoperative clinical status. Understanding these features could help optimize antibiotic treatment, even when no pathogen is isolated. Larger studies are needed to identify additional features that may be hidden by the small sample size.

### P264

Gripagain – Entwicklung einer mobilen Anwendung (App) für das Handfunktionstraining nach einer Nervenoperation Grip again - Development of a mobile application (App) for hand function training post-nerve surgery

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### Objective

The recovery of hand function following nerve surgeries is a critical aspect of rehabilitation significantly influencing patients' quality of life. Sensory and motor deficits of the hand can impair grasping ability and fine motor skills. It is self-evident that intense and targeted training can help quicker rehabilitation of these functions. This project had the aim to develop a mobile application designed to facilitate hand function training post-nerve surgery. The application incorporates evidence-based exercises and progress tracking to enhance patient engagement.

### Methods

The App was developed using Flutterflow as the front-end framework and Firebased as the back-end. Data security was ensured throughout the development process. A total of 21 exercise videos were integrated. The app was compared to other existing rehabilitation apps in terms of user-friendliness and content. It was also evaluated by 20 participants using a standardized questionnaire.

### Results

The results indicate that the app is competitive in terms of user-friendliness and functionality; however, there is potential for further optimization, particularly in the customization of treatment plans and in fostering long-term user motivation.

### Conclusion

Grip again represents an important step in the digital development of rehabilitation medicine

Abb. 1



### P265

Bedeutung des D-Dimer-Plasmaspiegels im Hinblick auf die Früherkennung tiefer Beinvenenthrombosen und Lungenarterienembolien nach neurochirurgischen Operationen Significance of d-dimer-level for early diagnosis of deep vein thrombosis and pulmonary embolism after neurosurgical procedures

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### Objective

This study aims to evaluate the relevance of postoperative D-dimer-plasma-levels three days after neurosurgical procedures in the early detection of venous thromboembolism with the objective of reducing severe surgery-related morbidity. Further investigations focused on spinal or cerebral surgeries while this study includes both groups.

### Methods

A retrospective single-center data analysis was conducted on 510 patients who underwent a neurosurgical procedure in 2023. Postoperative d-dimer-plasma-levels were compared between patients with and without postoperative venous thromboembolism and potential differences between different types of surgical procedures were also analyzed. The study also examines whether the cutoff-value of 8,2 µg/ml, measured on the third postoperative day, is suitable for this purpose, as recommended by Inoue et al. in 2018.

### Results

Venous thromboembolism was diagnosed in ten out of 510 patients. Of those, four patients underwent spinal surgery, five patients had cranial procedures and one patient underwent a different type of neurosurgical intervention. Six patients had d-dimer-levels exceeding 8,2  $\mu$ g/ml while in four patients D-dimer-levels remained below this cutoff value.

### Conclusion

Postoperative measurement of D-dimer-levels may serve as a valuable method for the early detection of venous thromboembolism. Adjusting cutoff- values and a detailed analysis of individual patient risk factors, e.g. duration of immobilization, usage of pneumatic anti-thrombosis tools, could further enhance diagnostic accurancy and prevention. Further studies are necessary to confirm this finding.



Abbildung 6: Verteilung D-Dimer-Werte VTE-negativ (n=500) und VTE-positiv (n=10). Eigene Darstellung.





Abbildung 8: D-Dimer-Konzentrationswerte der VTE-positiven Gruppe (n=10). Eigene Darstellung 2024.

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### P266

Die Rolle von Dexamethason während verschiedener Behandlungsphasen bei Glioblastomen: Erkenntnisse iner retrospektiven Analyse The Role of Dexamethasone During Treatment Phases in Glioblastoma: Insights from a Retrospective Observational Study

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### Objective

Glioblastoma is the most aggressive primary brain tumour and is often associated with severe perifocal oedema. Corticosteroids such as dexamethasone (DEX) are used to counteract this oedema. However, the impact of DEX on overall survival (OS) and progression-free survival (PFS) at different stages of treatment has not been well studied.

#### Methods

We conducted a single-centre retrospective study to analyse the impact of DEX on OS and PFS in GBM patients in the pre-operative, post-operative and adjuvant treatment phases. Data were collected from 106 patients treated between 2016 and 2020. Survival outcomes were analysed using Kaplan-Meier estimates and Cox proportional hazards models, with cut-off analyses to determine thresholds for DEX dosing in each treatment phase.

#### Results

Preoperatively, DEX showed a trend towards improved OS and PFS (HR: 0.998, p = 0.379 for OS; HR: 0.998, p = 0.373 for PFS). Postoperatively, DEX had a positive effect on OS (HR: 0.995, p = 0.017) and PFS (HR: 0.995, p = 0.029). However, in the adjuvant setting, DEX appeared to have a potentially negative effect on OS and PFS (HR: 1.001, p = 0.258 for PFS), suggesting an increase in risk. Group comparisons in the adjuvant setting showed that patients who did not receive DEX had a better OS (17.9 months vs. 6.4 months, p < 0.001) and PFS (9 months vs. 4.6 months, p = 0.007). The exploratory determination of cut-off values showed that a DEX dose of at least 60 mg preoperatively (OS: 4.9 months vs. 9.4 months, p = 0.007) and up to 140 mg postoperatively (OS: 6.3 months vs. 10.8 months, p = 0.039) and less than 40 mg during adjuvant therapy (OS: 5.8 months vs. 15.9 months, p = 0.0003; PFS: 4.6 months vs. 9 months, p = 0.007).

#### Conclusion

DEX administration has a different effect on OS and PFS depending on the treatment phase. Higher doses in the pre- and postoperatively are associated with better survival, while higher doses during adjuvant therapy correlate with a worse outcome. Careful dosing of DEX is critical in the treatment of GBM. This highlights the need for cautious use of corticosteroids and further studies to determine optimal dosing strategies.

### P267

Zusammenhang zwischen der kumulativen perioperativen Dexamethasondosis und dem Gesamtüberleben bei Patienten mit primärem Glioblastom

# Association of Cumulative Perioperative Dexamethasone Dose with Overall Survival in Primary Glioblastoma Patients

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### Objective

Dexamethasone (dexa) is administered perioperatively in glioblastoma (GBM) patients to alleviate neurological deficits caused by perifocal edema. This study examines the association between cumulative perioperative dexa dosage and overall survival (OS) in patients with primary GBM, incorporating key prognostic covariates to account for potential confounding factors.

### Methods

We conducted a retrospective analysis of 189 patients with primary IDH1-wildtype GBM at a single center, focusing on the 13-day perioperative dexa dosing surrounding primary tumor resection. Statistical analyses using R, employing the 'survminer' and 'survival' packages. Maximally selected rank statistics (Maxstat) identified optimal cut-off values for cumulative total dexa doses, categorizing patients into low (<84mg), medium (84–260mg), and high (>260mg) dose groups. Kaplan-Meier survival analyses and multivariable Cox proportional hazards models assessed the independent association of dexa dosage with OS, adjusting for confounders such as sex, age, MGMT promotor methylation status, tumor-/edema volume, ventricular contact, midline shift and adjuvant therapy.

### Results

Low-dose therapy was administered to 19%, medium-dose to 66.7%, and high-dose to 14.3% of patients. Kaplan-Meier analysis demonstrated a significant survival advantage for the low- and medium-dose groups compared to the high-dose group (median OS difference of 5.5 months). Lower doses were independently associated with improved OS, with hazard ratios (HR) of 0.46 [95% CI:0.23–0.91] (p=0.026) for low-dose group and 0.55 [95% CI:0.35–0.91] (p=0.013) for medium-dose group. Independent of established prognostic factors such as ventricular contact, sex, MGMT status and irrespective of adjuvant treatment, lower doses showed an improved impact on OS.

### Conclusion

Consistent with previous studies we show that lower cumulative perioperative dexa doses are associated with improved OS in GBM patients. Whether this is attributable to potential adverse effects of dexa or other contributing factors needs to be evaluated in a prospective study.

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Fig.1: Maximally selected rank statistic identifying two optimal statistical cut-off values for the dexa dose

Tbl.1: Multivariable Cox models illustrating independent influence of various covariates on OS

Abb. 1



### Abb. 2

Characteristic	HR <sup>1</sup>	95% Cl <sup>1</sup>	p-value
perioperative dexamethasone			
> 260 mg	007 80	-	
84mg – 260 mg	0.55	0.35,0.88	0.013
< 84 mg	0.46	0.23,0.91	0.026
tumor volume			
> 21cm <sup>3</sup>			
< 21cm³	0.6	0.35,1.02	0.058
Edema volume			
> 110cm <sup>3</sup>	<u>8</u>	-	
< 110cm <sup>3</sup>	1.07	0.61,1.89	0.8
ventricular contact			
yes	2		
по	0.63	0.4,0.98	0.038
midline shift			
yes			
no	0.85	0.51,1.43	0.5
sex			
female	Ē		
male	1.54	1.02,2.31	0.039
age	1.01	0.99,1.03	0.4
MGMT			
methylated	÷		
non-methylated	2.5	1.58,3.96	<0.001
adjuvant therapy			
STUPP or CeTeG	111 20		
Perry or Nordic	2.11	1.29,3.46	0.003
No therapy	6.07	2.52,14.6	<0.001

<sup>1</sup> HR = Hazard Ratio, CI = Confidence Interval

### P268

Neurochirurgische Eingriffe bei Patienten mit soliden Organtransplantationen Cranial procedures in solid organ transplanted patients: monocentric clinical experience

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### Objective

Neurosurgical procedures in solid organ transplant patients pose significant challenges due to immunosuppression, comorbidities, and complex pathologies. Despite the growing number of such patients, clinical data related to cranial procedures in this fragile patient population remain limited.

#### Methods

Data from 57 organ transplanted patients were reviewed between 2007 and 2024, analyzing complications, outcomes, and risk factors, with a median follow-up of 6.4 years. Patients were categorized by the type of transplant: kidney: 54.4%, liver: 26.3%, lung: 14%, heart: 8.8%.

#### Results

Mean age at surgery was 49 years (range 1–74 years). There were a total of 81 neurosurgical procedures, including craniotomies (n=49) and burr-hole trepanations (n=29). The indications for the surgery were intracranial hemorrhage (35.1%), tumor (30%), infections (12.3%), hydrocephalus (5.3%), cerebral infarction (3.5%), and others (14%). Kidney transplant patients most commonly had intracranial hemorrhage (45.2%) and infections (22.6%). Liver recipients frequently presented with tumors (46.7%) and intracranial hemorrhage (20%). Lung recipients showed high rates of intracranial hemorrhage (62.5%) and infections. Postoperative complications were observed in 70.2 % of the patients. The most frequent issues were infections (31.6%), with pneumonia being particularly common (28.1%). Systemic complications such as renal failure (22.8%), respiratory insufficiency (15.8%), and anemia (15.8%) were also documented. Postoperative neurological deficits were observed in 15.8% of patients, and seizures in 17.5% of them. Thirty-day postoperative mortality was 22.8%, with infections and severe brain injury related to the primary pathology accounting for the majority of deaths. Long-term outcomes varied significantly depending on the neurosurgical diagnosis and the comorbidities.

#### Conclusion

Organ transplant recipients undergoing neurosurgical procedures face a high risk of postoperative complications and mortality. Tumors and intracranial bleeding are common surgical indications, with significant variability in outcomes based on the type of transplant and the neurosurgical pathology. This study highlights the need for personalized perioperative management to reduce risks in this vulnerable population in highly specialized medical centers.

### P269

### Management postoperativer Hygrome nach intraaxialer Tumorresektion mit Ventrikeleröffnung Management of postoperative hygroma after intraaxial tumor resection with ventricular opening

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### Objective

When performing extensive, intraaxial tumor resections, opening of the ventricle and thereby creating a connection between the resection cavity and the ventricles sometimes might not be preventable. Some patients develop postoperative hygromas. Optimal management of these hygromas, i.e., necessity and timing of a surgical intervention, have not been determined yet.

#### Methods

In this single-center, retrospective study, patients having undergone craniotomy and intraaxial tumor resection between 2018 and 2023 were included. Operative reports and imaging data were screened for intraoperative opening of the lateral or third ventricle. Patients in which an opening was confirmed were then evaluated for development of postoperative hygroma (I), subsequent therapy strategies (II) as well as clinical and imaging outcome (III).

### Results

Overall, 608 patients having undergone intraaxial tumor resection were screened. Ventricular opening was reported in 224 patients (37%) and 89 patients (15%) subsequently developed a postoperative hygroma. Of these patients, 27 underwent surgical intervention for hygroma evacuation, i.e., burr hole trepanation (n=7), ventriculo-/subduroperitoneal shunt implantation (n=13) or open revision (n=7). A complete or near complete remission was observed in 17 patients (63%) having undergone surgical intervention. Within the non-intervention cohort (n=62), 38 patients (61%) showed complete or near complete remission (p=0.99). When looking at patients with hygromas measuring >1 cm, a remission was seen in 11/18 patients (61%) having undergone hygroma evacuation and in 5/13 patients (39%) in the non-intervention cohort (p=0.29).

### Conclusion

Postoperative hygroma is a common phenomenon after surgical opening of the lateral or third ventricle. These hygromas show a high rate of spontaneous partial or complete remission, while surgical intervention might be warranted in symptomatic hygromas measuring > 1cm.

Abb. 1



### P270

Rückkehr zur Arbeit nach chirurgischer Resektion von Hirnmetastasen: Eine Studie zur beruflichen und gesellschaftlichen Reintegration

# Return to work following surgical resection of brain metastases: a study on professional and societal reintegration

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### Objective

Patients with brain metastases (BMs) face advanced stages of cancer. While survival is primarily determined by systemic tumor burden, neurosurgical resection aims to reduce neurological morbidity and support patients in maintaining or regaining functional independence and active participation in daily life. Returning to work serves as a key indicator of successful reintegration into social and everyday life. This study examines the rate at which patients return to work following surgical resection of BMs and evaluates the extent to which employment was resumed.

### Methods

All consecutive patients aged 60 years or younger who had undergone surgical treatment for BMs between 2015 and 2020 at the authors' neuro-oncological center were included to represent individuals of working age. Clinical data were systematically collected, including preoperative work status, the proportion of physical versus sedentary work, education level, and return-to-work status. Data were stored and analyzed using SPSS (Version, 27, IBM Corp.). Overall survival (OS) rates were analyzed with the Kaplan-Meier method using GraphPad Prism software (Version 9.4.1, GraphPad Software).

### Results

Of 348 patients who underwent surgical treatment for BMs, 130 (37.3%) were under 60 years old. Work history data were available for 31 patients in this cohort, with 59.3% engaged in physically demanding jobs. Post-surgery, 14 patients (45.1%) returned to work, with 11 (78.5%) resuming their previous profession, 4 in full-time and 7 in part-time roles. Three patients transitioned to different professions, with 1 in full-time and 2 in part-time employment. The main reasons for returning to work were financial necessity (28.5%) and the desire for distraction and maintaining a daily routine (71.4%). Overall survival (OS) rates were 34 for patients who achieved professional reintegration compared to 8 months for the entire cohort (p= 0.01).

### Conclusion

This study suggests that a significant proportion of patients may return to work after BM surgery. The importance of distraction and maintaining daily structure was evident among patients. Given the critical role of preserving functional and social independence, even in the context of limited life expectancy associated with BMs, efforts should consider supporting workforce reintegration as part of comprehensive post-surgical care.

### P271

Lebensqualität von Patienten mit niedriggradigen Gliomen in Abhängigkeit von der adjuvanten Therapie nach der Operation: Ein Projekt aus dem LoG-Glio-Register *Quality of life in low grade glioma patients based on adjuvant treatment after surgery: A project from the LoG-Glio Registry* 

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### Objective

Quality of life (QoL) is a critical consideration for patients undergoing adjuvant treatment, especially with the availability of novel therapeutic options and the typically prolonged course of low-grade glioma (LGG). This study analyzed differences in outcomes between the "wait-and-scan" approach and conventional treatment options in LGG patients using data from the LoG-Glio Registry.

### Methods

A total of 183 patients with IDH-mutated grade 2 and 3 diffuse gliomas were evaluated for QoL using the EORTC C-30 and BN-20 questionnaires over 48 months post-surgery. Multivariate linear mixed model analysis was conducted to identify differences between observation and adjuvant treatment groups.

### Results

QoL data were available for all 183 patients. Overall QoL scores (EORTC C-30) were significantly lower in patients receiving adjuvant treatment during the first 6 months post-surgery compared to those in the wait-and-scan group (59.4 vs. 70.0; p = 0.005). Symptom scores were also significantly higher at 6 months in the adjuvant treatment group (27.1 vs. 15.7; p = 0.007) and showed a trend toward significance at 12 months (22.8 vs. 15.9; p = 0.055). While mean symptom scores remained elevated in the treatment group up to 36 months, no significant differences were observed after 12 months. Functioning scores showed no significant differences between the groups at any time point during the 48-month follow-up period. Figure 1

### Conclusion

Adjuvant treatment for LGG was associated with a temporary decline in QoL and an increase in symptom burden during the first year post-surgery. However, both QoL and symptom scores improved over time, ultimately reaching comparable levels between treatment and observation groups in the long term.




### P272

Intramedulläre Glioblastommetastasen: Eine systematische Übersicht und Überlebensanalyse Intramedullary spinal metastasis from glioblastoma: a systematic review and survival analysis

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### Objective

Intramedullary spinal metastasis from glioblastoma is an uncommon condition with limited documentation and significant management challenges.

### Methods

A systematic literature search from 2004 to 2024 was conducted. Survival analysis was performed, considering the influence of factors including patient age, sex, surgery for primary tumor, treatments for the primary tumor, surgery for spinal metastasis, treatments for spinal metastasis interact with metastatic time (MT), progression-free survival (PFS), metastatic survival (MS) and overall survival (OS).

### Results

Thirty-one studies comprising 36 patients, aged 11 to 75 years from 19 countries/regions, were included in the analysis. The median survival for the cohort was 17 months (95% CI = 9–25). Kaplan-Meier subgroup analysis revealed that treatment of the primary tumor had a significant impact on MT (log-rank, P < 0.0001). For PFS, surgery (log-rank, P = 0.029) and treatments for spinal metastases (log-rank, P = 0.006) were significant influencers. Similarly, surgery (log-rank, P = 0.008) and treatments for spinal metastases (log-rank, P = 0.009) significantly affected MS. Overall survival was significantly influenced by treatments for the primary tumor (log-rank, P < 0.0001) and surgery for spinal metastases (log-rank, P = 0.04). Univariate Cox regression analysis demonstrated that surgery combined with chemotherapy for metastases (HR = 0.18, 95% CI = 0.04–0.80) conferred a significantly improved MS compared to the non-surgical group. Multivariate Cox regression further identified surgery for spinal metastases (HR = 0.27, 95% CI = 0.08–0.96) as an independent predictor of MS as well as revealed male sex (HR = 0.33, 95% CI = 0.12–0.88) and surgery for spinal metastases (HR = 0.20, 95% CI = 0.06–0.66) were associated with improved OS.

