



Conference Report

# Abstracts of the Joint Annual Meeting 2024 of the Swiss Society of Neurosurgery (SSNS) and the Swiss Society of Neuroradiology (SSNR) Together with the Association of Neurosurgical Nursing Staff Switzerland

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**Abstract:** Main Topic: Artificial Intelligence and Digitalization: Applications to Neurosurgery and Neuroradiology. On behalf of the SSNS and SSNR, we are pleased to present the Abstracts of the Joint Annual Meeting, which is held at the Congress Kursaal Interlaken, Switzerland, 20–21 June 2024. In total, 62 abstracts were selected, of which 19 abstracts are oral presentations and 43 abstracts are for ePoster. We congratulate all the presenters on their research work and contribution.

**Keywords:** neurosurgery; neuroradiology; neurology; stroke; cerebrovascular; movement disorders; neurodegenerative; neurotrauma; neuroimmunology; neuro-oncology; spine and pain; biological psychiatry; epilepsy and sleep disorders; neuropsychology; behavioral neurology; clinical neurophysiology; headache; neuropathology; neurorehabilitation; AI



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O01

## Clinical outcome after Surgical Management of Spontaneous Spinal Epidural Hemorrhages (SSEH)—A Retrospective Case Cohort

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**Objective:** A spontaneous spinal epidural hematoma (SSEH) is a rare pathology characterized by a hemorrhage in the spinal epidural space without any prior surgical or interventional procedure. Recent literature reported contradictory findings regarding the clinical, radiological and surgical factors determining the outcome, hence the objective of this retrospective analysis was to re-assess these outcome-determining factors in a homogenous SSEH patient collective.

**Methods:** 26 patients surgically treated for SSEH at our institution from 2010–2022 were included and retrospectively assessed regarding the management, especially the time-to-treatment, the pre- and post-treatment clinical status, the radiological findings as well as other patient-specific parameters. The outcome was assessed using the modified McCormick scale. Statistical analyses included binary logistic regression and Fisher's exact test.

**Results:** The analysis yielded 17 male (65%) and 9 female (35%) patients aged 70 in median (interquartile range 26.5) with cervical (31%) and cervicothoracic (69%) SSEHs. 69% of the patients underwent surgery after less than 12 h, 31% of the patients after more than 12 h. Neither the craniocaudal hematoma expansion ( $p = 0.49$ ) nor the axial hematoma occupation of the spinal canal ( $p = 0.58$ ), nor anticoagulation ( $p = 0.67$ ) or antiaggregation ( $p = 0.74$ ),

nor the preoperative clinical status ( $p = 0.99$ ), nor the time-to-surgery ( $p = 0.24/0.74$ ) were significantly associated with the patient's outcomes. ( $p$ -values for binary logistic regression.) The outcome was generally good as 58% of the patients had a postoperative modified McCormick scale grade of I (no residual symptoms) and 31% had a grade of II (mild symptoms)—only 12% remained with a modified McCormick scale grade of IV or V (severe motor deficits/paraplegic).

**Conclusions:** Surgical evacuation of SSEH leads to a good clinical outcome regardless of the severity of symptoms and the symptom-to-treatment interval. Surgical treatment should thus be generously indicated in patients with SSEH.

O02

### Comparison of Microsurgical Suturing vs. Patching of Ventral Dural Leaks in Spontaneous Intracranial Hypotension

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**Aims:** Over the years, the understanding for the pathophysiology of spontaneous intracranial hypotension (SIH) has increased. Meanwhile there is growing evidence for the necessity of microsurgical repair in Type 1 leaks in SIH patients, when conservative measures fail. Studies have demonstrated significantly improved neurological outcome, patient symptom relief and resolution of spinal longitudinal extradural CSF collection (SLEC) after microsurgical closure of the underlying spinal CSF leak. However, there is lacking consensus on the optimal surgical technique to achieve permanent closure of a ventral CSF leak.

**Methods:** We performed a retrospective analysis of all SIH patients with Type 1 leaks who were microsurgically treated at our institution between 2013 and 2023. Patients were divided into two groups depending on the surgical technique: transdural (1) microsurgical closing suture and (2) extra- and intradural patching (sandwich-technique). Primary endpoints were changes in SIH Score (Bern Score) on brain MRI and resolution of SLEC on postoperative MRI at two months follow-up. As secondary endpoint, we compared operation duration.

**Results:** In total, 85 (66% female) consecutive SIH patients with a mean age of 47 years ( $\pm 11$ ) underwent transdural surgical repair of a Type 1 leak. Most (92%) of the leaks presented at the thoracic spine. The leak was sutured in 53 patients and patched in 32 patients. We found no significant difference in the rates of postoperative residual SLEC between the suture and patching groups (16.6% vs. 25.8%  $p = 0.38$ ) and Bern Score (mean 1.4 ( $\pm 2$ ) vs. 1.7 ( $\pm 2$ )  $p = 0.51$ ). Operation time was significantly shorter in the patching group (mean  $169 \pm 51$  min vs. mean  $139 \pm 48$  min  $p = 0.03$ ).

**Conclusions:** We found no significant difference in radiological outcomes between the two techniques. The sandwich-technique is feasible, equally effective and requires less operation time for microsurgical closure of ventral dura leaks. Therefore, in most cases, there is no need for intradural suturing of ventral CSF leaks.

O03

### Traumatic Occipital Condyle Fractures—A Retrospective, Level One Trauma Center Cohort Study: Epidemiology, Treatment and Outcome

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**Objectives:** Traumatic occipital condyle fractures (OCF) are infrequent injuries associated with severely injured trauma patients. The stand-alone relevance of OCF in polytraumatic patients however is unclear and high-level evidence for treatment is lacking. The aim of our study was to examine the role of concomitant injuries as well as treatment modalities and outcome within a large cohort of 152 OCF patients.

**Methods:** After retrospective patient selection from our radiological database within a 10-year period, fracture type, treatment modality and clinical features at admission and follow-up (mean: 6 weeks) were documented. Descriptive and bivariate statistics were used to define cohort variables and check for associations.

**Results:** 14% of OCF were classified as Anderson and Montesano type 1, 37% as type 2 and 49% as type 3. 60% of patients presented with concomitant intracranial injuries, 14% had associated fractures of the upper cervical spine and 34% had concomitant fractures of the remaining spine. Spinal cord injury (SCI) was observed in 8%, however never at the level of the OCF. 28% of patients had concomitant injuries of the thorax, abdomen, extremities and pelvis. 9.2% of patients showed focal neurological deficits and 65% presented with a reduced mental state. 43% of patients were treated using a semi rigid collar with lower jaw inclusion, 1.5% received Halo fixation and 1.8% received internal fixation. 40.8% did not receive documented treatment. All patients treated surgically had associated upper cervical spine fractures. We observed no SCI at the C0/C1 junction. Anderson/Montesano Type II fractures were left untreated significantly more often than other fracture types. At follow-up 41% of patients with initial focal deficits had no deficits and 55.7% of patients with neck pain at admission were pain free. Follow-up imaging was conventional radiography in 63% of cases whereby OCF could not be clearly delineated in 76% of cases. Secondary dislocation was observed in 0.8% of cases.