### Conclusion

Intramedullary spinal metastasis from glioblastoma is challenging to manage. Prophylactic imaging screening for patients with primary glioblastoma with aggressive genetic features might be beneficial. Surgical resection of metastatic tumor was beneficial.

### P273

Vergleich der subjektiven Erfahrung zwischen den anästhesiologischen Verfahren SAS (asleep-awake-asleep) und MAC (monitored anesthesia care) während einer Wachoperation *Comparison of subjective experiences between the anesthesiological procedures SAS (asleep-awake-asleep) and MAC (monitored anesthesia care) during awake brain surgery* 

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### Objective

Awake craniotomy (AC) with functional brain mapping is a standard approach for the resection of eloquent brain tumors. Two main anesthetic techniques are commonly employed: "asleep-awake-asleep" (SAS) and "monitored anesthesia care" (MAC). SAS involves general anesthesia during non-awake phases, while MAC utilizes conscious sedation, allowing for spontaneous ventilation without invasive airway devices. Both techniques are effective and safe, but information on patient experiences is lacking. Here, we compare the subjective experience of patients managed by SAS vs. MAC.

### Methods

We performed a postoperative telephone survey in all patients who underwent AC for eloquent brain tumors at the University Medical Center Freiburg between October 2018 and April 2024. SAS was employed between 10/2018 and 11/2023 and MAC was used thereafter. The third part of the Beez protocol and the EuroQol EQ-5D-VAS were delivered to assess patient-reported intraoperative experience and current quality of life. Surgical times were assessed.

### Results

34 of 40 patients were available for telephone interview. The SAS protocol was used in 17 patients and MAC in 17. 82% of patients managed with SAS vs. 12% managed with MAC were female (p=0.001), other baseline parameters were balanced. No significant differences between SAS and MAC were found in the 6 items of the Beez protocol and the EuroQol EQ-5D-VAS. Surgical times were significantly shorter for MAC: Door to door 365  $\pm$  55 min vs. 449  $\pm$  41 min (p = 0.0014).

### Conclusion

SAS and MAC protocols for awake surgery of eloquent brain tumors are highly accepted by patients and comparable experiences and QoL are reported. Surgical times were shorter with MAC management.

### P274

Hämangioblastome des Hypophysenstiels beim von Hippel-Lindau-Syndrom: Langzeitbeobachtungen zu Charakteristika und Spontanverlauf über die letzten 25 Jahre Pituitary stalk hemangioblastomas in von Hippel-Lindau disease: Long-term observations on characteristics and natural history over the last 25 years

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### Objective

Hemangioblastomas of the central nervous system are associated with von Hippel–Lindau syndrome (VHL) in 20–25% of cases. Suprasellar localization at the pituitary stalk is very rare (<1%) and is mainly described in case reports of surgical treatment for symptomatic lesions carrying a rather high risk of endocrinological or ophthalmological morbidity. The current study describes characteristics and natural history of pituitary stalk hemangioblastomas in a large VHL cohort.

### Methods

All VHL patients with pituitary stalk hemangioblastomas presenting for VHL screening examinations in our specialized center during the last 25 years were included in this retrospective monocentric study. Clinical and radiological findings at initial diagnosis and during natural history were analyzed.

### Results

The cohort included six VHL patients (50% male) with pituitary stalk hemangioblastomas, of whom five showed contact with the optic chiasm. All tumors were solid without cystic components and rather small (initial diagnosis: mean maximum diameter: 4.7 mm, mean volume: 31 mm^3). The mean age at initial diagnosis was 34.5 years. None of the patients suffered from endocrinological or ophthalmological symptoms. One patient had undergone previous external beam radiation therapy, and he remained asymptomatic and without progression during his follow-up period of 8.7 years. Among untreated patients, 80% showed tumor progression during the mean observation period of 11.1 years, without development of new endocrinological or ophthalmological symptoms. At last follow-up, the mean maximum diameter was 6.3 mm and the mean volume was 106.3 mm^3.

### Conclusion

Pituitary stalk hemangioblastomas in the VHL cohort were found to be rather small, solid lesions that tend to grow extremely slow during long-term observation. Based on their benign natural history, a wait-and-scan strategy seems to be preferable for the management of these lesions, monitored by regular imaging, as well as ophthalmological and endocrinological check-ups. If treatment is required, therapeutic options should be evaluated on an individual basis by interdisciplinary teams, and surgical therapy ought to be considered primarily in specialized centers.

### P275

### Die Auswirkung der Claudin-1-Expression auf die Invasivität von Hypophysentumoren The Impact of Claudin-1 Expression on Pituitary Tumor Invasiveness

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### Objective

Pituitary neuroendocrine tumors (PitNets) are often curable by complete surgical resection. However, a subset of these tumors exhibits invasive behavior, complicating complete removal. However, the mechanisms underlying this invasive phenotype remain poorly understood. We propose that downregulation of Claudin-1, a key cell adhesion molecule, may contribute to the pathophysiology of invasive pituitary macroadenomas, highlighting its potential role in tumor invasiveness.

### Methods

Tissue samples were prospectively collected from 120 patients with invasive or noninvasive PitNETs. Peripheral and central tumor regions were analyzed for Claudin-1 expression and Ki-67 index. Tumor invasiveness was assessed by radiological evaluation using the Knosp score and corroborated by intraoperative observations and histological reports.

#### Results

Among the 120 PitNETs, 70 were non-functioning (53.9% invasive), 34 were acromegaly (34.6% invasive), 7 were Cushing adenomas, and 10 were prolactinomas (both 5.8% invasive). The mean age was 51 years (range: 18–86), with a male-to-female ratio of 1.2:1, and a mean tumor volume of 5.4 cm<sup>3</sup>  $\pm$  6.1 cm<sup>3</sup>. Total resection was more common in non-invasive PitNETs than in invasive PitNETs (58% vs. 30.8%, p = 0.005).

Intraoperative and/or histological invasiveness of PitNets was inversely correlated with Claudin-1 positivity (p = 0.03). Peripheral Claudin-1 expression negatively correlated with higher Knosp Grades (III-IV, p = 0.04). Specifically, for Knosp Grades 0-II, peripheral Claudin-1 positivity was (+) in 27.3%, (++) in 31.8%, and (+++) in 40.9% of cases, whereas for Knosp Grades III-IV, Claudin-1 positivity was (+) in 51.4%, (++) in 35.1%, and (+++) in 13.5%. Higher peripheral Claudin-1 positivity was associated with a greater likelihood of complete tumor resection, with 40.9% of Claudin-1 (+++) and 31.8% of Claudin-1 (++) tumors completely resected, compared to 46.7% of Claudin-1 (+) tumors that underwent incomplete resection (p = 0.03). No significant difference in tumor volume was observed concerning Claudin-1 positivity (p = 0.46).

### Conclusion

Claudin-1 expression was found to be inversely associated with the invasiveness of pituitary macroadenomas, highlighting its role in cell-cell adhesion. These findings underscore the potential significance of Claudin-1 as a biomarker for invasive behavior in PitNETs. Further studies with larger cohorts are warranted to evaluate its impact on clinical outcomes and explore its potential as a therapeutic target.

### P276

Operative Resektion von rezidivierenden Hypophysenadenomen – eine retrospektive monozentrische Studie Surgical Resection of recurrent pituitary adenomas – a retrospective single center study

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### Objective

Although endoscopic endonasal transsphenoidal surgery (EETS) is a very effective and safe procedure for the treatment of pituitary adenoma (PA), tumor recurrence may occur in 10-20% and growth of residual tumor may be encountered in 12-58%. Endoscopic re-operation is a meaningful treatment option, but data regarding effectiveness and complication rate is scare and will be analyzed in this study.

### Methods

Based on our prospectively maintained perisellar tumor database (2009-2025), which includes 400 patients with PA, we identified patients with recurrent or growing residual PA, who underwent EETS for re-treatment. Three months postoperative MRI was used to assess any residual tumor tissue. Complication rate was analyzed up to 30 days postoperatively.

#### Results

46 patients were analyzed (16 female [34.8%], 30 male [65.2%]). Age ranged from 29 to 80 years (median 61 years). Surgery was performed between 5 and 248 months after primary EETS. 13 patients (28.3%) suffered from recurrent tumor and 30 patients (65.2%) from growing residual tumor. 29/46 patients underwent three-dimensional (3D-E-surgery; 63.04%) and 17 patients two-dimensional endoscopic surgery (2D-E surgery; 36.96%). In 33 patients (71.7%) residual tumor was found on postoperative following recurrent EETS, mainly in the parasellar (41.3%) space. Especially patients with a preoperative Knosp grade  $\geq$  2 were found to have residual tumor (Knosp grade 2: n= 7, 22.58%; Knosp grade 3 & 4: n=11 each, 35.48%). An improvement in visual acuity was observed in 9/23 patients (39.1%) and visual field in 10/24 cases (41.7%). Postoperative complications occurred in 7 patients (15.2%), mainly in the 3D-E group (n=6,1%). The most common postoperative complications were nasal bleeding (n=3, 6.5%) and cerebrospinal fluid fistula (n=2, 4.3%). A new postoperative anterior lobe deficiency occurred in 10 (21.7%) and a new diabetes insipidus in 4 (8.7%) patients.

#### Conclusion

EETS is a safe and effective treatment option for recurrent and growing residual PA. Overall complication rate is low, but postoperative pituitary insufficiency and CSF fistula may be encountered.

### P277

Radiomics zur Differenzierung von Hypophysenadenomen und Metastasen: Eine Pilotstudie Radiomics for Differentiating Pituitary Adenomas from Metastases: A Pilot Study

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### Objective

Pituitary metastases are rare, comprising 0.14% to 3.6% of all intracranial metastases, yet they pose a significant life-threatening risk to patients. Frequently, they are misdiagnosed radiologically as pituitary adenomas, and are confirmed only through histopathological analysis. This pilot study aimed to assess the feasibility of radiomics in distinguishing sellar metastases from adenomas preoperatively.

### Methods

MRI scans of 16 pituitary adenomas and 7 metastases were included, the latter representing all cases identified in our cohort since 2011. Data preprocessing was performed in Python using SimpleITK, incorporating bias field correction and intensity standardization via the N4ITK filter. Tumor segmentation was conducted in 3D Slicer 5.6.2, with radiomics features extracted using PyRadiomics. Intrarater reliability was evaluated using the intraclass correlation coefficient (ICC) and coefficient of variance (CV). Features with CV >10% were excluded, leading to a dataset of 528 radiomics features for final analysis. One adenoma and one metastasis case were excluded due to >50% of features having CV >10%, resulting in a final analysis of 8 adenomas and 6 metastases with 528 radiomics features.

### Results

Statistical analysis (Mann-Whitney U test) identified several significant discriminators between adenomas and metastases. Shape features such as sphericity (p < 0.0001) and surface-to-volume ratio (p = 0.0032) were the most distinctive. First-order features demonstrated strong discriminative power, with energy (p < 0.0001) and 10th percentile (p < 0.0001) showing the greatest differences. Texture features, including zone entropy (p = 0.0022) and run entropy (p = 0.0398), also provided valuable insights. Wavelet-transformed features further enhanced discriminative power, particularly in metrics like sphericity (effect size = 3.03) and energy (effect size = 2.89).

### Conclusion

These findings underscore that both morphological and textural characteristics differ significantly between pituitary adenomas and metastases, suggesting radiomics can support non-invasive differentiation. Key features included shape metrics, first-order statistics, and wavelet-transformed texture features, with sphericity and energy emerging as the most robust discriminators.

### P278

Anfallsfreiheit durch SEEG-geführte Thermokoagulation bei medikamenten-resistenter fokalen Epilepsie infolge eines hypothalamischen Hamartoms: ein Fallbericht Seizure freedom achieved with SEEG-guided thermocoagulation in drug-resistant focal epilepsy from a hypothalamic hamartoma: a case report

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### Objective

Hypothalamic hamartomas (HH) are a recognized cause of structural epilepsy, often presenting as refractory epilepsy with limited pharmacological treatment options. Due to the localization of HH, surgical approaches carry significant risks, making them less viable. Evaluating HH as a source of epileptogenic activity during invasive presurgical diagnostics, such as stereo-EEG (SEEG), poses additional challenges. This case report describes the treatment of a patient with HH and refractory focal epilepsy using SEEG-guided radiofrequency thermocoagulation (SEEGgRFTC) as a minimally invasive, awake procedure.

### Methods

We present the case of a 26-year-old male with drug-resistant focal epilepsy due to a left-sided hypothalamic hamartoma classified as type 2 according to the Delalande classification. Depth electrodes (Dixi Medical) were utilized for SEEG evaluation and SEEGgRFTC. Seizure outcomes were assessed using the ILAE classification system.

### Results

The patient had a history of epilepsy since the age of 11. The MRI revealed a non-contrast-enhancing lesion, approximately 0.7 cm in diameter, in the left hypothalamus, consistent with the morphology of a HH. Video-scalp EEG diagnostics localized an epilepsy focus frontocentrally. An interdisciplinary decision was made to perform invasive EEG monitoring, which was performed without complications. SEEG confirmed HH as the source of epileptogenic activity, with two medial contacts of an electrode implanted in the HH showing focal epileptogenic discharges. Based on these findings, SEEGgRFTC was successfully performed on the identified contacts without perioperative complications. Post-interventional an MRI confirmed the desired iatrogenic lesion within the HH. At six months follow-up the patient remains seizure-free (ILAE Class 1).

### Conclusion

SEEG has long been established in epilepsy surgery for invasive evaluations. Combining SEEG with SEEGgRFTC represents a promising, minimally invasive, and safe treatment option for refractory focal epilepsy caused by distinct localized epileptogenic lesions such as HH. Nonetheless, the limitations imposed by lesion size must be carefully considered when selecting candidates.



Figure 1 MRI of the hypothalamic hamartoma with outlined trajectory of the SEEG-electrode

### Abb. 2



Figure 2 SEEG recordings depicting the focus of epileptogenic activity on medial contacts of SEEG electrode implanted within the hypothalamic hamartoma

### P279

# Tractotraphie unter dem Mikroskop: Eine Systematic Review und Meta-Analyse der Diagnostischen Güte intraoperativer Traktographie

# Tractography under the microscope: A diagnostic test accuracy systematic review and meta-analysis of intraoperative tractography

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#### Objective

Tractography of the corticospinal tract is routinely employed for neurosurgical planning and navigation. Its accuracy has been evaluated through direct electrical stimulation of motor fibres but has not yet been quantitively summarised. This systematic review and meta-analysis sought to synthesise the accuracy of tractography, with a focus on comparing diffusion tensor imaging (DTI)- and fibre orientation distribution (FOD)-based tractography approaches.

#### Methods

Four databases (MEDLINE Ovid, Embase Ovid, Web of Science, CENTRAL) were systematically searched on 01.10.2024. Studies were included if they were (1) cross-sectional studies that (2) had adult (18+) participants with motor-eloquent pathologies undergoing surgery, (3) performed intraoperative mapping of the corticospinal tract, (4) compared stimulation sites with tractography, and (5) reported measures of test accuracy, e.g., sensitivity and specificity. Risk of bias was assessed using the QUADAS-2 tool. Data were analysed using a fixed-effects logistic regression model to derive pooled effect estimates of sensitivity and specificity of DTI- and FOD-based tractography.

#### Results

Sixteen studies met the inclusion criteria (670 patients in total). 14 studies employed DTI- and 4 employed FODbased tractography. For DTI-based tractography, sensitivity ranged from 25%-100% and specificity from 55.6%-100%. For FOD-based tractography, sensitivity ranged from 36%-79% and specificity from 77%-98%. Due to incomplete data reporting, pooled estimates for sensitivity and specificity could only be calculated for DTI-based tractography based on 6 studies using a fixed-effect logistic model (sensitivity: 84.45% (95% CI: 0.8118, 0.8724); specificity: 89.11% (95% CI: 0.7188, 0.9632)). For FOD-based tractography, none of the 4 included studies reported the 2×2 contingency tables required for meta-analysis, preventing the estimation of pooled sensitivity and specificity. Clinically, 10 studies reported motor outcomes, though the time of postoperative testing varied: 1 study reported a decrease, 6 a preservation, and 3 an improvement in motor function at follow-up.

### Conclusion

Overall, incomplete reporting prevented a quantified comparison of DTI- and FOD-based tractography. However, there is an indication that FOD-based tractography may be superior to DTI-based tractography in terms of sensitivity and specificity in a clinical setting. Future studies evaluating multiple tractography approaches within one setting are recommended.

### P280

Innovation im intraoperativen Ultraschall: Elastische Fusion für präzisere und anwenderfreundlichere Anwendung in der Neurochirurgie. Advancing Intraoperative Ultrasound in Neurosurgery: Elastic Fusion for Enhanced Accuracy and Usability

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### Objective

Brain shift during tumor surgery can compromise neuronavigation accuracy. Intraoperative ultrasound (iUS) provides real-time updates, but non-navigated iUS use is challenging for inexperienced surgeons. We investigated the accuracy and clinical feasibility of various iUS-MRI image fusion techniques emphasizing the benefits of elastic fusion (vMRI) in addressing brain shift and improving usability.

### Methods

Forty-seven patients undergoing brain tumor surgery were prospectively enrolled. 3D iUS was acquired using a navigation system (Ultrasound Navigation, Brainlab AG). A quality score based on landmark visibility, continuity, and overall image quality, was used for iUS stratification. Data with score  $\leq 2$  were selected for analysis. Three fusion methods were applied retrospectively: initial registration, rigid automatic fusion (Elements Image Fusion Snap-to-MRI, Brainlab AG)), and elastic image fusion (prototype version of Elements Virtual iMRI, i.e. vMRI) to calculate individual Target Registration Errors (TREs) and compare their accuracy. Factors potentially influencing iUS quality were analyzed using ANOVA and Pearson's correlation.

### Results

The mean TREs were 5.18 mm for initial registration, 2.98 mm for rigid automatic, and 3.03 mm for elastic image fusion. Paired t-tests revealed significant differences between initial registration and both rigid automatic (p = 0.014) and elastic automatic image fusion (p = 0.014). No significant difference was observed between the two advanced fusion algorithms, indicating that both rigid automatic and elastic image fusion techniques exhibit comparable performance under the tested conditions (p = 0.893). Rigid automatic fusion yielded the highest overall accuracy, while elastic image fusion showed superior performance in cases with pronounced brain shift and lower iUS quality scores. Analysis revealed that key factors influencing iUS quality included tumor characteristics, surgical access, and artifacts such as calcifications or edema.