**Conclusions:** Epidemiology of OCF in our study was comparable to smaller published cohorts. OCF may be seen as markers for severe trauma; however, their stand-alone role and influence on initial neurological impairment is not clear in view of more severe concomitant injuries. Our study shows that not all fracture types are treated equally despite clear recommendations. Plain radiography as a follow up imaging must be reevaluated as fractures are thereby seldom identified.

## O04

### Lateral Lumbar and Thoracic Interbody Fusion (LLIF) for Thoracolumbar Spine Trauma (Trauma LLIF)—A Single-Center, Retrospective Observational Cohort Study

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**Aims:** Pain, disability and progressive kyphosis is a common problem after traumatic injury of the thoracolumbar (TL-)junction. There is no data about the application of short-segment posterior fusion with anterior column support using lateral lumbar or thoracic interbody (LLIF) cages in this setting.

**Methods:** We reviewed consecutive patients with traumatic injury of the TL-junction (Th10/11-L2/3), treated by posterior instrumentation/fusion and LLIF. We analyzed segmental kyphosis, complications, and outcomes until last follow-up around 3 years

postoperative. We perform comparative analyses regarding different surgical strategies, e.g., monosegmental vs. temporary bisegmental instrumentation.

**Results:** We identified 61 patients (mean age 39.0 years (SD 13.3); 23 females (37.7%)) with mostly A3 (n = 48; 78.7%) or A4 fractures (n = 11; 18.0%); additional posterior tension band injury was present in n = 26 (42.6%). The mostly affected levels of injury were Th12/L1 in n = 25 (41.0%) and Th11/12 in n = 22 (36.1%). The segmental kyphotic angle was 14.6° (6.7°) preoperative and remained significantly reduced at all times of follow-up at discharge (5.4° 5.5°;  $p < 0.001$ ), at 90 days (7.2° 5.5°;  $p < 0.001$ ), after partial hardware removal (7.2° 6.0°;  $p < 0.001$ ) and at last follow-up (8.1° 6.3°;  $p < 0.001$ ). We noticed a tendency for less progression of kyphosis in the group with two-staged, compared to single-staged bisegmental surgery (mean difference (MD) 3.1° after partial hardware removal,  $p = 0.064$ ). The six patients receiving primary monosegmental fusion experienced good correction of kyphosis at discharge (MD 5.8°,  $p = 0.018$ ), but progressive kyphosis during follow-up (MD preoperative to last follow-up 1.5°,  $p = 0.472$ ). In n = 55 patients receiving temporary bisegmental instrumentation/fusion kyphosis correction was 9.5° before discharge ( $p < 0.001$ ) and persisted until last follow-up (MD 7.2°,  $p < 0.001$ ). Until last follow-up, n = 11 experienced complications (18%), n = 58 (95.1%) had an excellent or good outcome and solid fusion was noticed in n = 60 (98.4%).

**Conclusions:** “Trauma LLIF” should be considered for short-segment anterior-posterior fusion for injuries of the TL- junction. We observed most reproducible and long-lasting kyphosis reduction with a temporary bisegmental, two-staged procedure resulting in monosegmental fusion (posterior instrumentation/fusion with delayed LLIF and partial hardware removal to release the non-injured caudal motion segment).

## O05

### Machine Learning Based Automated Programming of Deep Brain Stimulation Systems

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**Introduction:** DBS has shown to be the most effective therapy for PD. However, still up to 30% of the patient may suffer from stimulation induced side effects, which may be due to the too large volumes of tissue activated using cylindrical electrodes. Novel DBS segmented leads have been developed to reduce and shape the VTA. The increased number of directional electrodes provides many more programming possibilities, while increasing the programming complexity and time consumption when using a trial-and-error approach, limiting the benefits of directional DBS. To overcome these limitations, this new technology, requires a computed data-driven approach for postop programming. Putting together a large cohort dataset allows identification of probabilistic best stimulation areas associated with the best clinical outcomes.

**Material and Methods:** We have been testing several probabilistic approaches including probabilistic sweet spot stimulation on a normalized and native space, as well as probabilistic hyperdirect pathway stimulation. Recently, we investigated a deep learning setup with convolutional networks on 120 patients

**Results:** We obtained an overall 50–70% electrode accuracy prediction with an amplitude error of 0.8–1.2 mA using the probabilistic sweet spot and hyperdirect pathway approach. Deep learning convolution significantly improved electrode accuracy prediction up to 85–90% with an amplitude error of <0.5 mA.

**Conclusions:** Postoperative DBS patient programming approach based on objective computed anatomical and electrophysiological Data shows an encouraging accuracy. Deep learning algorithms seems to improve the prediction accuracy without compromising

clinical outcome. These encouraging results need further prospective investigations as well as multicenter data

## O06

### Complications and Multidimensional Outcome after Endovascular versus Microsurgical Occlusion of Ruptured Intracranial Aneurysms—Comparative Analysis of a Swiss Multicenter Study

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**Aims:** Microsurgical clipping is perceived as a more invasive treatment form when compared to endovascular coiling for aneurysmal subarachnoid hemorrhage (aSAH). Some publications even assess a lower quality of life or more neuropsychological deficits in patients after clipping. However, detailed assessments of complications and neurological, neuropsychological and health-related quality of life (hrQoL) assessments in the early period after aneurysm occlusion remain scarce. The aim of this study was to investigate these multidimensional outcomes and to compare clipped versus coiled patients.

**Methods:** Within the prospective, multicenter “MoCA-DCI study” (ClinicalTrials.gov identifier: NCT03032471) alert patients underwent serial neurological (National Institute of Health Stroke Scale; NIHSS), neuropsychological (Montreal Cognitive Assessment; MoCA), headache (visual analog scale; VAS), disability (modified Rankin Scale; mRS) and hrQoL (Euro-QoL 5D; EQ5D) assessments < 72 h, 14 days and three months post-aSAH. Complications and outcome were compared in patients after clipping or coiling.

**Results:** We enrolled 122 aSAH patients at 6 Swiss centers (mean age 53.8 years; 78 (63.9%) female), n = 85 were coiled and n = 37 were clipped. Study groups were balanced for most variables, except for race, aneurysm location and laterality (all  $p < 0.05$ ). Intraoperative or -procedural aneurysm rupture was more frequent in surgically treated patients ( $p = 0.026$ ), seven patients underwent additional, secondary aneurysm occlusion therapy (Clipping or Coiling,  $p = 0.752$ ). There was no difference in in-hospital complications between both study groups (all  $p > 0.05$ ). Serial median MoCA results in clipped and coiled patients were 23 (IQR 7) vs. 24 (7;  $p = 0.142$ ), 25 (8) vs. 27 (5;  $p = 0.725$ ) and 27 (4) vs. 27 (5;  $p = 0.911$ ), respectively. There was no group difference in serial NIHSS (all  $p > 0.05$ ) but VAS headache was higher in clipped patients at three months follow-up ( $p = 0.025$ ).

**Conclusions:** After interdisciplinary selection of the most appropriate treatment, similarly favorable multidimensional outcome could be achieved in aSAH patients treated with microsurgical clipping or endovascular coiling. Interestingly, neuropsychological outcome was not worsened by microsurgical clipping compared to coiling even at an early timepoint post-aSAH.

O07

**Prevention of Cerebral Ischaemia in Stent Treatment for Carotid Artery Stenosis—Preliminary Results of a Randomised Multi-Centre Phase II Trial Comparing Ticagrelor versus Clopidogrel with Outcome Assessment on MRI (PRECISE-MRI)****MD Müller**<sup>1</sup>, **M Duering**<sup>2</sup>, **GJ De Borst**<sup>3</sup>, **T Cleveland**<sup>4</sup>, **P Lyrer**<sup>5</sup>, **M Mono**<sup>6</sup>, **K Nedeltchev**<sup>7</sup>, **M Arnold**<sup>8</sup>, **P Mordasini**<sup>9</sup>, **I Van Herzeele**<sup>10</sup>, **P Lerut**<sup>11</sup>, **E Cagliari**<sup>12</sup>, **A Pacchioni**<sup>13</sup>, **B Eckert**<sup>14</sup>, **O Jansen**<sup>15</sup>, **PA Ringleb**<sup>16</sup>, **LH Bonati**<sup>17</sup><sup>1</sup> Department of Neurosurgery, Bern University Hospital and University of Bern, Bern, Switzerland;<sup>2</sup> University Hospital Basel, Medical Image Analysis Center, Basel, Switzerland;<sup>3</sup> University Medical Center Utrecht, Department of Vascular Surgery;<sup>4</sup> The Northern General Hospital, Sheffield Vascular Institute;<sup>5</sup> University Hospital Basel, Department of Neurology;<sup>6</sup> Triemli Hospital Zürich, Neurology;<sup>7</sup> Kantonsspital Aarau, Department of Neurology;<sup>8</sup> University Hospital Inselspital Bern, Department of Neurology;<sup>9</sup> University Hospital Inselspital Bern, Institute of Diagnostic and Interventional Neuroradiology;<sup>10</sup> UZ Gent, Department of Vascular Surgery;<sup>11</sup> AZ Groeninge, Department of Neuroradiology;<sup>12</sup> Ospedale dell'Angelo, UOC Neuroradiologia;<sup>13</sup> Ospedale Civile di Mirano, Divisione di Cardiologia;<sup>14</sup> Asklepios Klinik Altona, Department of Neuroradiology;<sup>15</sup> UKSH Campus Kiel, Department of Neuroradiology;<sup>16</sup> Universitätsklinikum Heidelberg, Neurologische Klinik;<sup>17</sup> Reha Rheinfelden, Department of Research, Switzerland

**Background:** Carotid artery stenting (CAS) is an emerging treatment for atherosclerotic carotid stenosis. The main adverse event is embolic stroke during the procedure. Current medical management to prevent peri-procedural embolisation consists of dual antiplatelet therapy with clopidogrel + aspirin (ASA). Ticagrelor, a reversible inhibitor of the platelet adenosine diphosphate receptor P2Y<sub>12</sub>, was superior to clopidogrel, as add-on therapy to ASA, in preventing stent thrombosis, cardiovascular events, and death in patients undergoing coronary artery stenting. The aim of this study was to investigate if antiplatelet therapy consisting of ticagrelor + ASA is superior to clopidogrel + ASA in preventing ischaemic brain lesions occurring during CAS.

**Methods:** We performed a randomised, open, active-controlled trial with blinded outcome assessment including patients with symptomatic or asymptomatic ( $\geq 50\%$  narrowing of the lumen) carotid stenosis undergoing CAS. Patients were allocated in a 1:1 ratio to ASA + ticagrelor or ASA + clopidogrel. The primary efficacy outcome was the presence of at least one new ischaemic brain lesion on the second MRI scan performed 1–3 days after CAS or on the third MRI scan done 28–32 days after CAS, which had not been present on the first MRI scan done 1–3 days before CAS. The primary clinical safety outcome was the composite of stroke, myocardial infarction, major bleeding, or cardiovascular death occurring at any time during the study.

**Results:** In our preliminary per protocol analysis including 172 patients, the primary efficacy outcome did not differ between the two treatment groups (RR 0.94, 95% CI 0.79–1.10). However, the total number of new ischaemic lesions was significantly lower in patients treated with ASA + ticagrelor (Exp $\beta$  0.63, 95% CI 0.42–0.95) compared to patients treated with ASA + clopidogrel, as was the total volume of new ischaemic brain lesions (Exp $\beta$  0.30, 95% CI 0.10–0.92). There was no difference in the occurrence the composite clinical safety outcome between the two groups (ITT including 207 patients; RR 0.36, 95% CI 0.08–1.20).

Furthermore, there was no difference in the occurrence of new haemorrhagic brain lesions after CAS between the two groups (RR 0.90, 95% CI 0.63–1.26).

**Conclusions:** Ticagrelor is a safe alternative to clopidogrel as an add-on to ASA to prevent new ischaemic brain lesions occurring during CAS. Compared to clopidogrel, ticagrelor reduces the total burden of ischaemic brain lesions occurring during CAS.

O08

### Ultra-High-Resolution CT Angiography of Intracranial Stents Using Photon-Counting Detector CT

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**Aims:** Patency of intracranial stents may not be reliably assessed with either CT or MR-angiography due to imaging artifacts. Ultra-high-resolution CT angiography using photon-counting detector CT (PCD-CT) is a new imaging method that may improve visualization of intracranial stents. In this study, we optimized scanning and reconstruction parameters in a phantom and applied the results to patients with intracranial stents examined on a PCD-CT.