### Conclusion

Elastic image fusion may represent a valuable tool for guiding resections, especially in challenging cases and for surgeons with less iUS experience. Further investigation of clinical determinates affecting iUS quality is crucial for optimizing the use of iUS and elastic image fusion to maximize the benefits of this technology.



Figure 1 Two representative patient datasets used for navigation update by means of automatic rigid MR-US image fusion. The anatomical landmarks retrospectively determined in each image set show improved image co-registration accuracy of intra-cranial structures with mean target registration errors.

#### Abb. 2



Figure 2 Representative patient dataset used for navigation update by means of automatic rigid (top row) and elastic (bottom row) MR-iUS image fusion. Initial rigid alignment of MRI and iUS data acquired after resection is required to support elastic image fusion resulting in a 3D deformation vector field (visualized by arrows showing greatest magnitudes in voxels beneath the resection cavity).

### P281

### Alterabhängige Veränderungen der Konfiguration der sylvischen Fissur Age-dependent changes of the Sylvian fissure configuration

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### Objective

To investigate age-related morphological changes of the Sylvian fissure (SF) and their implications for neurosurgical procedures.

### Methods

A cohort of 150 individuals across the age groups 10-20, 40-50 and 80-90 years was analyzed using Brain Lab software for 3D visualization and volumetric analysis of the SF and various brain regions (Fig. 1). We compared SF volumes between age groups and investigated dynamic changes in SF configuration over time. Correlation analyses were performed to identify how atrophy in specific brain regions affects the SF volume and configuration.

### Results

Atrophy was evident in all measured regions of the brain. The frontoparietal lobe underwent the strongest atrophy while the occipital lobe showed the least. Each age group exhibited a consistent distribution of lobe volumes, although a marginal decrease in frontoparietal lobe proportion was observed in the groups of higher age. The annual atrophy rate in the frontoparietal and temporal lobes was steady. Additionally, brain volume showed a correlation with SF volume (r=-0,66) (Fig. 2). A consistent increase in SF volume in relation to the intracranial volume was observed across all age groups, with a notable increase in SF volume in older patients. This expansion, especially at the anterior-superior point, might be influenced by gravity, cerebral elasticity, and lobe torque.

### Conclusion

Our investigation highlights the significance of age-dependent changes in SF volume and configuration due to brain atrophy throughout life. These changes, influenced by physical factors, underscore the need for tailored surgical approaches. Additionally, brain pathologies affecting volume could significantly alter SF configuration.



Fig. 1 The figure illustrates the segmentation of the SF negative. The initial SF segmentation demonstrates some imprecision, highlighted by the area outlined in red. In a second step, the cerebrum was segmented using Brainlab's automatic segmentation tool. By utilizing Brainlab's subtraction method, the negative was determined with precision. The final SF segmentation is visualized in beige. For a better understanding, the anatomical relation of the SF to other segmented brain structures is shown in the right part of the figure.

Abb. 2



Fig. 2 Displays a correlation analysis between the brain and SF, revealing a robust Pearson coefficient of r = -0.66. Abbreviations: BV: Brain Volume; SFV: Sylvian fissure volume ICV: Intracranial volume

### P282

Die Mikrozirkulation des Sehnervs und die Reproduzierbarkeit der intraoperativen visuell evozierten Potenziale. *Microcirculation of the optic nerve and the reproducibility of intraoperative visual evoked potentials.* 

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### Objective

Understanding the arterial vascularization of the cranial optic nerve (ON) and its relationship to visual function is crucial for decompression surgeries of the nerve. Currently, intraoperative visual evoked potentials (ioVEP) are used to assess nerve function, but the reliability and reproducibility of this method remain questionable. Our study aims to demonstrate the limitations of ioVEP in predicting visual outcomes.

### Methods

Nine patients with unruptured aneurysms of the anterior circulation of the circle of Willis were selected for this study, all of whom had normal pial support of the optic nerve (ON), confirmed utilizing MRI. These patients underwent aneurysmal clipping for aneurysms located in the anterior circulation. Intraoperatively, indocyanine green (ICG) was administered at 0.2 mg/kg through peripheral vein access, following a rapid injection of 10 ml of 0.9% NaCl after clipping. A software flow analysis (Flow 800 software, Kinevo/Pentero, Carl Zeiss Co.) was used to assess the results. The intervals between the first appearance of ICG in the internal carotid artery (ICA) and the pial circulation of the ON, as well as the time to full saturation of both, were measured. Intraoperative visual evoked potentials (ioVEP) were applied during all surgeries.

### Results

9 patients were included in the study. Among them, 2 had clipping for MCA aneurysms, 6 for Acom or ICA aneurysms, and 1 for a p-com aneurysm. Delayed P100 on the ipsilateral optic nerve was observed in 88% (8/9 cases: mean for the MCA aneurysms 5±2.82 ms, for the ACI and A-com 7.9±13.58ms, p < 0.05). No significant time difference was noted between the ICA and the ipsilateral optic nerve at the peak maximal intensity of the ICG substance. The absence of relevant clinical visual impairment following elective clipping of the aneurysms supports the assumption of normal pial circulation in the optic nerve, which contradicts the prolonged P100 observed during the surgery.

### Conclusion

During surgeries of the anterior skull base, ioVEPs tend to be prolonged. Their reliability depends on several factors. More studies need to be conducted under normal conditions to determine the implications.

### P283

Referenzwerte für intraoperative Multikanalaufzeichnungen Visuell Evozierter Potentiale Reference values for intraoperative Visual Evoked Potentials obtained by multichannel recordings

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### Objective

Visual evoked potentials (VEP) are used for the intraoperative assessment of the visual pathways. For standard recording, occipital electrodes (O3, O4, Oz) are referenced to central (Cz), frontal (Fz) or linked earlobes (A1/A2). In neurosurgical procedures, where incision and craniotomy interfere with these electrode placements, intraoperative reliability could be reduced. We studied parietal electrode placements and compared those with the standard setting.

### Methods

We prospectively studied 137 eyes in 73 patients (36f; 55  $\pm$  15 years) who underwent surgery for 8 parietal, 6 parieto-occipital, 15 occipital, 4 temporal, 12 sphenoidal wing, 7 Sella/planum sphenoidal tumors and 21 other locations. Right and left eyes were stimulated seperately with a red flashlight emitting LED-diode (<10.000 Lux, 2.1 Hz frequency, Inomed Co., Germany). Multichannel recordings were as follows: parietal electrodes (P3, P4), Oz, O3, O4 each referenced to Pz, Oz and Cz, and O3-O4, electroretinogram (ERG) for control (bandpass filter of 10-1000 Hz, 70-100 averages, epoch length of 200 msec). Latencies and amplitudes of the N1, P1 and P2 responses (being defined as N1 as the first negative, P1 as the first positive, and P2 as the second positive peak) were analysed for right and left eyes and compared for each recording montage. Absolute and relative success rates, mean value, standard deviation and variance were determined.

### Results

VEPs were elicited in 128/137 eyes. The success rate was highest for PzFz (85%), OzFz (80%) OzPz (83%) and O3O4 (78%). Overall, when Pz and Oz served as active electrodes VEP could be recorded in 83%, O3 and O4 in68% and P3 and P4 in only 43%. Showing normal distribution of all right and left eyes (Shapiro-wilks-test), grand-average was performed. Overall, N1-mean was 73.5±12.9msec, P1 96.1±17.1 msec and for N2 121.3±26.5 msec Overall, N1-mean was 73.5±12.9msec, P1 96.1±17.1 msec and for N2 121.3±26.5 msec with high inter-individual variability (variance > 180), but not intra-individual (variance <50 for N1 and P1).

### Conclusion

We could demonstrate that the standard occipital electrodes are optimal for recording of VEPs. However, parietal electrodes can be considered as an alternative and increase the reliability of intraoperative VEP application. The influence of visual field deficits and tumor location on recordability need to be addressed in future studies.

### P284

Charakterisierung der hämodynamischen Antwort bei Multispektraler Intraoperativer Optischer Bildgebung von Sprachfunktionen mittels Fourier-basierter Phasenauswertung und Wavelet-Analyse Characterization of the hemodynamic response in multispectral intraoperative optical imaging of speech functions using Fourier-based phase evaluation and wavelet analysis

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### Objective

Intraoperative Optical Imaging (IOI) is a technique that is able to visualize functional areas of the cerebral cortex. Recently we have shown that the technique can be applied during awake surgery for language mapping but results with existing data analysis frameworks were too unspecific to be useful for surgical guidance. Here, we are presenting a new approach with multispectral image acquisition and in-depth analysis of recorded hemodynamic response signals to optimize the method in the future.

### Methods

Data from four patients (2 male, 2 female, median age 38) undergoing tumor resection in speech eloquent regions was acquired and analyzed. Imaging was performed using a customized multispectral imaging setup, allowing the simultaneous assessment of light wavelength bands that are sensitive to oxy- and deoxyhemoglobin as well as to changes in cerebral blood volume. Patients performed speech tasks (silent speech object naming) over 9 minutes with alternating 30 second rest and stimulation trials. After IOI, language mapping with DCS was performed to identify speech eloquent areas. The resulting imaging data was analyzed with a wavelet transformation to identify and characterize the frequency content of the signals especially in those speech eloquent regions of the cortex.

### Results

The results from the wavelet analysis are revealing that besides the actual stimulation frequency component (0.0167 Hz) and vasomotor components, especially the bands directly adjacent to the stimulation frequency are also represented with a high magnitude within the measured IOI signal. The magnitude of the stimulation frequency component is peaking in all 4 patients around 6 - 7 minutes after the beginning of the stimulation paradigm. Activity (phase) maps created from frequency bands adjacent to the stimulation frequency component are in all 4 patients in good agreement to intraoperative language mapping results with DCS.

### Conclusion

Overall, the findings are suggesting that optimization of IOI for the identification of speech eloquent areas during surgery is possible. Shifts in the measured frequency component might be a result of deviations from the actual task. Here, the silent speech protocol might be improved by haptic feedback for supervision of correct task execution. Further investigations are mandatory.

### P285

Identifizierung feinster Gewebeeigenschaften mithilfe hochentwickelter quantitativer MRT-Analysen bei Patienten mit pharmakoresistenter Temporallappenepilepsie Identification of subtle tissue properties using advanced quantitative MRI in drug resistant temporal lobe epilepsy patients

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### Objective

Despite neurosurgical advances, seizure recurrence after temporal epilepsy surgery remains a challenge, especially in patients, where the epileptogenic zone extends beyond the temporal lobe, e.g., into the piriform cortex and insula. Accurate definition of the epileptogenic zone is crucial for determining the extent of resection. This study uses quantitative MRI (qMRI) to characterize tissue microstructure (e.g., MTsat for myelin and mean diffusivity for inflammation) in the epilepsy network. We aim to assess how quantitative MRI can refine resection planning and improve surgical outcomes.

### Methods

In an explorative study design, two pilot patients with drug-resistant left temporal lobe epilepsy were included. Both underwent amygdalohippocampectomy and temporal pole resection. Preoperatively, a one-hour quantitative MRI protocol was performed on a 3T Prisma-fit system, including advanced diffusion imaging, relaxometry and myelin-water imaging. We explored left-right differences across clinically relevant "target" regions: hippocampus, temporal pole and amygdala, as well as the insula. Preprocessing steps were followed by the calculation of parameters such as MTsat (myelin marker), mean diffusivity (MD), and proton density (PD).

### Results

Histological findings revealed reactive CNS tissue in the grey matter (patient 1) and hippocampal sclerosis with discreet reactive gliosis in the amygdala (patient 2). Both patients suffered non-motor-onset seizures with emotional or sensory-autonomic phases. qMRI data confirmed the asymmetry in the areas shown on conventional MRI that are targeted in surgery (amygdala, temporal lobe). Interestingly, the insula showed a hyperintensity in MD and left-right differences in MTsat in the first patient, indicating reactive changes not detected by conventional MRI.

### Conclusion

The data show left-right differences in the temporal structures and the insula, suggesting pathological changes consistent with histological findings. Especially the findings in the insula were not visible on conventional MRI but are suspected to be part of the epilepsy network extending beyond the temporal lobe. This advanced quantitative MRI approach may enable differentiated predictions and visualizations of functional tissue properties (epileptogenic and irritative zones). The data from the two pilot patients demonstrate feasibility, but the hypotheses need to be further tested in a larger cohort.

#### Asymmetry in "target" regions



Abb. 2

Insular asymmetry in patient 1





### P286

Vergleich des ergonomischen Aspekts von Exoskop und Mikroskop in der Neurochirurgie unter Verwendung von Bewegungssensoren

Comparing the ergonomic aspect of the Exoscope and Microscope in neurosurgery using motion sensors

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### Objective

Providing better ergonomics for neurosurgeons in the operating room is crucial to minimizing musculoskeletal disorders, particularly during prolonged procedures. Traditional microscopes, with their limited range of motion (ROM), often force surgeons into uncomfortable positions, especially when operating on patients with challenging anatomy or widespread lesions. This study compares neurosurgeons' posture and handling of exoscope versus microscope in comparable cases, using mixed-method models and sensor-based movement measurements.

### Methods

Fifty-five cases from 2021 to 2024 were analyzed: 27 with a microscope (Carl Zeiss Meditec AG, Jena, Germany) and 28 with an exoscope (Sony Olympus Medical Solutions inc., Tokyo, Japan). Data included task-load index, fatigue score, manual camera/ocular adjustments and subjective assessments of posture. Sensor-based movement measurements were available for 29 cases, using inertial measurement units (IMUs) to evaluate neck posture and movement smoothness. Due to interference from the microscope"s electric field, neck rotation angles were excluded. Univariate analysis was used to compare outcomes.

### Results

The task-load index showed similar results between modalities. Fatigue scores were lower in the exoscope group (36.85% vs. 46.24%), though not statistically significant (p=0.170). Camera adjustments were more frequent with the exoscope (35.4 vs. 26.4 per procedure). Subjective assessments indicated milder posture angles with the exoscope, but without significant differences (p=0.505). IMU data revealed no significant differences in neck inclination (p=0.820), neck bending (p=0.524), or movement smoothness (p=0.256).

### Conclusion

The exoscope group reported lower fatigue scores and subjectively milder posture angles, suggesting ergonomic benefits, although measured differences were not statistically significant. The higher frequency of camera adjustments with the exoscope combined with lower fatigue scores, highlights its potential ergonomic advantages due to higher ROM, which may improve further with greater familiarity and experience.

### P287

Curtain-Fall"-Technik zur Verhinderung der Liquorfistel nach der Operation eines chronischen subduralen Hämatoms

Curtain-Fall Technique for Cerebrospinal Fluid Leak Prevention After Chronic Subdural Hematoma Surgery

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### Objective

Chronic subdural hematoma (CSDH) is a prevalent condition in neurosurgical practice that often necessitates urgent surgical intervention, particularly in cases of neurological deterioration. Various surgical techniques for CSDH evacuation have been described in the literature. Based on our clinical experience, the use of an external drainage system is pivotal in preventing recurrences. Recently, we introduced and published a simple surgical technique designed to prevent cerebrospinal fluid (CSF) leakage after subdural drainage removal. Here, we provide an update on our patient series.

### Methods

In this technique, the periosteum is harvested during surgery prior to hematoma evacuation. The harvested periosteum is sutured to the uncut lateral edge of the dura mater, positioned adjacent to the exit site of the Jackson-Pratt subdural drainage catheter. After the catheter is removed, the periosteal flap, partially secured by sutures, naturally falls over and seals the dural hole, effectively preventing CSF leakage. This method facilitates natural closure of the dural defect and enhances wound healing without requiring additional procedures.

### Results

The "curtain-fall" technique was successfully implemented in 23 patients undergoing CSDH evacuation and subdural drainage removal. None of the patients experienced postoperative CSF leakage.

### Conclusion

We describe a novel and effective technique for achieving dural closure that significantly reduces the risk of postoperative CSF leakage following subdural drainage removal. While specifically developed for CSDH cases, this approach can be adapted for use in other surgical procedures involving subdural catheter placement.

### P288

Umgekehrte Concorde-Lagerung für gleichzeitige endoskopische Drittventrikulostomie und hintere Schädelgrube-Operationen: Technische Aspekte und Klinische Ergebnisse Reverse Concorde Position in concomitant Endoscopic Ventriculostomy and Posterior Fossa Surgery: Technical aspects and clinical results

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### Objective

Hydrocephalus (HCP) has been playing a primary or secondary role in many neurosurgical diseases since ancient times. Endoscopic third ventriculostomy (ETV) has become first-line treatment for a number of both chronic and acute HCP conditions, especially when the cerebral aqueduct is affected. Regarding the latter, neurosurgeons are often confronted with (sub)acute posterior fossa lesions (PFL), requiring decompressive or resective surgery. In the perioperative period there might exist insecurity about patency of the CSF pathways, necessitating specific treatment with diversion. We propose a new operative position: the Reverse Concorde Position (RCP) – "raising the nose during the flight" – with a case series of PFL surgery with concomitant ETV, obviating the need for other CSF diversion.

### Methods

We initially position the patient semisitting (SS) with Trendelenburg (T) modification to enable a coronal approach and paying attention to neuronavigation. After completing the ETV, the patient is raised to a SS anti-T position with the same sterile draping for suboccipital/retromastoid surgery. We retrospectively analyzed RCP cases that were performed in our department from 1 Januar to 31 December 2024. Patients with ETV and PFL as separate procedures were excluded from further examination.

### Results

In 2024 we treated 18 cases with ETV plus PFL surgery, of which seven were done on separate days and thus excluded. 11 were performed in RCP. The mean age was 65,6 year. In 73% a PFO was ruled out, in 27% cases it was unknown. There was a 100% success rate of hydrocephalus treatment, i.e. no need for further postoperative CSF diversion, no clinically relevant venous air embolism and zero mortality. Two patients required reoperation (cerebellar hemorrhage and cerebritis). One developed meningitis.

### Conclusion

We propose our two-staged treatment in a single RCP, combining the well-known advantages of SS position with the success of ETV - while potentially saving time. Implementing RCP in a department might so contribute to effective management of both urgent and elective PFL cases.

### P289

Die Rolle der Knochendeckelexplantation in der Behandlung von postoperativen Wundheilungsstörungen nach elektiver Kraniotomie The role of bone flap removal in the treatment of postoperative wound healing disorders following elective craniotomy procedures

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### Objective

This study investigates whether the permanent removal of the bone flap during surgical treatment for postoperative wound healing disorders following elective craniotomy reduces the risk of recurrent wound healing complications.