**Methods:** A phantom with different flow-diverters was utilized to optimize PCD-CT reconstruction parameters. Patient scans were reconstructed based on the phantom results using 4 kernels (Hv40, 56, 64, 72; Hv: head vascular) and different slice-widths (0.2; 0.4; 0.6 mm). SNR and CNR measurements were performed for phantom scans. Subjective image quality (IQ) and diagnostic confidence (DC) were assessed by two independent board-certified neuroradiologists. IQ was assessed using a 5-point scale (5: best) and DC using a 3-point scale (1; best).

**Results:** 14 patients with intracranial stents who underwent PCD-CT were included in our study. Nine (64%) underwent treatment with 10 intracranial stents following percutaneous transluminal angioplasty for symptomatic arteriosclerotic stenosing lesions. The remaining five (36%) received treatment for intracranial aneurysms, with 6 flow-diverters implanted. Image noise increased and SNR and CNR decreased significantly with increasing kernel sharpness and decreasing image slice-width compared to control parameters (Hv40, slice thickness 0.6 mm). All reconstructions showed significantly higher IQ and DC compared to the control reconstruction with Hv40 kernel ( $p < 0.001$ ). IQ was highest for intracranial stents with Hv56 reconstructions. For flow-diverters, highest IQ was achieved with Hv72. Reconstructions with Hv 56–72 achieved higher DC than the control Hv40 kernel. DC was highest for intracranial stents with Hv54 at 0.4 mm and for flow-diverters with Hv72 at 0.4 mm.

**Conclusions:** Our results show that ultra-high-resolution PCD-CT angiography provides excellent visualization of the lumen of intracranial stents. Our results indicate, that a head vascular (Hv) kernel of 56 is optimal for intracranial stents and a higher kernel, Hv72, optimal for flow-diverters. The results indicate that for evaluation of intracranial stents, SNR and CNR are not the most relevant parameters. Reconstructions that virtually match the resolution of standard CT-angiography showed poorer subjective IQ and DC.

O09

**Proteomic Analysis of Glioma Reveals Distinct Signatures of Proteins and Pathways among Low and High-Grade Glioma Subgroups**J Boulay<sup>1</sup>, M Amer Salem<sup>1</sup>, M Ritz<sup>1</sup>, FS Halbeisen<sup>2</sup>, A Schmidt<sup>3</sup>, KB Buczak<sup>3</sup>, G Hutter<sup>4</sup>, S Leu<sup>5</sup><sup>1</sup> Brain Tumor Immuno-Therapy and Biology Laboratory, Department of Biomedicine, University Hospital of Basel, University of Basel, Basel, Switzerland;<sup>2</sup> Surgical Outcome Research Center Basel, Department of Clinical Research, University Hospital of Basel and University of Basel, Basel, Switzerland;<sup>3</sup> Proteomics Core Facility, Biozentrum, University of Basel, Basel, Switzerland;<sup>4</sup> Brain Tumor Immuno-Therapy and Biology Laboratory, Department of Biomedicine, University Hospital of Basel, University of Basel, Basel, Switzerland and Department of Neurosurgery, University Hospital of Basel, University of Basel, Basel, Switzerland;<sup>5</sup> University Hospital of Basel, Basel, Switzerland**Background** Proteomic data in diffuse glioma is sparse and has not yet provided profiling biomarkers to discriminate individual glioma subgroups.**Methods** A total of 82 fresh frozen glioma biopsies was prospectively collected and classified into conventional subgroups defined by DNA methylation classification from low grade gliomas (LGG) to high grade (HGG) subtypes. Proteins were extracted from samples devoid of necrosis and hemorrhage, and processed for mass spectrometry (MS), differential protein expression and further pathway identification.**Results** For each tumor sample, 5057 proteins were identified and quantified. Tumor grading turned out to be the strongest discriminator for differential expression patterns, followed by IDH mutation status. Up to 148 proteins showed differential expression between LGG and HGG subtypes, with the IDH mutant HGG subgroup being the most similar to the LGG. Increasing number of differently expressed proteins were identified when comparing LGG with proneural, classical and finally mesenchymal glioblastoma subtypes. Interestingly, there was limited redundancy among upregulated proteins between HGG subgroups and each of them could be distinguished by pattern signatures of individual over- and underexpressed proteins and pathways. This potentially allows each group to be recognized from one another. Major level changes were observed in proteins involved in innate immune system, extracellular matrix (ECM) and actin cytoskeleton organisation, metabolism, and translation.**Conclusions:** Overall, this comparative proteomic analysis shows changes consistent with glioma grade and IDH mutation status. Our study further reveals protein signatures of over/underexpressed proteins and pathways that feature each HGG subgroup compared to LGG. Those may represent potential targets to control progression of the distinct subgroups.

O10

**Differentiation of Tumor Progression from Pseudoprogression in Glioblastoma Patients with GRASP DCE-MRI and DSC-MRI**V Var<sup>1</sup>, S Leu<sup>2</sup>, TK Block<sup>3</sup>, N Rommers<sup>4</sup>, MN Psychogios<sup>1</sup>, D Cordier<sup>2</sup>, RA Todea<sup>1</sup><sup>1</sup> Department of Neuroradiology, Clinic of Radiology and Nuclear Medicine, University Hospital and University of Basel, Basel Switzerland;<sup>2</sup> Department of Neurosurgery, University Hospital and University of Basel, Basel, Switzerland;<sup>3</sup> Department of Radiology, NYU Langone Health Medical Center, New-York University, New-York, USA;<sup>4</sup> Department of Clinical research, University Hospital and University of Basel, Switzerland

**Aims:** After surgery and concurrent radiochemotherapy (RCT), patients with glioblastoma may present new or enlarging contrast-enhancing lesions related either to tumor-progression (PD) or therapy-related pseudoprogression (PsP). The current response assessment in neuro-oncology (RANO) criteria struggle to perform this distinction particularly within 12 weeks after completion of RCT. The purpose of our study was to investigate whether adding Golden Angle Radial Sparse Parallel Dynamic Contrast-Enhanced MRI (GRASP DCE-MRI) to Dynamic Susceptibility Contrast MRI (DSC-MRI) results in higher accuracy compared to DSC-MRI alone in distinguishing PD from PsP in glioblastoma patients in different time-windows after radiochemotherapy.

**Methods:** We performed a retrospective study in patients with glioblastoma between 01/2017–12/2021 who had undergone surgery and RCT and developed new or enlarging contrast-enhancing lesions suspicious for PsP or PD and had GRASP DCE- and DSC-MRI. The Area Under the Receiver Operating Characteristics Curve was used to evaluate the accuracy of the perfusion parameters differentiating PD from PsP.