### Methods

A multicenter, retrospective analysis was conducted across two university hospitals and two tertiary care facilities, using electronic medical records. Patients were categorized into two groups: those undergoing revision surgery with permanent bone flap removal and those where the bone flap was re-implanted. Propensity score matching was applied to account for potential confounders, including age and frailty score. A total of 160 patients were included in the analysis. Patient demographics, surgical interventions, imaging findings, and microbiological data were assessed. The primary outcome was the recurrence of wound healing disorders after initial revision surgery. Predictors of recurrence were evaluated using Cox regression analysis. All statistical analyses were performed using SPSS.

### Results

A significantly higher recurrence rate of wound healing disorders was observed in patients with re-implanted bone flaps (72%) compared to those with permanently removed bone flaps (27%) (p = 0.014). Cox regression analysis identified two significant predictors of reduced recurrence: a hospital stay of fewer than 11 days following the initial revision surgery (the median value) (HR = 0.488 [CI: 0.257–0.922]; p = 0.027), and radiological evidence indicating subcutaneous involvement of the affected tissue only (HR = 0.454 [CI: 0.256–0.808]; p = 0.007).

### Conclusion

Findings from this propensity-matched multicenter cohort suggest that permanent removal of the bone flap during surgical revision for cranial wound healing disorders significantly lowers the risk of recurrence. This reduction is likely attributable to the bone flap serving as a potential microbial reservoir that impedes effective wound healing.

### P290

### Der wasserdichte Duraverschluss in der neurochirurgischen Praxis: Ergebnisse einer Umfrage in der D-A-CH-Region

### The Watertight Dural Closure in Neurosurgical Practice: Results of a Survey in the D-A-CH Region

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### Objective

The objective of this study was to investigate the importance and interpretation of watertight dural closure among neurosurgeons in the D-A-CH region. The survey explored definitions, closure techniques, suture materials, and the perceived influence of dural closure on operative costs and duration.

#### Methods

A survey was designed by seven neurosurgeons, each with more than 25 years of professional experience, and distributed to neurosurgeons across Germany, Austria, and Switzerland. The survey included 120 participants (13% female, 87% male) with the following age distribution: 10% under 35 years, 27% between 36-45 years, 23% between 46-55 years, 30% between 56-65 years, and 10% above 65 years. Questions focused on the definition of watertight dural closure, suture preferences, verification methods, and perceived impact on costs and operative time.

#### Results

Definitions of watertight dural closure varied among respondents: 11% equated it with gapless adaptation without needle entry-point gaps, 4% accepted gaps up to 5 mm, 10% allowed gaps up to 2 mm, and 75% defined it as gapless adaptation with acceptable needle entry-point gaps. If a dural substitute was necessary to achieve gapless adaptation, the most commonly suggested method was an autologous galea-pericranium graft. Additionally, when further sealing of the dura was required, a fibrin patch with or without liquid sealant was selected in most cases (>90%). Suture materials were evenly distributed among monofilament, braided, absorbable, and non-absorbable types. The most commonly used suture thickness was 4/0 (55%). Verification methods included the Valsalva maneuver (most common), subdural irrigation, and dry swab inspection. A majority of respondents indicated that watertight closure did not significantly affect operative costs or duration.

### Conclusion

This survey underscores the variability in defining watertight dural closure among neurosurgeons in the D-A-CH region. Despite diverse interpretations, the predominant technique involved gapless adaptation, with needle entry-point gaps considered acceptable by most. The use of autologous grafts or fibrin patches reflects common practices for enhancing closure. Importantly, watertight closure was not perceived as a factor influencing operative costs or time. These findings suggest the need for a consensus on defining and standardizing techniques for watertight dural closure.

### P291

### Seltene Manifestation eines primären intraduralen extraossären Ewing-Sarkoms: Ein Fallbericht und Literaturübersicht

Rare Presentation of Primary Intradural Extraosseous Ewing's Sarcoma: A Case Report and Literature Review

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### Objective

Ewing's sarcoma, an aggressive malignancy typically affecting bones in children and adolescents, rarely manifests as an intradural extramedullary mass, mimicking more common spinal tumors. This case report highlights the extreme rarity of primary intradural extraosseous Ewing's sarcoma (IEES).

### Purpose

To contribute to the limited body of knowledge on primary intradural extraosseous Ewing's sarcoma by presenting a unique case.

### Methods

A 40-year-old female patient presented with rapidly deteriorating lumboischialgia on both sides and diffuse paresthesia in both legs, without bowel or urinary sphincter disturbances or motor deficits. MRI identified intradural tumors at the L4 level. Gadolinium-contrast T1-weighted MRI revealed diffusely enhanced signals for the tumor lesion in the lumbar spinal cord.

A hemilaminectomy of L4 and microsurgical tumor resection under intraoperative neuromonitoring led to improved radiculopathy, and the patient was able to mobilize on day two. Pain medication was significantly reduced.

### Results

Histopathology revealed that the tumor consisted of vascular-rich fibrous soft tissue with relatively high cell density. Immunohistochemically, there was positive S100 and Synaptophysin staining, and increased proliferation activity (Ki67). FISH testing showed EWSR1 translocation in 70 out of 100 cell nuclei. The lesion was diagnosed as primary intradural Ewing"s sarcoma. Immediate referral to medical oncology facilitated the expeditious initiation of adjuvant chemotherapy and radiation.

### Conclusion

A literature review of IEES cases shows the 1- and 5-year overall survival rates are 79.8% and 26.6%, respectively, and the 1-, 2- and 5-year progression-free survival rates are 61.0%, 52.3%, and 10.9%, respectively. Therefore, primary IEES has a poorer prognosis compared to Ewing's sarcoma of bone, highlighting the need for novel agents and treatment strategies. A broad differential diagnosis, encompassing both common benign and rare malignant lesions, is crucial for newly identified nerve root-associated tumors. Preoperative imaging may not be definitive, as illustrated by the initial suggestion of a nerve sheath tumor in this case. Ewing's sarcoma, though rare, should be considered, particularly when encountering rapidly worsening symptoms or progressive growth on imaging. Early diagnosis facilitates the prompt initiation of comprehensive oncological care, while long-term multidisciplinary follow-up is essential for monitoring disease progression.





Figure 1: Preoperative sagittal (A–C) and axial (D–E) MRI of the lumbar spine. A nodular intradural mass associated at L4 was T1 <u>hypointense</u> (A), T2 <u>hyperintense</u> (C and E), and contrast enhancing (B and D).



Figure 2: Postoperative MRI of the lumbar spine at day 1 (POD 1): sagittal (A–C) and axial (D–E). Precontrast T1-weighted (A), postcontrast T1-weighted (B and D) and T2-weighted (C and E) MRI demonstrated post-surgical changes together with interval resection of the L4–associated mass.

### P293

Ausbildung in der spinalen Chirurgie angesichts des berufspolitischen und gesellschaftlichen Wandels -Ergebnisse einer online Umfrage unter Deutsch-sprachigen Chirurgen Spine Surgery Training considering Employment and societal changes – Results of an Online Survey among German speaking Surgeons

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### Objective

In Germany, training in spine surgery is part of two different residency programs; Neuro- and orthopedic/ trauma surgery. This study was conducted to evaluate the respondents" subjective perception of their own training in this field regardless of specialty, and to identify possible demand for improvement

#### Methods

The online survey of 58 questions taken by trainees and specialists after being invited via the German Spine Society newsletter and social media, inquired involvement in spine surgery, certifications, personal and departmental surgical and technical circumstances, perception of training, experience and capabilities, scientific engagement and impact on personal life. Standard statistical methods were applied

#### Results

281 Respondents took the survey; 276 properly completed surveys were included in final analysis. Most contributions originated from Germany, Switzerland and Austria. Male surgeons accounted for 65% of responses. 58% were orthopedic/ trauma surgeons. 35% of responses were from residents, 45% in their 6<sup>th</sup>year of training. Overall, 58% reported more than 50% of their practice being in spine surgery. 60% of participants had no personal spine certification. 42% worked at a spine certified facility. Most Facilities had modern surgical equipment including microsurgery, navigation and 3D imaging. Deformity surgery, lateral approaches and neuromodulation were less common among centers. 54.5% found their training adequate, 32.5% inadequate and 13% were uncertain. The average rating of spine surgery training was 3.4/5 stars. In detail 71% reported sufficient operating room (OR) time as assisting surgeon, 53% as main surgeon. 70% blamed high workload for lack of mentoring. Online lectures and videos seem to play an important role in self-education. However, mentoring in the OR remained the major education source. Scientific engagement appears of moderate relevance, only 25% of respondents were actively involved in projects. Only 29% thought spine surgery and family are compatible. 23% abandoned spine surgery due to training conditions.

### Conclusion

With changing work and societal requirements in addition to increasing patient numbers and staff shortages, training in spine surgery is no doubt becoming more challenging. Training appears heterogenous among German speaking surgeons in this field, regardless of specialty. Despite technical advancements and contactless means of education, there is no substitute for personal OR mentoring.

### P294

Aktuelle Perspektiven zur Chirurgie spinaler duraler arteriovenöser Fisteln: Intradurale radikulomedulläre Venenokklusion oder extradurale radikuläre Arterienligatur – Erkenntnisse aus 21 Eingriffen *Current Perspectives on Spinal Dural Arteriovenous Fistula Surgery: Intradural Radiculomedullary Vein Occlusion or Extradural Radicular Artery Ligation – Insights from 21 Procedures* 

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### Objective

While microsurgical intradural occlusion of the arterialized radiculomedullary vein is a well-established approach for spinal dural arteriovenous fistula (SDAVF) tretment, the benefit of adding extradural ligation of the radicular artery remains a matter of debate. This report explores the management of SDAVF by comparing the effectiveness of intradural vein occlusion alone with its integration alongside extradural radicular artery ligation.

#### Methods

A retrospective analysis was performed on patients who underwent microsurgical occlusion of SDAVF at a single center between May 2011 and May 2024. Clinical, radiological, and intraoperative data were collected, and patients were followed prospectively. The two strategies were compared with respect to their efficacy, safety, and overall success in the postoperative follow-up period.

#### Results

A total of 21 microsurgical procedures for the occlusion of SDAVFs were performed on 15 patients (3 females, 12 males), with a mean age of 64.87 years (range: 28–83 years). The majority of SDAVFs (66.7%) were located in the thoracic region. The mean preoperative Aminoff & Logue Disability Score was 6.16. In 7 procedures (33%), a simple microsurgical intradural interruption of the radiculomedullary vein was performed. A combined intraextradural approach, integrating extradural radicular artery ligation, was utilized in 13 procedures (61.9%). Extradural ligation of the radicular artery alone was carried out in one case (4.8%). No intraoperative complications occurred. One patient required reoperative clinical improvement, regardless of the surgical technique used. Although no statistically significant differences were observed between the intradural and intra-extradural groups (Mann-Whitney U test, p = 0.47-0.86) at early postoperative intervals (up to 10 days, 1–3 months, and 3–6 months), descriptive analyses consistently indicated superior and faster clinical improvement in the intra-extradural group. Surgical occlusion of SDAVF was successfully achieved in 95.23% of cases, with an average follow-up period of 32 months, ranging from 1 to 154 months.

### Conclusion

The combined intra-extradural approach has consistently demonstrated superior clinical outcomes, in the early postoperative period, making it a comprehensive strategy for the management of SDAVF.

### P295

Therapieinduzierte Rekalzifizierung von Wirbelsäulenläsionen bei Patienten mit Multiplem Myelom Therapy-induced recalcification of spinal lesions in Multiple Myeloma patients

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### Objective

Multiple Myeloma (MM) frequently causes vertebral lesions that require treatment. Indication for surgery depends on the response to systemic therapy and radiotherapy as well as clinical factors such as spinal instability, load-dependent pain and the presence of neurological deficits. Both radiotherapy and systemic therapy can lead to bony consolidation, which can alleviate symptoms and thus avoid surgical therapy. The aim of this study is to analyse the effect of such therapies on bony consolidation by the standardized determination of Hounsfield units (HU) on serial CT examinations of the spine and to identify risk factors for a lack of such consolidation.

#### Methods

248 MM vertebral column lesions from a total of 40 patients were included in this study between 2005 and 2020. All included lesions were treated with chemotherapy and 74 lesions received additional radiotherapy. Surgically stabilized vertebral bodies were excluded. CT scans were performed both before therapy start and 3-24 months after initiation of therapy. HUs were measured in three regions of a vertebral body in a standardized fashion, whereby the cortical bone was excluded. The mean values per vertebral body were calculated and the standard deviation and differences between the groups were calculated using the Šídák multi-comparison test. A linear mixed effect model was used to analyse differences in HU with influencing factors associated with osteoporosis and oncological aspects. The significance level was set at p<0.05.

### Results

Of the 40 MM patients, 50% showed no or a minimal change in HU over 24 months observation period. At 3 months follow up, a slight decrease in HUs was observed whereas at 6-9 months follow up without being significant. A significant increase in HUs from baseline (1.4-fold increase) was first measurable at 24 months follow up (p=<0.0001, SD: 0.05458). Neither the osteoporosis associated factors age, BMI and gender nor oncological factors such as ISS, the use of bisphosphonates, stem cell transplantation and radiotherapy did significantly influence HU changes.

### Conclusion

This study shows that the recalcification of vertebral lesions of treated MM is measurable with HUs, however significant changes were first observed 24 months after therapy initiation. Predictive factors for the extent of recalzification could not be identified, therefore additional studies investigating predictive biomarkers in a bigger cohort are desirable.

### P296

Zeitaufwand der intraoperativen CT bei dorsalen Wirbelsäulenfusionen bei degenerativen Wirbelsäulenerkrankungen – eine retrospektive Analyse von 518 degenerativen Fällen *Time cost of the intraoperative CT in dorsal spinal fusion surgery in degenerative spinal disorders - a retrospective analysis of 518 degenerative cases* 

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### Objective

To evaluate the impact of intraoperative CT (ioCT)-based navigation on surgery duration, non-surgical anesthesia time, and postoperative length of stay in dorsal spinal fusion procedures for degenerative spinal disorders, while accounting for surgeon performance and other procedural factors.

### Methods

This retrospective, single-center study analyzed 518 cases of dorsal spinal fusion performed between 2013 and 2018 for degenerative spinal disorders. The use of ioCT-based navigation was recorded, along with demographic and clinical variables such as the number of screws implanted, use of cages, revision status, and surgeon performance. Surgery duration (skin-to-skin time), non-surgical anesthesia time, and postoperative length of stay were assessed using generalized linear models (GLMs). Subgroup analyses were conducted based on surgical complexity. Interobserver agreement for variable extraction was evaluated using intraclass correlation coefficients (ICC).

### Results

The mean age of the cohort was 65.67 years, with 52.5% female patients. ioCT-based navigation was used in 209 cases (40.3%). The use of ioCT added an average of 18.5 minutes to skin-to-skin time in the entire cohort and 14.3 minutes in simpler cases (4 screws or fewer), but its effect was not significant in complex surgeries (8 screws or more). ioCT also increased non-surgical anesthesia time by approximately 8 minutes across most subgroups. Surgeon performance was a significant determinant of skin-to-skin time, with high-performance surgeons completing surgeries more efficiently across all subgroups. The ioCT usage had no significant impact on postoperative length of stay. Interobserver agreement for data extraction was excellent, with an ICC of 0.95.

### Conclusion

Intraoperative CT-based navigation modestly increases surgical and procedural time in simpler spinal fusion cases but has no significant impact in complex surgeries. Surgeon performance remains a critical factor influencing operative efficiency. ioCT use did not affect postoperative hospital stay in our analysis. Further prospective studies are needed to validate these findings and assess long-term clinical and economic implications.

### P297

Chirurgische Behandlung von Frakturen der oberen Halswirbelsäule bei Patienten, die älter als 80 Jahre sind *Surgical treatment of fractures of the upper cervical spine in octogenarians* 

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### Objective

Surgical treatment of upper cervical spine injuries in elderly patients is increasing in high-income countries and poses a risk due to comorbidities, impaired general health and osteoporosis. The aim of this study was to investigate surgical outcomes in octogenarians (patients aged between 80 and 90 years) who underwent surgical treatment of C1/2 fractures compared with a younger population.

### Methods

All patients who underwent navigated dorsal stabilization of upper cervical spine trauma (C1/2 fracture) with automated intraoperative CT (iCT)-based registration at a single institution between 2016 and 2024 were retrospectively analyzed. Clinical and radiologic outcomes were compared between patients older and younger than 80 years.

### Results

A total of 61 patients underwent dorsal stabilization after a C1/2 fracture. The average age was 72.3  $\pm$  16.4 years; 31 patients (50.8 %) were 80 years and older. 40 patients had an isolated C2 fracture (five Hangman fractures, 14 Anderson D'Alonzo grade II, 19 grade III and two Wenzel type I fractures), 18 patients had combined C1 and C2 fractures and three patients had a simultaneous C2 and C3 fracture. Four patients had concomitant traumatic brain injury and three patients had vertebral artery dissection. The average surgery time was 187.6  $\pm$  54.03 minutes. All patients underwent an intraoperative registration scan and an intraoperative scan to check the screw position, and no screw misplacement occurred. Two patients suffered construction failure and had to undergo revision surgery, both in the non-octagenerian group. Two further patients in the octagenerian group underwent revision surgery for wound healing deficits. Three patients died during the follow up, two from octagenerian group. Clinical and radiological outcome did not differ between the two groups (p < 0.05).

### Conclusion

Surgical treatment of upper cervical spine trauma in elderly patients is as safe and effective as it is in the younger population. [MB1]

### P298

Prädiktoren für Revisionsoperationen nach instrumentierter Chirurgie bei pyogener Spondylodiszitis Predictors of Revision Surgery Following Instrumentation for Pyogenic Spondylodiscitis

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### Objective

There are many causes for revision surgery after instrumentation for pyogenic spondylodiscitis, including screw loosening, rod fractures, implant displacement, and the development of new deformities. These complications often result in recurrent symptoms such as pain or neurological deficits, necessitating revision surgery. This study aims to identify the risk factors associated with revision surgery following instrumented treatment for pyogenic spondylodiscitis across the lumbar, thoracic, and cervical spine.

#### Methods

retrospective analysis was performed, including patients who underwent surgery for pyogenic spondylodiscitis between 2013 and 2022. We analyzed risk factors for revision surgery excluding wound revisions. The analyzed factors were age, osteoporosis, CRP levels, epidural abscess, number of spinal levels treated, wound infection, hospital stay duration, relapse infection and screw displacement. Statistical analysis included univariate chi-square tests and multivariate logistic regression to identify significant predictors of revision surgery.