**Results:** 83 patients (mean age 59 years  $\pm$ 14 [standard deviation], 54 men) with glioblastoma were classified in two groups: the PD-group (n = 62) and the PsP-group (n = 21) according to the contrast-enhancing lesion outcome on serial MRI and histology. The combination of perfusion parameters showed higher diagnostic accuracy in differentiating between PD and PsP (Sensitivity 78%, Specificity 100%) compared to rCBV alone in all time windows with the highest accuracy  $\geq$  16 weeks after completion of RCT: rCBV 2.87 (Sensitivity 71%, Specificity 94%), Ktrans 0.12 (Sensitivity 73%, Specificity 76%), Ve 0.31 (Sensitivity 75%, Specificity 65%) and Vp 0.06 (Sensitivity 79%, Specificity 60%). Within 12 weeks after the RCT, the combination of parameters showed a sensitivity of 80% and a specificity of 64%.

**Conclusions:** Adding Golden Angle Radial Sparse Parallel Dynamic Contrast-Enhanced MRI to the more commonly used Dynamic Susceptibility Contrast MRI leads to higher diagnostic accuracy in differentiating progressive-disease from pseudoprogression in glioblastoma patients compared to Dynamic Susceptibility Contrast MRI alone, even within 12 weeks after completion of radiochemotherapy.

## O11

### The Potential of 7 T in Functional Mapping: Comparison of Gradient-Echo EPI Sequences for Whole-Brain fMRI at 7T

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**Aims:** Ultra-high field MRI with radio-frequency parallel transmission improves signal-to-noise ratio (SNR) leading to either increased image quality in regions such as the temporal

lobes and the cerebellum, or increased temporal resolution compared to that of more common clinical field strengths<sup>1,2</sup>. However, determining the optimal combination of spatial and temporal resolution for whole-brain functional MRI (fMRI) at 7T remains a challenge. We aimed to compare BOLD images from three protocols at 7T with different temporal and spatial resolutions, by assessing SNR, task activation, and resting-state networks. In addition, we compared task-activation maps acquired at 3T and 7T.

**Methods:** Ten healthy volunteers performed a 7T MRI with an 8-channel transmit and 32-channel receive head-coil. MP2RAGE structural image<sup>3</sup> and three simultaneous multi-slice gradient-echo echo-planar-imaging (EPI) protocols, namely Lower\_Res (1.6 mm<sup>3</sup>; TR = 1 s), Mid\_Res (1.4 mm<sup>3</sup>; TR = 1.5 s) and Higher\_Res (0.855 × 0.855 × 1.25 mm; TR = 3 s) were acquired during resting-state and task-based paradigms. The task consisted of pseudorandomized blocks involving motor, auditory, and visual stimulations. One healthy subject performed separate language, visual and motor task in 3T and 7T.

**Results:** Wrap-around artefacts were present at 7T, but whole-brain submillimetric fMRI was feasible without compromising image quality. The 3 protocols demonstrated high spatial and temporal SNR in various brain regions. The Mid\_Res protocol gave superior SNR than the others. Task activation patterns were robust across all protocols. Lower resolution protocols were associated with higher statistical significance and activation volume. Finally, resting-state networks were reproducible across protocols. In respect to 3T data, motor, visual and motor areas were detected at 7T with higher statistical power and showed better confinement to the grey matter.

**Conclusions:** Ultra-high field MRI provided good signal homogeneity in fMRI images in cortical and deep brain structures, fostering comprehensive whole-brain resting-state and task-based fMRI analyses at a submillimetric scale. Future work will address artifacts, minimizing signal loss, for more advanced functional connectivity analyses and exploring temporal dynamics of the functional signal. 7T outperformed 3T functional imaging both in terms of power and localization by offering promising results to define eloquent cortex, especially in patients.

## O12

### Clinical, Radiological, Neurocognitive, and Patient Reported Outcomes Following Surgical Treatment of Arachnoid Cysts in Adults

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**Background:** Arachnoid cysts (AC) are typically incidental findings most often managed conservatively. There is limited literature on the effectiveness of surgical management in symptomatic patients. We aim to present our case series of surgically treated patients with AC, focusing on clinical, radiological, neurocognitive and patient reported outcomes (PROMs).

**Methods:** Retrospective case series of adult patients who underwent surgical treatment of AC between 2010 and 2024. The primary outcome was clinical improvement of the main presenting symptoms. Secondary outcomes were volumetric changes of the AC, neurocognitive outcome, revision rate, PROMs and mortality.

**Results:** A total of 2349 AC were radiologically diagnosed at the University Hospital Basel from 2010–2024. Within this time frame, 18 patients (0.77%) were surgically treated for AC. Out of the 18 surgically treated patients, with a median age of 54 (range 20–82) years, 7 (38.8%) patients presented with convexity, 4 (22.2%) with middle fossa, 5 (27.7%) with retrocerebellar, 1 (5.5%) with cerebellopontine angle and 1 (5.5%) with quadrigeminal cistern AC. The main preoperative symptoms were headache (61.1%), cognitive decline

(44.4%) and nausea (16.6%). Thirteen (72.2%) patients underwent endoscopic fenestration, 3 (16.6%) microsurgical fenestration and 1 (5.5%) patient underwent cystoperitoneal shunt placement. During the follow-up (median 1.3 (range 0–7.4) years) cyst volume decreased by a mean of 44.5% ( $\pm 30.4\%$ ). Clinical symptoms improved at the last follow-up in 17 (94.4%) patients. The relative AC volume reduction was not associated with an improvement in clinical symptoms during follow-up (OR 1.02, [95% CI 0.95–1.08];  $p = 0.637$ ). Four (22.2%) patients underwent neuropsychological examinations before surgery and at follow-up. Preoperatively these patients showed neurocognitive deficits in the functional domains of memory (100%), concentration (75%) and execution (50%). These deficits showed improvement in all patients at last follow-up. Overall, 3 (16.6%) patients required revision surgery due to ventriculitis, hydrocephalus or insufficient fenestration. No mortality occurred. To further evaluate the impact of surgical treatment on the patient's quality of life, PROMs were collected and are currently being analyzed.

**Conclusions:** Surgical treatment of AC seems to be effective in selected patients, leading to improvement of clinical symptoms and neurocognitive function, with a low morbidity rate.

### O13

#### PosESS-Study (Positioning in Endoscopic Skull Base Surgery): Semi-Sitting versus Supine: Interim Analysis of a Randomized Controlled Trial

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**Aims:** Endoscopic endonasal pituitary surgery is standardly performed with the patient in supine position. In semi-sitting position, the intracranial pressure is lower than in supine position due to decreased venous congestion. As a result, intraoperative bleeding may be reduced, potentially leading to decreased surgical morbidity and improved surgical workflow. Aim of the study is to compare the supine and the semi-sitting position (head elevation of 30°) in endoscopic endonasal pituitary surgery.

**Methods:** This study is a prospective randomized clinical trial. Inclusion criteria are as follow: adult patients with a presumed pituitary adenoma, who are suitable for endoscopic endonasal surgical resection. The primary outcome is intraoperative bleeding, assessed by the blood loss and the frequency of hemostatic maneuvers. Secondary outcomes include surgical ergonomics (assessed for both patient positions by the means of a standardized questionnaire) and the incidence of air embolism (monitored with a precordial Doppler probe). A minimum of 60 patients (30 per group) have to be enrolled to show a statistically significant difference of blood loss between the control group (supine position) and the intervention group (semi-sitting position) (superiority trial).

**Results:** 51 patients (85% of the expected 60 patients) have been randomized so far (24 patients (47.1%) in the semi-sitting and 27 (52.9%) in the supine group). There were no differences in the baseline characteristics of both patients' groups. The median blood loss was 163 mL (IQR 64–278.75) in the semi-sitting vs. 238 mL (IQR 111–356.5) in the supine group ( $p = 0.06$ ). The mean frequency of hemostatic maneuvers was 83 ( $\pm 25$ ) in the semi-sitting vs. 113 ( $\pm 43$ ) in the supine group ( $p = 0.006$ ). There were no significant differences in the incidence of air embolism (3 (15.8%) in the semi-sitting vs. 0 (0%) in the supine group ( $p = 0.230$ )), no difference between groups in the surgical ergonomic score for both neurosurgeons and ENT-surgeons ( $p = 0.773$  for neurosurgeons and  $p = 0.175$  for ENT-surgeons), and no difference in the duration of surgery (99 min (IQR 77–119) in the semi-sitting vs. 101 min (IQR 60–132) in the supine group ( $p = 0.938$ )).

**Conclusions:** This study has the potential to establish a new standard in patient positioning for endoscopic skull base surgery. The hypothesized decrease in intraoperative bleeding may enhance the surgical workflow.

**O14****European Survey on Follow-Up Strategies for Unruptured Intracranial Aneurysms****D Nasiri, T Petutschnigg, M Murek, WJ Z'Graggen, D Bervini, A Raabe, J Goldberg**

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**Aims:** The increasing detection rates of unruptured intracranial aneurysms (UIA) pose a challenge for both neurovascular centers, tasked with managing a growing pool of patients requiring regular monitoring with imaging, and the healthcare system that must bear the costs of such surveillance. While there is consensus on the need for follow-up of UIA, uncertainties persist regarding the optimal cessation of surveillance, especially when considering diverse patient risk factors and, notably, in cases of treated aneurysms with stable rest perfusion. Detailed guidelines on UIA follow-up are currently lacking, exacerbating these challenges. We sought to investigate European strategies for follow-up of untreated, microsurgically and endovascularly treated UIA.

**Methods:** An online survey consisting of 15 questions about follow-up management of UIA was sent out to the cerebrovascular section of the European Association of Neurosurgical Societies (EANS).

**Results:** The survey response rate was 27.3% (68/249). There was consensus upon the necessity for longterm follow-up of UIA (100% [n = 68]). The recommendation to perform follow-up was inversely correlated with patient age and more prevalent among endovascularly compared to microsurgically treated patients (92.6% [n = 63] vs. 70.6% [n = 48]). A majority recommended continued follow-up of treated aneurysms with stable rest perfusion, with lifelong surveillance in patients under 60 years and continuation for 5–10 years in patients aged 61–80, irrespective of whether they underwent microsurgical (38.3% [n = 23]; (33.3% [n = 20]) or endovascular (41.9% [n = 26]; (30.6% [n = 19]) treatment.

**Conclusions:** This survey confirmed a European consensus on the necessity of longterm follow-up for untreated UIA. However, significant variations in follow-up strategies, especially for treated UIA and post-treatment rest perfusion, were noted. Despite limited evidence suggesting low risk from aneurysm remnants, respondents favored long-term follow-up, highlighting uncertainty in management. This underscores the need for collaborative research on aneurysm remnants and standardized follow-up protocols for UIA in Europe.

**O15****An Extended Follow Up of Spinal Instrumentation Rescue with Cement Augmentation****F. Polinelli<sup>1,\*</sup>, M. Pileggi<sup>2,\*</sup>, I. Cabrilo<sup>1</sup>, C. Commodaro<sup>2</sup>, S.M.J. Van Kuijk<sup>3</sup>, A. Cardia<sup>1,‡</sup>, A. Cianfoni<sup>2-4,‡</sup>**

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**Introduction:** Percutaneous cement augmentation has been reported as an effective salvage procedure for frail patients suffering from spinal instrumentation failures, as screw loosening, hardware breakage, cage subsidence, and fractures within or adjacent to stabilized segments. Favorable results were reported over a median follow-up period of 16 months in a retrospective analysis of 31 consecutive procedures performed in 29 patients. In the

present study the long-term effectiveness of this treatment to avoid or postpone revision surgery is reported.

**Methods:** Clinical and radiological data of our original cohort of patients were retrospectively collected and reviewed, in order to provide an extended follow assessment. The need of revision spinal surgery was assessed as the primary outcome and the radiological stability of the implants of the previously treated segments was considered as the secondary outcome.

**Results:** An extended radiological follow up was available in 27/29 patients with an average of 50.9 months. Overall, 18/27 (66.7%) patients, originally candidate for revision surgery, avoided a surgical intervention after the cement augmentation rescue procedure. In the remainder patients, the average time period between the rescue cement augmentation and the revision surgery was 22.5 months. Implant mobilization occurred in 2/27 (7.4%) patients, rod breakage in 1/27 (3.7%), a new fracture within or adjacent to the instrumented segment occurred in 4/27 (14.8%) patients and screw loosening in rescued segments in 5/27 (18.5%) patients.

**Conclusions:** In this cohort, cement augmentation rescue procedure held its effectiveness to avoid or postpone revision surgery during a long-term follow up.

## O16

### Virtual Reality for Patient Informed Consent in Skull Base Tumors and Intracranial Vascular Pathologies—A Pilot Study

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**Background:** Innovations and accessibility for virtual (VR) and augmented reality technologies have contributed to their relevance in daily life and medical research activities over the last few years. So far, the main clinical applications include surgical planning and medical education. With the increasing demand for shared decision-making and patient-centered care, optimal informed consent (IC) gains relevance. VR could improve preoperative informed consent and patient satisfaction, particularly in surgical specialties. The aim of our prospective pilot trial was to investigate the feasibility of VR-IC in Neurosurgery.