#### Results

A total of 385 patients were included (58% male, mean age 67.3±12.8). They underwent dorsal instrumentation (87%) or two-stage 360° fusion (13%) for treatment of pyogenic spondylodiscitis. Spinal epidural abscess was present in 30%, and Staphylococcus aureus was the most common pathogen (50%). Sixty-five patients (16.9%) required revision surgery. Of the revision group, 37% had robotic-assisted instrumentation, 63% used navigation, and 9% developed new neurological deficits postoperatively

Univariate Analysis: Significant factors included relapse infection (p

Multivariate Analysis: Screw loosening (OR 26.9, 95% CI 10.1-71.5, p

### Conclusion

Relapse infection and screw loosening were the most significant predictors of revision surgery. These findings emphasize the importance of surgical precision, infection control, and comprehensive postoperative monitoring to minimize revision risks. Non-significant factors highlight the variability in revision surgery and the need for tailored patient management.

### P299

Die chirurgischen Behandlung der eitrigen Spodylodiszitis: Ist ein Bandscheibendebridement notwendig? *Surgical treatment of pyogenic spondylodiscits: Is intradiscal debridement necessary?* 

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### Objective

The role of intradiscal debridement and fusion in the surgical treatment of pyogenic spondylodiscitis is under debate. For the present study we have therefore compared outcomes and complications in patients with pyogenic spondylodiscitis with vs. without discectomy/fusion.

#### Methods

Pertinent clinical and imaging data were retrospectively analyzed for 147 consecutive patients who underwent surgery for spondylodiscitis 2016-2022 after exclusion of all cases with tuberculous, fungal or secondary spondylodiscitis.

#### Results

The most common causative organism was S. aureus (38.1%). Complications requiring revision surgery were seen in 19.0%. CTCAE grade 3-5 medical complications were recorded in 19.0%. There were 9 (6.1%) in-hospital deaths and 3 months mortality was 12/103 (11.7%). There were no surgical recurrences.

Among 129 cases with single site infections (cervical: 21 [16.3%]) 84 (65.1%) had a discectomy/fusion (DF) and 45 did not (noDF). Anterior approaches were more frequently performed for kyphosis >15° (14/29 [48.3%] vs. 29/118 [24.6%], P=.012) and vertebral destruction (e.g. >25%: 18/36 [50.0%] vs.  $\leq$ 25%: 25/111 [22.5%], P<.001).

DF and noDF patients did not differ with respect to sex, age, SIRS, ASA score, admission KPI and MRC grade, microbiology findings, paravertebral abcess, location (cervical, thoracic, lumbosacral), no. of involved segments, segmental kyphosis >15°. DF surgery was performed in 9/10 (90.0%) cases with vertebral body destruction >50% (cf.  $\leq$ 50%: 75/119 [63.0%], P=NS). DF pts. had a lower Charlson comorbidity index (P=.045) and higher empyema incidence (P=.003). DF and noDF pts. did not differ with respect to treatment duration (IV antibiotics: 24.0±12.4 vs. 22.4±13.0 days, overall antibiotics: 79.4±21.8 vs. 73.3±32.1 days, hospital stay: 31.6±17.7 vs. 28.0±14.8 days; all P=NS), in-hospital deaths, 3 months mortality, and complication rates.

18 pts. had multiple site infections (noDF: 6, at least 1 DF segment: 8, all segments with DF: 4). Treatment duration, complication rates and outcomes did not vary with the surgical strategy.

### Conclusion

Treatment duration,outcomes and complication rates did not vary significantly between pts. undergoing surgery with vs. without DF. The respective patient cohorts were well balanced with respect to many clinical characteristics (possible exceptions include comorbidities,empyema incidence, and vertebral body destruction). These data suggest that intradiscal debridement may not be necessary in many spondylodiscitis cases.

### P300

Indikationen für eine Operation versus konservative Behandlung bei der Therapie von lumbalen Bandscheibenvorfällen: Eine systematische Übersichtsarbeit Indications for Surgery Versus Conservative Treatment in The Management of Lumbar Disc Herniations: A Systematic Review

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#### Objective

Lumbar disc herniation (LDH) is a leading cause of radiculopathy and low back pain, significantly contributing to global disability. Management strategies include conservative therapies and surgical intervention, yet clinical decision-making lacks standardisation, particularly in indications for surgery, optimal timing, and criteria for transitioning from conservative management.

#### Methods

This systematic review adhered to PRISMA guidelines. A comprehensive search across four databases identified studies reporting on LDH surgical indications. Nineteen studies were included, and risk of bias was assessed using the Newcastle Ottawa Scale and RoB1 tools. A qualitative synthesis was performed, with the Index of Qualitative Variation (IQV) applied to quantify variability in indications across studies.

#### Results

Imaging-confirmed nerve root compression (n=17) and severe/refractory pain (n=16) were the most consistent indications, while thresholds for sensory deficits (n=7) varied widely. Early surgery (48 hours to 6 weeks) was associated with superior recovery, particularly for mild/moderate motor deficits graded  $\leq$ MRC 3/4, achieving >90% recovery rates. Delayed surgery (>6 weeks) resulted in prolonged symptoms and poorer outcomes, especially in severe cases. Transition criteria included a patient-specific combination of failure of conservative therapy (n=11) after a most frequently 4–6-week trial, neurological progression, and worsening imaging findings. Significant heterogeneity was observed in thresholds for motor and sensory deficits, with high IQV scores for definitions of conservative treatment failure (IQV=0.98) and motor deficit (IQV=0.98).

#### Conclusion

The variability in surgical indications, timing, and decision-making underscores the lack of standardised criteria in LDH management. These findings highlight the urgent need for robust, evidence-based guidelines to improve clinical decision-making and optimise patient outcomes.



Abb. 2



Index of Qualitative Variation by Variable

845
## P301

Klinische und radiologische Analyse der anterioren zervikalen Diskektomie und Fusion in ein bis drei Etagen ohne Plattenosteosynthese: eine monozentrische Erfahrung *Clinical and radiological analysis of anterior cervical discectomy and fusion involving one to three levels without additional plate fixation: a single-center experience* 

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#### Objective

This study aimed to evaluate clinical and radiological outcomes of patients who underwent anterior cervical discectomy and fusion (ACDF) without additional anterior plate fixation.

#### Methods

A retrospective single-center analysis was conducted. Clinical outcomes were assessed by the Visual Analog Scale (VAS) scores, Neck Disability Index (NDI), and Odom's criteria. Radiological outcomes were evaluated based on changes in segmental disc height (subsidence), and Cobb angle by X-ray. Fusion was defined as a consistent distance between spinous processes.

#### Results

The study population consisted of 98 patients (mean age of 55.8 years) and a follow-up of 22.1 months. Procedures included 55 one-level, 33 two-level, and ten three-level surgeries. The study demonstrated good clinical outcome, with statistically significant reductions in NDI scores with notable improvements in VAS (p<0.001). Radiologically, we recorded a subsidence and reduction in Cobb angle of 1.6mm/2.2° in one-level, 3.8mm/3.0° in two-level, and 2.5mm/2.4° in three-level surgeries, respectively. Complete postoperative fusion was recorded for 86.7% patients, comprising rates of 87.3% for one-level, 90.9% for two-level, and 70.0% for three-level procedures. No revision surgery had to be performed.

#### Conclusion

ACDF without additional plating is an effective procedure for surgical treatment of single- and multi-level degenerative cervical disease with good clinical outcome.

## P302

Genauigkeit der navigierten Pedikelschraubenplatzierung mit robotergestützter im Vergleich zu handgeführter Schraubentechnik: eine prospektive monozentrische Studie Accuracy of navigated pedicle screw placement using robotic-assisted compared to hand-guided screw technique: a prospective monocentric study

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#### Objective

Posterior stabilization with pedicle screw-rod system +/- intervertebral cage for the treatment of degenerative spondylolisthesis (DS) has firmly established itself as a reference technique. Navigated pedicle screw placement (NPSP) represents the standard-of-care, and besides the hand-guided (HG) procedure, this can also be provided by robotic-assistance (RA). This study aims to compare the precision of these two techniques.

#### Methods

We prospectively included all patients undergoing surgical treatment for DS Meyerding Grade I from February-October 2024. Patients were dichotomized into those undergoing NPSP with HG or RA technique. We fused and metrically compared pre- and postsurgical CT images in a navigation software in a blinded fashion. Screw placement accuracy was measured by comparison of the implanted screw position with the planned trajectory by deviation in mm at the entry point in the craniocaudal (DEcc) and mediolateral plane (DEml), deviation at the screw tip in the craniocaudal (DTcc) and mediolateral plane (DTml), and angular deviation (AD) as well as by Gertzbein Robbins-System (GRS).

#### Results

We analyzed 111 screws in 28 patients (10 women, 18 men, w/m ratio 0.56, median age 61.5, range 19-78 years). 14 Patients were treated with the RA technique placing 53 screws, and 14 with the HG technique placing 58 screws overall. No differences were observed in age (p= 0.22), gender (p=0.13), BMI (p=0.97), and ASA score (p=0.88). Between implanted and planned pedicle screws, mean DEml in the RA group was  $2.6\pm1.4$  and  $2.1\pm1.2$  in the HG group, mean DTml in the RA group was  $2.7\pm1.5$  and  $2.6\pm1.6$  in the HG group, mean DEcc in the RA group was  $2.5\pm1.1$  and  $2.2\pm1.1$  in the HG group, mean DTcc in the RA group was  $2.4\pm1.3$  and  $2.1\pm1.0$  in the HG group, and mean AD in the RA group was  $3.5\pm2.2$  and  $3.4\pm2.1$  in the HG group. Altogether, there was a trend for a slightly higher screw placement inaccuracy in the RA group, with statistical significance only for the mean DEml (p=0.037). However, considering the GRS classification, in RA group 52 (96%) were Grade A and 2 (4%) Grade B and in HG group 54 (93%) were Grade A and 4 (7%) Grade B with no statistical difference between groups (p=0.46) meaning an adequate screw positioning in all cases.

#### Conclusion

Accuracy in pedicle screw placement significantly differs only regarding DEml in favor of the HG cohort. However, according to GRS all screws were placed adequately, and no intraoperative revision was required.







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## P303

#### Wirbelsäulenchirurgie bei organtransplantierten Patienten Spinal surgery in solid organ transplant patient

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#### Objective

Spinal surgery in solid organ transplant recipients is inherently challenging due to immunosuppression, multiple comorbidities, and complex pathologies. This study aims to evaluate the safety, outcomes, and complication rates of spinal neurosurgical interventions in this high-risk population.

#### Methods

A retrospective analysis was conducted on solid organ transplant recipients who underwent spinal surgery. Patient demographics, medical history, type of transplant, surgical procedures, and postoperative complications were reviewed and analyzed.

#### Results

Sixty-seven patients (mean age:  $64 \pm 9.4$  years; male-to-female ratio: 41:26) met the inclusion criteria and were selected for further analysis. The patients had undergone various organ transplantations and subsequent immunosuppressive treatments, including kidney (n = 44, 6%), lung (n = 9, 1%), heart (n = 7, 1%), liver (n = 6, 9%), and combined kidney and pancreas transplantation (n = 1, 1%). A total of 85 spinal surgical procedures were performed on these 67 patients, including lumbar (n = 43), cervical (n = 7), thoracic spine decompression (n = 2), spine stabilization (n = 10), tumor resection (n = 4), and vertebroplasty (n = 1). Sixteen patients (24%) underwent more than one spinal surgery. The majority of patients (n = 56, 8%) did not experience complications, while the remaining patients had complications such as wound healing problems (n = 6, 9%), abscess formation (n = 2, 3%), empyema (n = 1, 1%), cerebrospinal fluid (CSF) fistula (n = 1, 1%), and transplanted kidney failure (n = 1, 1%).

#### Conclusion

Spinal surgery in solid organ transplant recipients is associated with a higher complication rates although one carefully managed. While most patients experience favorable outcomes, wound healing complications remain the most frequent concern. A multidisciplinary approach and vigilant perioperative care are essential to optimize outcomes and minimize risks in this vulnerable and complex patient population.

### P305

#### Eosinophile Meningitis nach neurochirurgischer Intervention Eosinophilic Meningitis Following Neurosurgical Intervention

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#### Objective

Eosinophilic meningitis is most commonly associated with helminthic infections but can also arise from allergies, medications, and malignancies. Rarely, cases of aseptic eosinophilic meningitis have been reported following neurosurgical procedures, initially presenting with symptoms that mimic other types of postoperative infections.

#### Methods

A comprehensive literature review was conducted using the PubMed, Cochrane, and Embase databases. Additionally, we reviewed the medical records, laboratory findings, and radiographic images of our patient.

#### Results

We report the case of a 5-year-old male with Chiari malformation, Noonan syndrome, and Factor VII deficiency who underwent Gardner decompression with bovine graft duraplasty following progression of a syrinx. Despite an uneventful initial postoperative course, he was readmitted two weeks later with headaches and intermittent fevers. Investigations revealed elevated serum eosinophils, decreased CSF glucose, elevated CSF leukocytes, and significantly elevated IgE levels in both serum and CSF, with all cultures negative. Initial antibiotic therapy was followed by a two-week course of corticosteroids, leading to symptom resolution. In our literature review, we identified five additional cases of postoperative eosinophilic meningitis. Four of these cases involved cranial suboccipital or occipital surgeries, while one involved a spinal myelolysis procedure. A bovine graft was used in four cases. Among these, three cases occurred in pediatric patients, and two were in adults. Symptoms and investigative findings varied. Corticosteroids, alone or with antibiotics, were the mainstay of treatment, with one patient requiring graft removal. Clinical outcomes were favorable in all cases.

#### Conclusion

Postoperative eosinophilic meningitis is an uncommon complication of neurosurgical procedures. Nevertheless, recognizing this potential complication is crucial. It should be considered as a differential diagnosis in patients presenting with postoperative aseptic meningitis to facilitate timely and appropriate treatment.

## P306

## Osteolyse nach Kranioplastik im Anschluss an eine dekompressive Hemikraniektomie bei Kindern Osteolysis after cranioplasty following decompressive hemicraniectomy in children

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#### Objective

Decompressive hemicraniectomy (DHC) is a life-saving procedure, but data on its use in children is limited in the literature. Autologous cranioplasty is typically performed to reconstruct the calvarial defect once brain swelling has subsided. The two major causes of failure following autologous cranioplasty are bone flap resorption (BFR) and graft infection (GI). Here, we present the outcomes of autologous cranioplasty in our series of pediatric patients who underwent DHC.

#### Methods

A total of 39 children who underwent DHC followed by autologous cranioplasty were identified over a 15-year pediod. The following data were analyzed: demographics, clinical features, mortality, time to cranioplasty, failures associated with autologous cranioplasty, and the subsequent need for implantation of a 3D personalized skull implant (PSI).

#### Results

Among the 39 children included in the study, median age of 11.67 years (range: 0–17.92 years), 24 (61.54%) were male. The most common indication for DHC was traumatic brain injury (TBI), accounting for 21/39 cases (54%). The overall mortality rate was 26.7% (10/39). The median time to autologous cranioplasty following DHC was 100 days (range: 17–216 days). The median last available follow-up period was 42 months (range: 5–176 months). A total of 5 patients (17.2%) developed osteolysis after a median of 15 months (range 9-159) post-cranioplasty. Of these, 4 cases were attributed to BFR, and 1 case was due to GI. Four of these patients required subsequent implantation of a 3D PSI. One patient, who had undergone bilateral DHC, developed BFR on both sides. In another patient, an autologous rib graft was implanted, which showed osteolysis after 159 months, necessitating revision surgery with a PSI. The median time to autologous cranioplasty in patients who did not develop osteolysis (N=24) was 102.5 days, compared to 93 days in those who developed osteolysis (N=5).

#### Conclusion

Autologous cranioplasty following DHC in pediatric patients is a generally effective procedure. No significant difference in the time to cranioplasty between those who developed osteolysis and those who did not was found.

## P307

Chirurgische Behandlung eines orbitalen plexiformen Neurofibroms bei einem Kind mit Neurofibromatose Typ 1: Ein Fallbericht Surgical Management of Orbital Plexiform Neurofibroma in a Child with Neurofibromatosis Type 1: A Case Report

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#### Objective

Neurofibromatosis type 1 (NF1) is a relatively common genetic disorder, affecting around 1 in 3,000 to 3,500 live births. Although optic tract gliomas are the most common tumors in children with NF-1 and visual disturbances, plexiform neurofibromas represent an important differential diagnosis in these cases. This report aims to describe the case of a child with NF1 and orbital plexiform neurofibroma who underwent surgical treatment.

#### Methods

After consent from the patient's legal guardians and authorization from the hospital's ethics committee, data was collected by analyzing the patient's medical records and imaging tests.

#### Results

An 8-year-old female patient, previously diagnosed with NF-1 since the age of 5, lost her medical follow-up during the pandemic. In 2024, she went to the emergency department complaining of a severe headache. On initial physical examination, the patient was conscious, oriented, in good general condition, with no motor or sensory deficits, presenting only proptosis of the left eye.

An MRI scan revealed the presence of an expansive lesion in the orbital region, without involvement of the optic nerve and without intracranial extension. Surgical resection of the lesion using a pterional craniotomy was planned. However, during the procedure, it was found that the lesion extended to the supraorbital region. It was therefore decided to perform a partial resection of the lesion using this approach, without the need to continue with the craniotomy.

Postoperatively, the patient had a good clinical evolution, with no neurological deficits, and there was a significant reduction in proptosis.

#### Conclusion

The case described highlights the importance of early diagnosis and individualized management in patients with type 1 neurofibromatosis and orbital lesions. The decision to modify the surgical approach during the procedure, opting for partial resection through the supraorbital region, avoided more invasive interventions and resulted in a satisfactory clinical recovery. The significant reduction in proptosis and the absence of neurological deficits in the postoperative period reinforce the benefits of an adaptive surgical strategy

## P308

## Zusammenhang zwischen klinischen Variablen und Ergebnissen bei pädiatrischem TBI: Eine retrospektive Kohortenstudie.

Association Between Clinical Variables and Outcomes in Pediatric TBI: A Retrospective Cohort Study

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#### Objective

Traumatic brain injury (TBI) is a leading cause of morbidity and mortality in pediatric populations. While much is known about the outcomes of TBI in adults, pediatric-specific studies are limited. This study aims to examine the relationship between clinical and epidemiological variables and outcomes in pediatric patients undergoing neurosurgery for TBI.