**Methods:** Patients scheduled for skull base meningioma or brain aneurysm surgery between May and December 2023, were screened and included prospectively. Primary exclusion criteria included visual or cognitive impairment. Participants received the standard informed consent followed by a customized VR-enhanced informed consent before surgery, including their patient specific VR model of their pathology. After initial VR demonstration by the treating surgeon, patients were enabled to utilize the VR station by themselves. Subjective impression was assessed with a questionnaire including 18 questions using a 5-point Likert scale.

**Results:** We included ten patients, of whom six underwent aneurysm clipping and four resections of skull base meningioma. All questions regarding the superiority of VR for patients' understanding of the pathology, indication, and surgical risks, as well as confidence in the surgeon, were answered positively with an overall mean of 4.07 points (range 2–5). The Participants perceived VR-based IC as highly helpful for visualizing their pathology (Mean 4.23) and understanding the planned procedure (Mean 3.90).

**Conclusions:** Virtual reality-enhanced patient informed consent is a feasible procedure that benefits subjective patient' comprehension, without mentionable side effects. It contributes to a better understanding of complex surgical procedures, improving the perioperative process for patients in Neurosurgery. The pilot study showed good feasibility for a randomized controlled trial, currently planned at our institution.

## O17

**The Current Diagnostic Performance of MRI-Based Radiomics for Glioma Grading: A Meta-Analysis**

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**Background:** Multiple radiomics models have been proposed for grading glioma using different algorithms, features, and sequences of magnetic resonance imaging. The research seeks to assess the present overall performance of radiomics for grading glioma.

**Methods:** A systematic literature review of the databases Ovid MEDLINE PubMed, and Ovid EMBASE for publications published on radiomics for glioma grading between 2012 and 2023 was performed. The systematic review was carried out following the criteria of Preferred Reporting Items for Systematic Reviews and Meta-Analysis.

**Results:** In the meta-analysis, a total of 7654 patients from 40 articles, were assessed. R-package mada was used for modeling the joint estimates of specificity (SPE) and sensitivity (SEN). Pooled event rates across studies were performed with a random-effects meta-analysis. The heterogeneity of SPE and SEN were based on the  $\chi^2$  test. Overall values for SPE and SEN in the differentiation between high-grade gliomas (HGGs) and low-grade gliomas (LGGs) were 84% and 91%, respectively. With regards to the discrimination between World Health Organization (WHO) grade 4 and WHO grade 3, the overall SPE was 81% and the SEN was 89%. The modern non-linear classifiers showed a better trend, whereas textural features tend to be the best-performing (29%) and the most used.

**Conclusions:** Our findings confirm that present radiomics' diagnostic performance for glioma grading is superior in terms of SEN and SPE for the HGGs vs. LGGs discrimination task when compared to the WHO grade 4 vs. 3 task.

## O18

**Usefulness of Direct Auricular Artery Injection as Refinement of the Rabbit Shunt Subarachnoid Haemorrhage Model**

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**Introduction:** Given the impact of aneurysmal subarachnoid hemorrhage (aSAH) on patients' health, preclinical research is crucial to understand patients' outcomes, necessitating reliable and comprehensive models. In this context, traditional aSAH models with iliacal

or subclavian access often require invasive procedures associated with significant risks. Therefore, our aim was to explore a less invasive technique that similarly replicates the traditional aSAH model.

**Material and Methods:** In a total of 6 female New Zealand white rabbits (3.2–4.1 kg body weight) an experimental SAH was induced by applying a subclavian-cisternal shunt. For this, subclavian access was gained via microsurgical preparation, followed by digital-subtraction-angiography. Afterwards, insertion of an ICP-probe, puncture of the cisterna magna and induction of the shunt followed. On day 3, all procedures without inserting the ICP-probe were repeated. Prior euthanasia, contrast agent was given over an arterial catheter located in the auricular artery to induce retrograde filling of the basilar artery.

**Results:** None of the rabbits died. In two of the rabbits ( $n = 2$ ), a postoperative hemisyn-drome was observed, which improved significantly by the time of the follow-up. No further relevant morbidities were found. Macroscopically, all animals showed clear sub-arachnoid bleeding pattern. Retrograde bolus injection over the auricular artery led to a strong contrasting of the basilar artery in all animals.

**Conclusions:** Auricular access demonstrated imaging quality comparable to that of sub-clavian access, underscoring its potential for meaningful advantages. This non-surgical access offers a significantly shorter operation time. Moreover, employing the aforemen-tioned injection technique mitigates the risks associated with catheter dislocation from the subclavian artery when turning the rabbit from supine to prone. Neurological recovery in rabbits is facilitated by avoiding the need for dissection through the pectoralis muscle. Nonetheless, it's crucial to note the adherence to the principles of replacement, reduction, and refinement (the 3Rs) in animal research.

## O19

### Evaluation of Carotid Bifurcation Plaque Vulnerability: Comparing MRI and Ultrasound-Based Modalities

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**Aims:** Vulnerable plaques are important risk factors for the development of TIA and ischemic stroke. The vulnerability of carotid artery plaques can be evaluated using MRI. The value of plaque evaluation using ultrasound remains under study. We aimed to evaluate the congruence of ultrasound compared to MRI for the prediction of plaque vulnerability.

**Methods:** In a retrospective analysis, a cohort of stroke/TIA admitted to the University Hospital Zürich fulfilled the criteria of a combined special protocol of plaque visualization utilizing MRI/ultrasound and CTA of the carotid bifurcation due to suspected unstable plaques within the 24 h after admission. The hallmark of carotid plaque characteristics, such as hemorrhage, ulceration, lipid-rich necrotic core, thin/ruptured fibrous cap, and degree of stenosis of 29 patients (20 male, 9 female, mean age: 68 years) were categorized by two blinded investigators.

**Findings:** 13 plaques were classified as vulnerable on MRI, and 12 plaques were sus-pected to be unstable on ultrasound. One patient was considered uncertain. MRI and ultrasonographic techniques were in agreement with a 92% accuracy.

**Conclusions:** Through a retrospective analysis using the multimodal approach in a regular stroke workup setting, we demonstrate that ultrasound of the carotid bifurcation may be a suitable tool to exclude plaque vulnerability (by identifying true negatives).

## P01

**Unblackboxing Decision Making behind Artificial Intelligence Algorithms in Intraoperative Neurophysiologic Monitoring**J Wermelinger<sup>1</sup>, Q Parduzy<sup>2</sup>, S Koller<sup>3</sup>, M Sariyar<sup>3</sup>, A Raabe<sup>1</sup>, U Schneider<sup>2</sup>, K Seidel<sup>1</sup><sup>1</sup> Inselspital—Universitätsspital Bern;<sup>2</sup> Luzerner Kantonsspital (LUKS);<sup>3</sup> Berner Fachhochschule, Switzerland

**Objective:** We elucidate the decision making that lies behind artificial intelligence algorithms in the example of muscle classification in intraoperative neurophysiological monitoring (IONM). The goal is to uncover decisive parameters in motor evoked potentials (MEP) to understand intraoperative changes and optimize AI decision making.