#### Methods

A retrospective cohort study was conducted with pediatric patients (0-18 years) who underwent neurosurgical intervention following TBI at a tertiary hospital in Brazil (2020-2024). Data collected included sex, age, injury mechanism, time from trauma to surgery, computed tomography (CT) findings, Glasgow Coma Scale (GCS) scores, and outcomes (discharge or death). Statistical analyses included the Mann-Whitney U test, Kruskal-Wallis test, and chi-square tests.

#### Results

A total of 79 patients were included, with a predominance of male patients (73%). Most injuries resulted from car accidents (60%), followed by falls (30%). Mortality rates were significantly higher in patients with gunshot wounds (72%), severe TBI (p=0.001), and combined extradural and subdural hematomas (p=0.004). Patients with anisocoric pupils had significantly worse outcomes (p<0.001). The interval between trauma and surgery was associated with outcome, with shorter intervals correlating with poorer prognosis (p=0.039). GCS scores at discharge were notably lower in patients with gunshot wounds compared to those with car accidents or falls (p<0.005).

#### Conclusion

Clinical factors such as the severity of TBI, mechanism of injury, tomographic findings, and pupillary reactivity are related to outcomes in pediatric TBI patients undergoing neurosurgery. Further prospective studies are needed to refine these associations and guide clinical decision-making.

## P309

Erfahrungen mit einem programmierbaren Ventil mit integrierter Gravitationseinheit bei Hydrozephalus im Kindesalter Experiences with a programmable valve with an integrated gravitational antisiphon device in childhood

hydrocephalus

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#### Objective

Ventriculoperitoneal shunt placement is performed worldwide as a standard therapy for childhood hydrocephalus. In clinical practice, complications such as infection and shunt malfunction related to underdrainage or overdrainage are still a major concern.

#### Methods

A programmable valve (ProGAV 2.0 Miethke-Aesculap) with an integrated gravitational antisiphon device was implanted over a 4-year period in 59 children (33 boys and 26 girls) with hydrocephalus of various origins (intraventricular hemorrhage (n = 19), tumor and aqueductal stenosis (n = 18), hydrocephalus unknowen (n = 3), infection (n = 3), myelomeningocele (n = 11), pseudotumor cerebri (n = 2), and trauma (n = 3)). The initial opening pressure of the adjustable unit was set at 6 cm H2O.

#### Results

Age ranged from 1 month to 17 years at the time of surgery (mean age: 22.9 months). The new valve was used as a replacement for a valve implanted earlier in 10 patients with valve dysfunction. The mean follow-up period was 5.6 months (range 2–12 months). Eight children had a valve dysfunction, Two other children had proximal catheter dysfunction and 11 had infections. In 17 of the 59 patients, 35 opening-pressure changes were necessary. The opening pressure was increased in 20 children with symptoms of overdrainage and decreased in 15 children with symptoms of underdrainage. Readjustment was uncomplicated and did not cause pain in any instances. Symptoms were abolished accordingly in all instances.

#### Conclusion

Programmable valves are both useful and safe in hydrocephalic children. New valve designs may be associated with longer shunt survival and more reliable function.

## P310

#### Prädiktoren für die Notwendigkeit einer Liquorableitung bei Läsionen der hinteren Schädelgrube Predictors of cerebrospinal fluid diversion in posterior fossa lesions

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#### Objective

The aim of this study is to assess the indication for cerebrospinal fluid (CSF) diversion prior, during and after resection of posterior fossa lesions (PFL), as well as to identify factors predicting persistent hydrocephalus after tumor resection.

#### Methods

We performed a retrospective analysis of patients who underwent surgery for PFL between 2021 and 2023 in our department. The factors evaluated included severity of hydrocephalus (i.e. transependymal flow), tumor location, volume of the tumor, extent of resection and histology.

#### Results

Thirty-two (16%) of 204 patients with PFL underwent CSF diversion procedures. This cohort was divided into two groups: group A (18 patients), comprising patients who required CSF diversion procedures before or during surgery, and group B (14 patients) including cases with hydrocephalus that occurred after surgery. In general, tumor volume was greater in group A (mean 39,77 +/- 6,06 ml vs. 16,87 +/- 4,37 ml). Additionally, transependymal flow was found to be predictive for the necessity of placement of an external ventricular drainage prior to surgery (p=0,0361), with incomplete tumor removal linked to shunting in this group. In contrast, surgical complications (including intraventricular hemorrhage) were the major predictor of permanent CSF diversion in group B (p=0,0233). While there was no statistical significance, the rate of permanent CSF diversion by shunting was higher in group B (43% vs 17%).

#### Conclusion

Our study demonstrates tumor size and the presence of transependymal flow as predictive factors of preoperative EVD placement, whereas partial/subtotal resection and surgical complications are predictors of the necessity for shunting.

## P311

Endoskopische Foraminoplastie zur Therapie des biventrikulären Hydrozephalus Endoscopic foraminoplasty for the treatment of biventricular hydrocephalus

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#### Objective

Biventricular hydrocephalus due to bilateral obstruction of the foramina of Monro is rare. Standard therapy is ventriculoperitoneal shunting. To avoid shunt dependency, we performed endoscopic foraminoplasty. In this study, we report our experience with this technique.

#### Methods

A retrospective study was conducted on seven patients (5 males, 2 females) diagnosed with biventricular hydrocephalus who underwent endoscopic foraminoplasty. The procedure involved neuroendoscopic visualization of the obstructed foramen of Monro, controlled enlargement of the foramen of Monro using balloon dilatation, plexus coagulation, and, if needed stenting. If the septum pellucidum was not fenestrated by the chronic hydrocephalus, a septostomy was performed as well. Clinical and radiological outcomes were assessed over a mean follow-up of period of 4.8 years. Success was defined as symptomatic improvement and radiological reduction in ventricular size without the need for permanent CSF diversion.

#### Results

Preoperatively, patients presented with various symptoms, including headache, dizziness, memory impairment, visual disturbances, resting tremor, and cognitive disfunction. Postoperative imaging showed a significant reduction in ventricular size in 6 (86%) patients, with an equivalent percentage experiencing symptomatic improvement. In three patients, a stent was inserted. One patient required a secondary intervention due to restenosis, ultimately necessitating a ventriculoperitoneal (VP) shunt. One patient was diagnosed with neurosarcoidosis. This patient developed a CSF fistula postoperatively which resolved spontaneously. At the final follow-up, only one patient remained shunt-dependent.

#### Conclusion

Endoscopic foraminoplasty is a promising minimally invasive approach for selected patients with biventricular hydrocephalus to avoid the sequelae of shunt dependency. If the septum is not perforated, a septostomy is indicated. Bilateral foraminoplasty should be avoided because of the risk of bilateral fornicial injury.

## P312

Analyse von Progranulin (PGRN) als potenzieller Biomarker für idiopathische Normaldruckhydrozephalus: eine vorläufige Studie

Analysis of progranulin (PGRN) as a potential biomarker of idiopathic normal pressure hydrocephalus: preliminary study

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#### Objective

The pathogenesis of idiopathic normal pressure hydrocephalus (iNPH) is associated with progressing demyelination and occuring periventricular white matter lesions. Neuroinflammation emerging to be one of the key components that contribute in drive ongoing neuronal injury. Progranulin (PGRN) constitutes a pleiotropic growth factor exhibiting potent neurotrophic, anti-inflammatory, and immunomodulatory activities. The purpose of this study was to examine the serum and cerebrospinal fluid (CSF) levels of PGRN of the corresponding patients with suspected iNPH and its correlation with neuroradiological and clinical parameters.

#### Methods

The preliminary study was performed on 13 patients (n=13) suspected of iNPH. The serum and CSF were collected during the tap test and PGRN concentration level was analyzed using ELISA test. All patients included in this study performed the pre- and post-puncture gait analysis which was also consecutively supplemented by neuropsychological, neuroimaging and clinical testing.

#### Results

The neuroradiological data regarding Evans-index and ALVI-index showed a positive correlation with the PGRN concentration levels in serum (r=0.541/r=0.265). The positive correlation of the PGRN concentration levels in CSF with Evans-index was also observed (r=0.273). Therefore, the negative correlation was observed regarding callosal angle with the PGRN concentration levels in serum (r=-0.426). The concentration levels of PGRN in serum and CSF were negatively correlated with Kiefer score results (r=-0.109/r=-0.231). No obvious trends were observed regarding the gait speed and number of steps after the tap test. The largest observed positive correlation was for pre- and post-puncture turning time and PGRN concentration levels in CSF (r=0.222/r=0.684).

#### Conclusion

The possible implementation of performed PGRN assays in serum and CSF offers a novel interesting tool for clinical diagnosis of iNPH. Furthermore, the surrogate PGRN biofluid assays in combination with other clinical, laboratory and neuroradiological parameters may be potentially useful in clinical prognosis and risk calculation predicting shunt responsiveness.

## P313

## Chirurgische Revisionen bei Shunt-Komplikationen: eine umfassende monozentrische Analyse *Surgical revisions due to shunt complications: a comprehensive monocentric analysis*

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#### Objective

Cerebrospinal fluid (CSF) shunt implantation is a common neurosurgical procedure. However, complications requiring surgical revision pose a considerable challenge. This study aims to analyze key factors contributing to these complications.

#### Methods

We analyzed diseases and causes linked to shunt complications necessitating revision surgeries. Factors included initial diagnosis, number of surgeries, shunt type, dysfunction causes, and valve longevity. Only adult patients were included.

#### Results

Between 2018 and 2024, 164 adult patients (83 female) underwent revision surgeries. The median age at first shunt implantation was 55.9 years (range, 0-84.3). The most common initial diagnosis leading to shunt implantation was subarachnoid hemorrhage (SAH) (25.6%), followed by intracerebral hemorrhage (ICH) (19.5%), tumor-associated hydrocephalus (13.4%) and normal pressure hydrocephalus (10.4%). A total of 238 revision surgeries were performed. Shunt infection was the most common cause (21.5%), followed by ventricular catheter malposition/displacement (13.4%), valve dysfunction (12.6%) and peripheral catheter malposition/displacement (9.6%). A rare complication involving dislocation of the pressure control cam of a Codman-Hakim programmable valve was identified in 4 cases (1.6%) via x-ray. Most revisions occurred in SAH (42 surgeries) and ICH (32 surgeries) patients (p<0.001). The median time to first revision was 45 days for SAH and 31.5 days for ICH. Ventriculoperitoneal shunts were initially used in 92.2% of patients. Shunt conversion was performed in 29 patients (17.7%), mostly from ventriculoperitoneal to ventriculoatrial (86.2%). Notably, three out of four patients with pseudotumor cerebri ultimately required ventriculoatrial shunts due to abdominal complications. Codman-Hakim programmable valves were initially used in 79.8% of patients. Valve replacement due to dysfunction occurred in 50 patients (30.7%), with SAH (24%) and ICH (20%) as leading diagnoses (p=0.016). Shunt explantation predominantly due to infection without severe consequences occurred in 24 patients (14.6%), mainly in SAH and ICH.

#### Conclusion

CSF shunt revision surgeries are a frequent aspect of neurosurgical practice. SAH and ICH emerged as the most common initial diagnoses associated with complications. Shunt infection remains the leading cause of revision, and rare complications, such as Codman-Hakim valve pressure control cam dislocation, underline the need for meticulous follow-up and management.

Abb. 1



## P314

Vergleich der endoskopischen Drittventrikulozisternostomie mit der stereotaktischen Implantation eines inneren Shuntes nach präpontin bei Patienten mit Aquäduktstenose Comparison of endoscopic third ventriculostomy with stereotactic prepontine stenting in patients with aqueductal stenosis

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#### Objective

The standard treatment for non-communicating hydrocephalus is endoscopic third ventriculostomy (ETV). An alternative procedure is the stereotactic implantation of a shunt catheter through the ventricles into the prepontine cistern, which serves as a stent (STS). This procedure may reduce the risk of stoma occlusion. The aim of this study is to compare the surgical and clinical results of both procedures.

#### Methods

Patients with aqueductal stenosis treated by either ETV or STS were included in this single-center retrospective study from January 2013 to July 2024. Patient records were searched for indication, procedural data, complications and clinical outcomes. In addition, available MR images were analyzed for Evans index, basilar artery to clivus distance and ventricular width. Parameters were compared between ETV and STS groups.

#### Results

STS was performed in 50 patients with a mean age of 46 years and ETV in 97 patients with a mean age of 36 years. STS was carried out more frequently in patients with secondary aqueductal stenosis due to a tumor (66% vs. 21%), while ETV was conducted more frequently in patients with primary aqueductal stenosis (76% vs. 26%). The distance between basilar tip and clivus was significantly smaller in the STS group (2.8 vs. 3.7 mm, p=0.0007). The most common symptoms before surgery in both groups were headaches (48%), cognitive impairment (46%), and gait disorder (48%). Both procedures resulted in significant improvement of symptoms. There was no significant difference in the number of revision surgeries due to infection or bleeding (STS 8% vs. ETV 4%), or insufficiency of the hydrocephalus treatment (STS 4% vs. ETV 13%, p=0.09).

#### Conclusion

The safety and efficacy of both surgical procedures are comparable. The selection of the surgical approach must be made on an individual basis.

## P315

Prävalenz von Spinalkanalstenosen bei Patienten mit einem Normaldruckhydrocephalus (NPH)- eine monozentrische Erhebung Prevalence of spinal canal stenoses in patients with normal pressure hydrocephalus (NPH)- a single center study

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#### Objective

The etiology of NPH is unknown but might be related to alterations of craniospinal compliance and intraspinal CSF resorption rate, which could be influenced by narrowing of the spinal canal. While in vitro investigations indicate an influence of spinal stenosis on CSF hydrodynamics, clinical data of NPH patients supporting this hypothesis is lacking. In a first exploratory approach, we therefore investigated prevalences of cervical (CS) and lumbar spinal stenosis (LS) and potential associations with clinical parameters in NPH patients.

#### Methods

A retrospective chart study was conducted on NPH patients planned for shunt surgery at a university hospital between 2013-2023. Clinical presentation, MR-imaging characteristics and patients' demographics were evaluated preoperatively. Spinal stenoses were evaluated based on radiological parameters (cervical: Muhle Grade 0/1/2/3, lumbar: Schizas Grade A/B/C/D; ap diameter [AP] and dural sac cross-sectional area [DSCSA]), and partial correlations of clinical and spinal imaging parameters were analyzed.

#### Results

Out of 423 NPH patients screened, 93 (mean age 71±11 yrs, 52 males) had cervical imaging, with 79 of these (85%) showing CS (Muhle Grade  $\geq$  2: 46%; mean ap diameter: 8.4 mm; mean DSCSA: 1.4±0.5 cm2). Out of 81 patients with lumbar imaging (mean age 72±12 yrs, 38 males), 67 (83%) had LS (Schizas Grade  $\geq$  B: 36%; mean ap diameter: 8.9 mm; mean DSCSA: 1.4±0.5 cm2). 42 patients had both, cervical as well as lumbar spinal stenosis. The NPH grading score (median 7±4) did neither correlate with CS stenosis parameters (AP: r=.208, p=.341; DSCSA: r=.050, p=.829), nor with LS stenosis parameters (AP: r=.329, p=.273; NPH grading-DSCSA: r=-.359, p=.229) in our cohort.

#### Conclusion

NPH patients showed higher prevalences of cervical and lumbar spinal stenosis than reported in the general population. Prospective studies should further analyse, whether degenerative spine disease and spinal stenoses have an impact on CSF flow dynamics and craniospinal compliance in NPH patients.

## P316

#### Ex vivo Organoid Modell für Vestibularisschwannome Ex vivo organoid model of vestibular schwannoma

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#### Objective

Vestibular schwannoma (VS) are benign tumors, which grow bilaterally in most cases of neurofibromatosis type 2 (NF2). In addition, these patients develop several other tumor entities, have a high recurrence rate and tumor invasiveness, and display functional deficits. Therefore, a systemic therapeutic approach is urgently needed. However, to develop such therapies, adequate tumor models are required. We established and evaluated an *ex vivo* organoid model of vestibular schwannoma.

#### Methods

In order to generate our *ex vivo* organoid model, freshly obtained tumor tissue was cut three times with a tissue chopper at medium force and a thickness of 0.55 mm. Proliferation and apoptosis was analyzed by immunostaining with Ki67 as proliferation marker and CC3 as apoptosis marker in 4 individual tumors. Tumor microenvironment components were analyzed by immunostaining with CD7 as T-cell marker, CD14 as marker for monocytes and macrophages, CD 45 as marker for leucocytes, and CD68 as marker for macrophages.

#### Results

The *ex vivo* organoid model could be cultured for at least twelve weeks. The proliferation as well as apoptosis rate was stable at 0 to 2 % over time with patient specific differences.

CD7 and CD45 showed a stable low expression of 0 % to 3.3 % and 0 % to 4 % over twelve weeks, respectively. CD14 displayed expression rates between 1 % and 8.75 % and CD68 had the highest expression rates of 2 % to 26 %, with interindividual differences, which were stable over the observation time of twelve weeks.

#### Conclusion

With this organoid model, pharmaceutical screening of patients" individual tumor tissue is feasible and probably more realistic than testing in primary cell culture. Standard parameters for a medical testing panel are currently under development.

## P317

Vestibularisschwannome nach LINAC- oder Cyberknife®-basierter stereotaktischer Radiochirurgie: Langzeit-Nachbeobachtung von 277 Patienten.

Vestibular schwannoma treated with LINAC- or Cyberknife® based stereotactic radiosurgery: long term follow-up of 277 patients.

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#### Objective

Stereotactic radiosurgery (SRS) states an over decades well-established guideline-based treatment for selected patients with vestibular schwannoma (VS). However, long term follow-up (FU) data on tumor control and clinical outcome beyond a median FU of 5 years are scarce. Here we present our clinical and radiologic long term data.

#### Methods

In this retrospective monocentric analysis, we included all patients with VS who underwent single-fraction LINAC- or robotic guided- (Cyberknife®) SRS between 1991 and 2013 and who had at least one FU contact. Patient data were analysed with regard to tumor control, preservation of functional hearing, and the occurrence of treatment-related early and late complications.

#### Results

277 patients (f:m = 147:130, median age = 58 years) matched the inclusion criteria and were treated either with LINAC (n=258) or Cyberknife<sup>®</sup> (n=20) -based SRS. Median tumor volume was 1.1ml  $\pm$  2.8 ml (0.1-23.7). The median radiation dose was 12 Gy (range 11-20) at a median isodose level of 70 % (32-86). Median and mean FU was 101 months (3-326 months) and 110 months  $\pm$  90 months, respectively. According to the Koos classification we identified 45 (16.2%) Koos I, 124 (44.8%) Koos II, 45 (16.2 %) Koos III and 63 (22.7%) Koos IV tumors. About 20 % (n=57) of the patients had surgery prior to SRS.

The 2-, 5- and 10-year tumor control rate was 100%, 95% and 94%, respectively. Treatment failure was observed in 5% (n=14). Re-treatment included re-SRS and microsurgery. In patients with functional hearing (n=148) before SRS crude rate of hearing preservation was 45% (n=66) at LFU. Clinical deterioration during FU were observed in 5% (n=14) cases.

#### Conclusion

SRS for VS provides a reliable good long term tumor control with a considerable rate of hearing preservation and a low rate of permanent side effects. SRS should always be considered as treatment alternative in the management of VS in select patients.

### P318

Assoziationen zwischen psychologischen Faktoren und langfristigem Schwindelhandicap bei Patienten mit vestibulärem Schwannom: Eine querschnittliche Studie Associations between Psychological Factors and Long-Term Dizziness Handicap in Vestibular Schwannoma Patients: A Cross-Sectional Study

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#### Objective

Vestibular schwannoma (VS) often results in persistent dizziness that negatively affects quality of life (QoL). While the physical effects are well documented, the influence of psychological factors on dizziness severity is less well understood. This study examines how psychological characteristics affect dizziness in patients with VS.

#### Methods

In this cross-sectional study, 93 VS patients were analyzed, of whom 77 (82.8%) reported postoperative dizziness. Psychological factors, including premorbid psychological disorders, personality traits (Trierer Integriertes Persönlichkeitsinventar), somatization (Screening 1für somatoforme Störungen, SOMS-2), and current levels of depression and anxiety (Hospital Anxiety and Depression Scale, HADS-D), were assessed using self-report questionnaires. Correlations between these factors and dizziness severity, as measured by the Dizziness Handicap Inventory (DHI-G), were examined.

#### Results

Patients with postoperative dizziness had higher levels of depression and a greater prevalence of preoperative dizziness than those without postoperative dizziness. Significant correlations were found between dizziness severity and psychological factors: conscientiousness (r = .30, p = .03), social support (r = .32, p = .03), and HADS total score (r = .36, p = .01). Emotional aspects of dizziness (DHI-E) were correlated with somatization (r = .27, p = .04) and anxiety (r = .40, p = .01). Functional aspects (DHI-F) were related to Conscientiousness (r = .31, p = .03) and Depression (r = .26, p = .06).

#### Conclusion

Psychological factors significantly influence the severity of dizziness in patients with VS. Incorporating psychological assessment and interventions, such as cognitive-behavioral therapy and combined vestibular and psychological rehabilitation, may improve treatment outcomes and QoL. Further research is needed to assess the effectiveness of these approaches and their impact on the relationship between psychological factors and dizziness.

### P319

Einsatz von CT in der Navigation rahmenloser stereotaktischer Hirnbiopsien: Vergleich der Genauigkeit von MRT-CT-Fusion und rein MRT-basierter Navigation – Eine Pilotstudie Incorporating CT into Frameless Stereotactic Brain Biopsy Navigation: Accuracy of MRI-CT Fusion Compared to MRI Alone – A Pilot Study

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#### Objective

Stereotactic-guided biopsy remains the gold standard for diagnosing intracranial lesions, with frameless techniques such as the VarioGuide system offering minimally invasive alternatives to traditional frame-based approaches. While these techniques are typically MRI-guided, challenges like sequence-dependent distortions in MRI imaging—more pronounced in T2-weighted sequences compared to T1—can compromise geometric accuracy. CT imaging, on the other hand, when performed with well-calibrated equipment and thin slices, generally provides higher geometric precision. Combining MRI and CT imaging has been proposed to leverage the anatomical detail of MRI with the geometric accuracy of CT. This pilot study aims to directly compare the accuracy of frameless stereotactic biopsies using MRI-CT fusion and MRI-only navigation, assessing the potential benefits of incorporating CT-based guidance.

#### Methods

42 patients undergoing frameless stereotactic brain biopsies between February 2023 and September 2024 at Evangelisches Krankenhaus Oldenburg, Germany, were included. Patients were divided into two groups: MRI-CT fusion navigation (n = 10) and MRI-only navigation (n = 32). The VarioGuide system (Brainlab) was used for trajectory planning and biopsy execution. Postoperative CT scans evaluated accuracy by measuring deviations at entry and target points. Additional parameters analyzed included lesion location, lesion volume, and target depth.

#### Results

Lesion volumes and target distances were comparable between the two groups. Accuracy, assessed by measuring deviations at the entry and target points, revealed no statistically significant differences. The mean entry deviation was 6.1 mm for the MRI-CT fusion group and 4.9 mm for the MRI-only group (p = 0.31). Similarly, the mean target deviation was 4.7 mm for the MRI-CT fusion group compared to 3.8 mm for the MRI-only group (p = 0.29).

#### Conclusion

This pilot study suggests that frameless stereotactic biopsies achieve high accuracy with both MRI-CT fusion and MRI-only navigation. While the theoretical advantages of CT in addressing MRI-related distortions are promising, they did not result in measurable improvements in accuracy within this small cohort. The choice of imaging modality should therefore be guided by clinical context, resource availability, and individual patient factors.

### P320

Lokale Tumorkontrolle und neurologisches Ergebnis nach Operation von spinalen Hämangioblastomen bei sporadischer und Von-Hippel-Lindau-Erkrankung: Eine multizentrische internationale Untersuchung Local tumor control and neurological outcome after surgery for spinal hemangioblastomas in sporadic and Von-Hippel-Lindau Disease: A multicentric international Investigation

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#### Objective

To evaluate the impact of complete resection (CR) on local tumor control and neurological outcomes in patients with sporadic and von Hippel-Lindau (VHL)-associated spinal hemangioblastomas (sHBs).

#### Methods

This multicentric, international, retrospective cohort study included 357 patients with histopathologically confirmed sHBs from 13 neuro-oncological centers. Primary outcomes included local progression-free survival (PFS) and functional outcomes measured at 12 months postoperatively.Unfavorable outcomes at 12 months post-surgery were defined by the modified McCormick Scale, where patients in the poor outcome group (P-group) either declined by one grade or more from baseline or remained at grades IV or V. Those in the good outcome group (G-group) maintained or improved to grades I–III without significant decline. Cox proportional hazards models, including multivariable adjustments, were used to assess local PFS, while multivariable logistic regression identified predictors of unfavorable functional outcomes and factors indicating VHL-associated sHBs.

#### Results

One hundred ninety-nine (55.7%) had VHL-associated sHBs, while 158 (44.3%) presented with sporadic tumors, with a balanced distribution in demographic and clinical characteristics across both groups. CR was achieved in 87.7% of cases, leading to significantly improved 72-month local PFS for both sporadic (95.1%) and VHL-associated (91.1%) tumors. In multivariable Cox regression, CR remained the only significant factor for improved local PFS (HR: 0.18, 95% CI: 0.08–0.4, p < 0.001). Multivariable binary logistic regression analysis revealed that unfavorable functional outcomes at one year is associated with intramedullary tumor location (OR: 9.5, 95% CI: 1.7–52.6), impaired baseline functional status (OR: 5.2, 95% CI: 1.6–17.3), and preoperative bleeding (OR: 31.1, 95% CI: 3.5–280.9). Predictive factors for a VHL-associated hemangioblastoma included intramedullary growth

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(OR: 2.4, 95% CI:1.5-3.8) non-cervical location (OR: 2.1, 95% CI: 1.3–3.4) and younger age (<43 years) (OR: 3.2, 95% CI: 2.0–5.2).

#### Conclusion

Safe complete resection is crucial for achieving long-term local tumor control in both sporadic and VHLassociated sHBs. Timely surgical intervention in symptomatic sporadic patients and progressive tumors is valuable, particularly when addressing the potential impact of preoperative of neurological decline or bleeding on postoperative outcomes.

## P321

Die Zuverlässigkeit der ICG-Angiographie des Sehnervs bei der chirurgischen Entfernung von Meningiomen an der vorderen Schädelbasis.

The reliability of ICG-angiography of the optic nerve in the surgical removal of meningiomas at the anterior skull base

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#### Objective

Meningiomas are the most common skull base tumors, frequently causing visual impairment when infiltrating the perichiasmatic region. The primary surgical goal is to preserve vision, yet no reliable intraoperative tools currently exist. This study examines the reproducibility of indocyanine green (ICG) angiography of the optic nerve (ON) during decompression surgery.

#### Methods

Six patients with perichiasmatic meningiomas and seven with non-meningeal perichiasmatic pathologies were included. All underwent imaging, ophthalmological exams, intraoperative visual evoked potentials (ioVEP), and standardized ICG angiography. ICG was performed pre- and post-resection using Flow 800 software (Kinevo/Pentero, Carl Zeiss Co). The time intervals between ICG appearance in the internal carotid artery (ICA), arrival in the pial ON circulation, and full saturation were recorded before and after tumor resection.

#### Results

Tunnel vision was more common in non-meningeal tumors, while 83% of meningioma patients experienced nonspecific visual disturbances (p < 0.05). Tumor infiltration patterns differed: 50% of meningiomas affected one ON, while 42.9% of non-meningeal tumors involved both the chiasma and one ON. Tumor volumes showed no significant differences between groups.

Intraoperatively, delayed ipsilateral P100 was observed in 66.7% of meningiomas and 57.1% of non-meningeal tumors. Stable ioVEP was recorded in 2 meningioma cases and 3 non-meningioma cases during resection.

ICG angiography demonstrated an 80% improvement in ON blood circulation for meningiomas, compared to 28.6% for non-meningeal tumors. Good visual outcomes were achieved in 83% of meningiomas and 71.4% of non-meningeal tumors, postoperatively (p > 0.05).

#### Conclusion

ICG angiography appears to be a safe and reproducible method for assessing postoperative outcomes in anterior skull base surgeries. While visual outcomes for meningiomas and non-meningeal pathologies are comparable, ICG offers potential as a tool for intraoperative ON monitoring. Further research is required to confirm its value.

## P322

Gesamtüberleben und progressionsfreies Überleben bei pädiatrischen Meningeomen: Eine systematische Übersichtsarbeit und Meta-Analyse auf der Ebene individueller Patientendaten Overall survival and progression-free survival in pediatric meningiomas: A systematic review and individual patient-level meta-analysis

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#### Objective

Pediatric meningiomas (PMs) are rare central nervous system tumors, accounting for 1–5% of all meningiomas, and differ from adult meningiomas in clinical, histopathological, and molecular features. Current guidelines primarily focus on adults, leaving a gap in evidence-based management for PMs. This study presents the largest meta-analysis of longitudinal individual patient data (IPD) to date, addressing progression-free survival (PFS) and overall survival (OS) in pediatric patients.

#### Methods

Data from 20 studies (2011–2023), including 1,010 pediatric meningioma cases, were analyzed to assess PFS and OS stratified by WHO grade, NF1/NF2 status, extent of resection (EOR), and adjuvant radiotherapy. Longitudinal survival data were reconstructed from Kaplan-Meier curves using IPD extraction methods.

#### Results

PMs affect males and females nearly equally (52.1% vs. 47.9%). WHO grade 3 tumors had significantly shorter PFS (72.1 months) compared to grades 1 (209.8 months) and 2 (137.5 months) (p<0.001). No significant OS difference between WHO grades 1 and 2 PMs were observed. NF1- and NF2-associated tumors showed shorter PFS (59.7 and 138.4 months) than sporadic cases (180.6 months) (p=0.02). GTR significantly improved PFS (113.8 vs. 40.1 months, p<0.001) and OS (602.9 vs. 173.8 months, p<0.001). Radiotherapy enhanced PFS (72.5 vs. 23.8 months, p=0.009) and OS (140.7 vs. 63.0 months, p=0.002) in grade 3 tumors but not in WHO grade 2 PMs (p=0.43).

#### Conclusion

This largest meta-analysis highlights the critical roles of GTR and adjuvant radiotherapy in improving outcomes for high-grade PMs and underscores the urgent need for pediatric-specific management guidelines based on robust longitudinal data.

## P323

Die Lage der Nervenwurzel bei posterioren endoskopischen Halswirbelsäulenoperationen The position of the nerve root during posterior endoscopic cervical surgery

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#### Objective

Posterior endoscopic cervical surgery (PECS) has a reported complication rate of 1.15–33.3%, with higher rates of nerve root injuries and dural tears than anterior approaches. The aim of the following study is to enhance the anatomical understanding from the endoscopic surgeon's perspective to minimize complications.

#### Methods

This retrospective study analyzes the intraoperative course and position of the 112 nerve roots in relation to the disc space and dura of 88 patients who underwent PECS between 2011 and 2024. Accordingly, the intraoperative video recordings (Abb. 1), lateral fluoroscopy images, and surgical documentation were subjected to analysis.

#### Results

The predominant nerve root position relative to the disc space was cranial in 64 cases (57.14%), followed by horizontal in 26 cases (23.21%), and caudal in 22 cases (19.64%). The evaluation revealed that in 60% of cases, C5 was in a horizontal position, while C6 was cranial in 64.71% and C7 in 80.39% of cases. In contrast, C8 is positioned more caudally in 93.75 % of cases. Apart from the position, the exiting nerve roots demonstrate variations in relation to the dura. The course of C5 is 44.44 % horizontal, while that of C6 is 61.76 % horizontal. The course of C5 is 44.44% horizontal, while that of C6 is 61.76% horizontal. A caudal course is observed in 52.94% of C7. In C8, a cranially angled course is present in 81.25%. In 82.35% of cases, compression of the cranial nerve roots manifests itself from the cranial side. In 82.35% of cases, compression of the horizontal nerve roots occurs from both sides, starting from the root. In the caudal courses, compression on the root occurs caudally in only 56.82% of cases.

#### Conclusion

In relation to the disc space, nerve roots are predominantly cranial, exhibiting variations: C5 is frequently horizontal, C6 and C7 are typically cranial, and C8 is often caudal. The courses of the nerve roots vary by level. Horizontal courses predominate in C5 and C6, caudal in C7, cranial in C8. This anatomical knowledge is crucial for surgical outcomes.

Abb. 1



### P324

Krankengymnastik, Manipulation und Traktionsphysiotherapie in der konservativen Behandlung von lumbalen Bandscheibenvorfällen: Eine systematische Übersichtsarbeit und Meta-Analyse Exercise, Manipulation and Traction Physiotherapy in the Conservative Management of Lumbar Disc Herniation: A Systematic Review and Meta-Analysis

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#### Objective

Lumbar disc herniation (LDH) is a leading cause of back pain globally, with substantial socioeconomic impact. Conservative physiotherapy, including exercise therapy, manipulation therapy, and traction therapy, is commonly used as a first-line treatment. However, the relative efficacy of these modalities and their applicability to specific patient subgroups remain unclear.

#### Methods

A systematic review was conducted, screening 19,644 studies. A total of 42 studies were included in the qualitative synthesis, with 20 included in the meta-analysis. Random-effects models were used to calculate pooled standardised mean changes (SMCs) for each modality. Heterogeneity was assessed using I<sup>2</sup>, publication bias was analysed through funnel plots and Egger"s test, and meta-regression identified covariates influencing variability in effect sizes.

#### Results

The pooled SMC across modalities was 2.28 (95% CI: 1.51, 3.05), indicating large treatment effects, though heterogeneity was high ( $I^2 = 97.9\%$ ). Traction therapy had the highest effect size (SMC = 2.52, 95% CI: 1.57, 3.37), followed by exercise therapy (SMC = 1.97, 95% CI: 0.46, 3.48) and manipulation therapy (SMC = 1.91, 95% CI: 0.24, 4.04). Follow-up duration significantly influenced effect sizes (p < 0.001), with shorter durations associated with larger effects. Qualitative findings suggested potential subgroup benefits for complex or chronic pain patients, but quantitative evidence for subgroup differentiation was limited.

#### Conclusion

This study confirms the effectiveness of conservative therapies for LDH but highlights high heterogeneity and methodological inconsistencies. Traction therapy showed the highest pooled effect size, but the lack of direct comparisons and standardised methodologies hampers identification of optimal modalities for specific subgroups. Future research should focus on head-to-head comparisons with rigorous designs and standardised outcome reporting to improve evidence-based recommendations and optimise care for LDH patients.

Abb. 1



Abb. 2



### P325

#### Stellenwert der FDG-PET-Bildgebung bei Patienten mit Spondylodiszitis The Role of FDG-PET Imaging in Patients with Spondylodiscitis

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#### Objective

Spondylodiscitis poses significant diagnostic challenges due to nonspecific symptoms and limitations of conventional imaging modalities. Moreover, causative infection foci are often not identified. Early and accurate detection of spondylodiscitis and treatment of the focus of infection is critical to prevent severe complications. Positron Emission Tomography (PET), particularly using 18F-fluorodeoxyglucose (FDG), has emerged as a complementary tool to MRI, offering high sensitivity in identifying metabolic activity associated with infectious foci. This study aims to evaluate the diagnostic accuracy of PET in detecting and monitoring patients with spondylodiscitis and the detection of other infectious foci.

#### Methods

A retrospective analysis was conducted on 198 patients who underwent FDG-PET imaging for infection-related indications between 2016 and 2023. The primary objective was to assess efficacy in diagnosing spondylodiscitis and identifying additional infectious foci. PET findings were compared with MRI, pathological, and microbiological results and clinical data.

#### Results

Among 198 patients, PET imaging identified new infectious foci in 25 cases while 2 cases with suspected foci (endocarditis and dental infection) were missed. Tracer uptake without clinical relevance was observed in 12 cases. PET confirmed previously known foci in 21 cases, primarily in joints. PET was performed in 160 cases of suspected spondylodiscitis to identify infectious foci and was used as an MRI alternative in 4 cases due to contraindications. In 30 cases with unclear MRI findings, PET aided in diagnosis, while it was used in follow-up for 4 cases. Notably, in seven cases, MRI falsely indicated spondylodiscitis, which was not confirmed by PET imaging or clinical evaluation. Conversely, PET failed to detect spondylodiscitis in five clinically confirmed cases, three of which were identified as low-grade infections.

#### Conclusion

PET imaging shows potential added value, particularly in identifying infection foci and aiding in diagnosingspondylodiscitis, especially when MRI results are inconclusive. However, discrepancies between PET, MRI, and microbiological findings suggest that PET may have limitations in certain scenarios, warranting further investigation into its diagnostic role

## P326

Sarkopenie bei Patienten mit osteoporotischen Wirbelfrakturen erhöht das Risiko von multiplen Frakturen Sarcopenia in patients with osteoporotic vertebral fracture is associated with higher risk of multiple fractures

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#### Objective

The association of sarcopenia and increased fracture risk has been well documented. However, studies investigating the role of sarcopenia in osteoporotic vertebral fractures (OVFs) are scarce. This study aimed to retrospectively evaluate the prevalence of sarcopenia among patients with OVFs and its association with clinical presentation and outcomes.

#### Methods

A retrospective analysis was conducted on patients with OVFs treated at a single spinal center between January 2022 and June 2024. Quantitative assessment of the psoas muscle was performed using axial spinal CT images. The cross-sectional area of the psoas muscle (pCSA) was measured at the L4 vertebral level and normalized using the psoas muscle index (PMI = pCSA/height<sup>2</sup>) and the psoas muscle lumbar vertebral body index (PLVI = pCSA/vertebral body area). Sarcopenia was defined using established PMI cut-off values. Clinical parameters, osteoporosis diagnostics (DEXA T-scores, CT-based Hounsfield Units [HU]), and clinical outcomes were recorded.

#### Results

A total of 142 patients with OVFs were included, with a median age of 81 (74 – 85) years and 94 (66.2%) females. Sarcopenia was identified in 103 (72.5%) patients. Patients with sarcopenia had significantly lower BMI, lower serum Albumin and lower lumbar T-scores (*Fig. 1*) in DEXA scans. Multiple (2 or more) fractures were significantly more frequent in patients with sarcopenia (37.2% vs 18%, p = 0.018, see *Fig. 2*). Logistic regression revealed that patients with sarcopenia were 2.78 times more likely to have multiple fractures (95% CI; 1.1 - 6.9, p = 0.027). No significant differences were observed in HU values, time to mobilization postoperative, length of hospital stay, or incidence of postoperative wound infection rates.

#### Conclusion

Sarcopenia is highly prevalent among patients with OVFs and is a significant risk factor for multiple acute fractures. The coexistence of osteoporosis and sarcopenia should be an integral part of the assessment and care for these patients.





### P327

Entwicklung eines neuen in-vitro Modells für osteoporotische Frakturen beim Schaf als Plattform für die Simulation chirurgischer Eingriffe Development of a novel ovine in-vitro model of osteoporotic vertebral compression fractures (OF2) to simulate surgical interventions

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#### Objective

Due to loss of bone mass and strength, low impact fragility fractures are a critical event in osteoporosis, causing back pain and disability. Kyphoplasty has been shown to be beneficial for height restauration and pain relief. *In vitro* osteoporosis fracture models to test the efficacy of new surgical procedures are scarce. Here we present a novel ovine lumbar osteoporotic vertebral compression fracture model.

#### Methods

For decalcification, lumbar ovine vertebrae (n=10) were dissected and then perfused with 25%TBD-1-decalcifier solution using a double syringe pump set-up for 16h.Radiographic bone density (Hounsfield Units, HU) was measured in the center of a mid-sagittal cross-section CT-scan of each vertebra prior and after decalcification.Vertebrae were then fractured using a hydraulic press with linear compression vector on axial angulated vertebrae.For quantitative assessment,geometrical parameters (anterior- and posterior vertebral height (AVH, PVH), anterior-posterior ratio (APR) and the anterior wedge angle (AWA) were measured in the center of a mid-sagittal cross-section CT-scan.Patients with osteoporotic wedge fractures (OF2) were used as a control.For vertebral(VB) height restoration,a mechanical vertebral fracture reduction system(vFRS) and ballon assisted kyphoplasty(BAK) with cement augmentation were used.

#### Results

Human osteoporotic vertebrae showed a reduction of 36%(150±90HU to 55±19HU)compared to nonosteoporotic vertebrae. In vitro, a comparable bone density reduction after decalcification by 44%(408±40HU to 230±69HU)was observed.APR was 1.0±0.1 before and 0.9±0.1 after linear compression,while AWA was 3.5±2.3° in unfractured, and 9.6±4.0° in fractured ovine vertebrae(p=0.0007).Fractures generated in vitro were comparable to OF2 fractures in vivo(APR:0.8±0.2, AWA:16.6±4.1°). In vitro, post interventional restoration of the AWA to its physiological composure was superior using vFRS(68.8±9.8%)compared to BAK(36.8±8.1%)(p=0.0064).APR restoration was similar using vFRS(APR: 92.0±6.0% compared to BAK(APR: 90.1±10%)(p=0.76).

#### Conclusion

Our model provides a similar loss of bone marrow density as expected from osteoporotic vertebrae *in vivo*.Semiquantitative assessment before and after linear compression showed similar effects on APR and AWA comparable to OF2 fractures in vivo. Two different methods for VB height restoration and augmentation showed superior relative AWA restauration using vFRS.This model provides a platform to simulate and evaluate surgical interventions *in vitro*.

## P328

Die operative und antibiotische Behandlung zervikaler Spondylodiszitiden: eine bizentrische Outcome-Analyse Operative and Antibiotic Treatment of Cervical Spondylodiscitis: A Bicentric Outcome Analysis

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#### Objective

Cervical spondylodiscitis is a rare but complex disease due to its potential for severe neurological impairments and post-infectious deformity. The mortality rate ranges from 5% to 10%. Often radical surgical treatment is followed by antibiotic therapy. However, implant choice, extent of fusion and duration of treatment vary across centers, as there is no uniform treatment guideline. The aim of this study is to analyze patients with cervical spondylodiscitis over a 11-year period to gain insights for improving existing treatment strategies.

#### Methods

This is a retrospective analysis of surgically treated patients suffering from cervical spondylodiscitis between January 2014 and December 2024 in 2 centers. Pre- and postoperative imaging and clinical course were evaluated and included outcome analysis with assessment of implant complications, corrections of sagittal and coronal profiles, complication rates, length of hospital stay, neurological deficits, pain intensity and 1 year survival.

#### Results

The study included 33 patients, averaging 67 years old and predominantly male (52%). The most common pathogen was Staphylococcus aureus (39%). All patients underwent radical surgical debridement, predominantly ventral decompression and fusion (90%). Following surgery, significant number of patients showed an improvement in cervical radiculopathy and neck pain (p < 0.0001). Postoperative there was 1 case of screw misplacement. The average hospital stay was 23 days, with 15 patients requiring postoperative treatment in the intensive care unit. In follow up (median 5 month) there was radiological evidence of implant-loosening in 5 cases. 3 patients died within one year because of sepsis, all of whom were older than 75 years and had significant comorbidities (ASA score > 3).

#### Conclusion

Radical surgical treatment, particularly ventral decompression and fusion, is effective for managing cervical spondylodiscitis, significantly improving radiculopathy and pain. However, 1-year mortality remains high among elderly patients with severe comorbidities. Future research should prioritize long-term outcomes and strategies to reduce complications in this challenging condition.

## P329

Reversibles posteriores Enzephalopathie syndrom nach Wirbelsäulenoperationen: Fallbericht Reversible Posterior Encephalopathy Syndrome after Spinal Surgery: Case Report

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#### Objective

Reversible Posterior Encephalopathy Syndrome (PRES) is a rare but potentially serious neurological condition characterized by symptoms such as headache, visual disturbances and seizures. Usually associated with high blood pressure, pre-eclampsia and immunosuppression, it can also occur after spinal surgery. Factors such as abrupt changes in blood pressure, reaction to anesthetic drugs and post-operative pain can contribute to its pathophysiology. We report the case of a patient diagnosed with PRES after spinal decompression and thoracic arthrodesis.

#### Methods

With the approval of the hospital's ethics committee and the patient's consent, information was collected from medical records.

#### Results

A 58-year-old female patient with hypertension and a diagnosis of multiple myeloma undergoing conservative treatment was admitted with progressive motor deficits in her lower limbs which had started 48 hours previously. On examination, she was in good general condition, conscious and oriented, presenting with grade II spastic paraparesis. Magnetic resonance imaging of the thoracic spine revealed an expansive tumor lesion with significant compression and signal alterations in the spinal cord. She underwent spinal decompression surgery and arthrodesis, and her neurological condition improved immediately (grade III paraparesis in the immediate postoperative period).

However, in the immediate postoperative period, she presented with difficult-to-control arterial hypertension associated with complaints of bilateral visual loss. The neuro-ophthalmological assessment revealed no alterations, and the magnetic resonance imaging of the brain showed only minor signal alterations in the occipital lobe, with no involvement of the optic nerves. After 48 hours, the patient showed complete recovery of the visual deficit. The condition was diagnosed as PRES.

#### Conclusion

It is essential that spine surgeons and their teams be aware of the risk of developing PRES in the postoperative period and implement preventive measures to reduce this possibility.
## P330

Resektion der pseudoartikulierten Querfortsätze bei Patienten mit Bertolotti-Syndrom mit Hilfe dreidimensionaler bildgesteuerter Navigation Resection of Pseudo-articulated Transverse Processes in Patients with Bertolotti's Syndrome with Threedimensional Image-guided Navigation

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### Objective

Bertolotti's syndrome is characterized by enlargement of the transverse process with lumbosacral pseudoarticulation between the transverse process of L5 and sacral ala. This disorder affects up to 8% of the population and is leading to irregular spinal mobility and pain. The management of this patient cohort is challenging, and universal treatment guidelines are missing. Surgery is indicated if conservative treatment is failing. Resection of the enlarged transverse process, either unilateral or bilateral, can be an initial surgical option to avoid dorsal instrumentation and fusion. Here we describe the use of intraoperative three-dimensional image-guided navigation for resection of articulated transverse processes in Bertolotti's syndrome.

#### Methods

Five patients with Bertolotti's syndrome had been treated with this surgical procedure. The five patients all were females, age rangend from 32 to 48-years. All patients presented with severe, chronic low back pain, resistant to conservative treatment. Imaging revealed lumbosacral transitional vertebrae at the level of L5-S1, which was consistent with Bertolotti's syndrome (1 type IIA, 2 type IIB, 2 Type IIIB).

### Results

All patients experienced immediate pain resolution and 4 patients remained asymptomatic in the follow-ups after 3 months and 1 year later. Due to Patient Satisfaction Index (PSI) 80% of the patients were very satisfied postoperatively, 20% were dissatisfied after 3 months. No perioperative complications occured. Revision surgery was not needed. No instability or residual articulation in the follow up functional X-rays and CT-scans after 3 month and 1 year after surgery. 1 patient underwent additional dorsal instrumentation and fusion in a second surgery after 3 months due to persistent chronic lower back pain.

#### Conclusion

Intraoperative three-dimensional imaging and navigation guidance is a safe and effective option for resection of anomalous transverse processes in patients with Bertolotti's syndrome.

## P331

## THERAPEUTISCHES PROTOKOLL ZUR REPARATUR VON DURARISSEN NACH WIRBELSAULENOPERATIONEN MIT DEM BLOOD PATCH

Therapeutic protocol for repairing dural tears after spinal surgery using the Blood Patch

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### Objective

Dural tear is a frequent complication in neurosurgical practice. It usually results in many clinical signs due to spinal cerebrospinal fluid leakage. Its severity is linked to the risk of infection of the central nervous system. The Surgical treatment may be not effective if not associated with biological glue. The purpose of this article is to provide an economical treatment protocol, well codified, based on epidural injection of autologous blood or "Blood patch

### Methods

This is a retrospective study of 92 cases of dural tear, over 2 108 lumbar spine procedures, achieved by different surgeons and conducted over a period of 7 years from may 2008 to may 2015. In 36/92 patients, the following treatment protocol was applied : Dural suture if possible, complemented by fat or muscle patch overlaid with surgicel. A clamped non-suction Redon is set up, followed by a tight closure. The day after, the Redon drain is opened. In case of Cerebrospinal Fluid leakage, autologous blood is taken from a peripheral vein and injected with a volume depending on each case. The procedure is repeated up to three times. All patients are left in bed for 48 hours and receive intravenous antibiotics for 48 hours then orally for 8 days.

### Results

Among the 92 cases, 48 (52%) were successfully treated by dural suture. Eight cases (8,6%) were reopeated for excessive CSF leakage. The remaining 36 cases (39%) benefitted from BP ; Among them, in 28 cases (78%) the first injection of BP was efficient but the 8 others required a second or third injection. No complications were noted during and after the Blood-patch procedure.

### Conclusion

Once the BD is diagnosed, the cure by the BP, which is always efficient, is now systematically recommended after surgery, when biological glue is lacking

## P332

Korrelieren Schmerzorte und Symptom Score bei Wirbelsäulenpatienten? Analyse von mehr als 4000 konsekutiven Patientenerfassungen Do Pain Localizations and Symptom-Score correlate in spine patients? An analysis of over 4000 consecutive assessments.

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#### Objective

Do Pain Localizations and Pain score correlate in spine patients?

#### Methods

Pain localization is important information for correct diagnosis in spine patients. A new method was used to assess pain using a mannequin with a grid of 105 localizations on the body surface, which were then evaluated as a sum. This study presents a description of the method, grid, and results of an observational analysis. The correlation between pain localizations and symptom scores is examined. The study included all consecutively patients with spinal pathologies and mixed conditions (Large joints/spine). Patients marked their pain localizations on a semi-oblique mannequin (front and back). The body surface was divided into palm-sized elements or clearly defined locations (total of 105 elements). The questionnaires were analyzed digitally. The symptom score (0 to 100) was calculated as the sum of intensities of five symptoms: difficulties getting up, pain during daily activities, night pain, muscle weakness/instability, and sensory disturbances/cramps. The analysis and statistics were conducted at a polytechnical institute. The study analyzed men and women separately due to slightly higher symptom scores in women. The correlation between the number of pain localizations and symptom score was analyzed using the Spearman correlation coefficient (rho).

### Results

The study included 4236 assessments from October 2016 to May 2023, with 2340 women (55.2%). The mean pain localizations were 5.25 for women (4.84 men), with a median of 3 pain localizations for both genders. The mean symptom score was 36.29 for women (32.56 for men). The correlation between pain localizations and symptom scores was high (rho=0.59 for women, 0.66 for men).

### Conclusion

Pain localizations can be easily assessed and analyzed using a pain drawing mannequin and grid in routine practice. Women tend to have more pain localizations and a higher symptom score. There is a strong linear relationship between pain localizations and symptom score. The combination of pain localizations and symptoms has great potential for diagnosis (It is important to note that this is only a first impression and further evaluation is necessary. The pain localizations allow more precise diagnosis in spine patients with cervical or lumbar pathology).

## P333

Neue Wege in der neurochirurgischen Ausbildung: Einführung eines Simulators für Stabilisierungstechniken bei C1-C2-Frakturen

*Overcoming Barriers in Neurosurgical Education: Introducing a simulator for stabilization techniques in C1-C2 fractures* 

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### Objective

Managing C1-C2 instability due to dens fractures presents significant challenges. This study aimed to develop and validate a 3D-printed simulation model for stabilization techniques. These simulations replicated the critical anatomical and biomechanical complexities of the atlantoaxial region, providing a platform for skill enhancement and preoperative planning.

### Methods

Patient-specific CT scans were used to segment anatomical structures of the cervical spine and dens fracture configurations. These segmentations were transformed into 3D models and manufactured using PLA and TPA materials to realistically represent tactile feedback and biomechanical properties (Figure 1). The models facilitated simulations of stabilization techniques, including the Harms technique, in a step-by-step manner to reflect surgical workflows and enhance the learning process. To evaluate the educational impact, 8 participants, including experienced neurosurgeons, conducted three simulation sessions each. The learning curve during the operation was assessed through subjective surveys that measured participants' confidence, skill improvement, and perceptions of procedural realism.

### Results

Subjective evaluations on a 5-point Likert scale demonstrated excellent face and content validity. Objective assessments indicated significant construct validity, with participants showing marked improvements in procedural accuracy and reductions in operative time over the three sessions. The surveys underscored the simulation's effectiveness in facilitating skill acquisition and enhancing procedural understanding.

### Conclusion

The developed simulation model provides a high-fidelity platform for mastering stabilization techniques in C1-C2 dens fractures. Its demonstrated ability to improve surgical precision, confidence, and the learning process highlights its value in neurosurgical education and preoperative preparation. Future research should explore its application to other cervical pathologies and multidisciplinary team training scenarios.

### Abb. 1

Figure 1. A) Atlantoaxial joint with the transverse ligament of the atlas; B) 3D-printed model of the cervical region (occiput to thoracic vertebrae 2)



## P334

Beziehung zwischen DEXA-basierten T-Scores von Lendenwirbelsäule, Hüfte und Femur und CT-basierten Hounsfield-Einheiten bei Patienten mit manifester Osteoporose Relationship of DEXA-based T-scores of lumbar spine, hip and femur in correlation to CT-based Hounsfield units

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### Objective

Dual-energy X-ray absorptiometry (DEXA) and the resulting T-score are currently still considered the gold standard for bone density measurement and diagnosis of osteoporosis. In this study, we investigated the relationship of DEXA-based T-scores of the lumbar spine (LS), hip and femur in comparison to CT Hounsfield Units (HU) in patients with manifest osteoporosis.

#### Methods

From 2019 to 2024, we analysed 350 patients with osteoporotic fractures of the spine. All patients underwent CT imaging of the lumbar spine. 170 patients were examined via DEXA scan (n=170 with T-score of the lumbar spine, n=123 with T-score of the hip, n=113 with T-score of the femur). DEXA and CT scans were filtered out of the patient data and only patients who had undergone both examinations were included. The DEXA scan was assessed using the T-scores of the lumbar spine, hip and femur. The HU was examined axially in each of three non-fractured vertebral bodies of the lumbar spine.

### Results

A low HU score was found in 165 patients (97%), with a T-score in the osteoporotic range in 33% of DEXA lumbar spine scans, 26.8% of DEXA femur scans and 24.1% of DEXA hip scans. A statistically significant correlation was found between HU and DEXA T-score of the spine (11.6 (2, n= 113), p = 0.003) and DEXA T-score of the hip (10.3(2, n= 113), p = 0.006. No significant correlation was found between the DEXA-T score of the thigh and the HU. In addition, no other significant differences were found with regard to demographics, age, number of fractures and fracture location. Patients who had osteoporosis on DEXA scan all showed a very low CT HU of less than 50.

### Conclusion

Even though the DEXA scan is still the gold standard, HU appears to be better suited to detecting manifest osteoporosis. DEXA was only able to reliably detect osteoporosis in patients with HU values below 50. In comparison, the T-scores of the lumbar spine and hip appear to be more suitable for detecting osteoporosis than the T-score of the femur. However, the reliability of the T-scores for the lumbar spine is also low compared to the reliability of the CT-HU of the lumbar spine and is probably unsuitable for detecting manifest osteoporosis.



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