**Methods:** We classified MEP in supratentorial surgery in a bi-centric setup, training on 160 patients from one center and validating on 50 patients from an independent center. We trained random forests and 1D convolutional neural nets (CNN) on a total of 37'000 MEPs and uncovered the decision making by looking into the feature importance and gradient class activation maps (Grad-CAM).

**Results:** The random forest achieved 89% test accuracy and 80% accuracy on the validation dataset from the independent center, whereas the CNN achieved 85% test and 76% validation accuracy. Inspecting the random forest feature importance reveals that the algorithm focuses on the time interval where the potential has highest amplitude. On the other hand, the grad-CAM reveals that the CNN might be focusing on the biggest slope of the potential.

**Conclusions:** Analyzing the decision making of artificial intelligence algorithms is an essential part of ensuring the quality and evidence behind the good performances of these methods. Understanding this rationale will be crucial when improving intraoperative MEP alarm criteria. We showed the key features during identification of MEPs and validated the results in a bicentric setup. To our knowledge, it is the first time an IONM machine learning classification task has been implemented in a multicenter setup.

## P02

**Influence of Eloquent Brain Tumors on Excitability of the Primary Motor Cortex**J Wermelinger<sup>1</sup>, K Lutz<sup>1</sup>, H Lenggenhager<sup>2</sup>, K Seidel<sup>1</sup><sup>1</sup> Inselspital—Universitätsspital Bern;<sup>2</sup> Universität Bern, Switzerland

**Objective:** The effects of motor eloquent brain tumors on cortical excitability and the motor network are still not completely understood. In this study, we compare the motor evoked potential (MEP) resting motor threshold (RMT) during preoperative transcranial magnetic stimulation (TMS) examination with the baseline MEP motor threshold (MT) of intraoperative neurophysiological monitoring (IOM) in relation to various clinical and tumor characteristics.

**Methods:** We included 65 patients with motor eloquent tumors who underwent surgery with IOM and had a preoperative TMS examination. The TMS-RMT and the IOM-MT of the abductor pollicis brevis muscle (APB) were collected. A previously defined threshold ratio was used for TMS ( $TMS-RMTratio = TMS-RMT_{tumor} / TMS-RMT_{healthy}$ ) and similarly for IOM ( $IOM-MTratio = IOM-MT_{tumor} / IOM-MT_{healthy}$ ). These ratios were used as surrogate markers for cortical excitability analysis. Additionally, a random forest (RF) classifier was used to see whether a machine learning (ML) algorithm was able to tell healthy from tumor side IOM MEPs apart.

**Results:** Tumor side TMS-RMT was significantly higher than healthy side TMS-RMT ( $TMS-RMTratio = 112\%$ ), and tumor side IOM-MT was significantly higher than healthy

side IOM-MT (IOM-MTratio = 152%). There was a significant positive linear correlation between the TMS-RMTratio and the IOM-MTratio. For tumors in the precentral gyrus, the average TMS-RMTratio and IOM-MTratio were significantly higher than 100% (TMS-RMTratio = 123% and IOM-MTratio = 158%). Furthermore, the RF model achieved 87% accuracy on the IOM MEP data classification task.

**Conclusions:** We observed a lower excitability in the tumor hemisphere compared to the healthy hemisphere, both pre- and intraoperatively. Low excitability in preoperative TMS generally correlated with lower intraoperative excitability. In particular, tumors in the precentral gyrus seem to affect the excitability of the motor system more than tumors in other cortical regions, with the healthy side being more excitable than the tumor side. Finally, a standard ML algorithm was able to classify healthy and tumor side MEPs accurately with our data, indicating that there might be additional neurophysiological markers of excitability in MEPs.

### P03

#### Reliability of Self-Measured Objective Functional Impairment Using the Timed up and Go Test in Patients with Diseases of the Spine

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**Aims:** The accurate assessment of a patient's functional status is essential. In addition to subjective, patient-reported outcome measures, measures of objective functional impairment (OFI) have recently been proposed. The Timed-Up and Go (TUG) test, measured by healthcare personnel, is one of the best studied options. We set out to study, whether patient self-measurement is similarly reliable.

**Methods:** In a prospective, observational study patients with spinal diseases underwent two serial TUG assessments, of which one was measured by a healthcare professional and the other by the patient him/herself. Interrater reliability was determined by calculating the intraclass correlation coefficient (ICC) with a two-way random-effects model, interpreted as excellent between 0.75–1.00 according to Cicchetti (1994). Paired *t*-tests were used to determine the difference between both measurements. The influence of patient-specific variables on interrater reliability were studied.

**Results:** We included 83 patients with a mean age of 62.2 years (SD 17.8); 34 (41.0%) were female. Fifty-two patients (62.6%) were treated for degenerative disc disease, 16 (19.3%) for spinal trauma, 14 (16.9%) for spinal infections and one (1.2%) for deformity. The lumbosacral region was most affected (*n* = 58; 69.9%), fifty-nine patients had undergone previous surgical treatment (71.1%). The reliability of patient self-measurement was excellent (ICC 0.9386, *p* < 0.001) and the difference between measurements of the healthcare professional (19.3 9.4 s) and patient (18.4 9.7 s) was insignificant (*p* = 0.116). Interrater reliability was slightly inferior in patients > 65 years (ICC 0.8776, *p* < 0.001), patients with ASA grades 3 & 4 (ICC 0.8743, *p* < 0.001), patients considered vulnerable or frail (ICC 0.8980, *p* < 0.001), and in patients not using any type of walking aid (ICC 0.8003, *p* < 0.001). Symptom severity, determined by an Oswestry Disability Index of > 40 points for patients with thoracolumbar disease did not influence interrater reliability, but patients with cervical diseases and a Neck Disability Index of > 40 points scored slightly worse (ICC 0.8204, *p* = 0.018).

**Conclusions:** Patients with diseases of the spine can self-determine OFI using the TUG test with excellent reliability under all studied conditions and circumstances. Knowledge gained from this study may help to optimize objective patient assessments, especially in regions and settings with limited healthcare resources.

P04

**Increased Mortality, Reduced Life Expectancy and Increased cardiovascular Co-Morbidities in Patients with Intracranial Aneurysms****B Grüter**<sup>1</sup>, **B Bandhauer**<sup>2</sup>, **S Wanderer**<sup>2</sup>, **P Gruber**<sup>1</sup>, **J Berberat**<sup>1</sup>, **C Blohm**<sup>3</sup>, **M Cattaneo**<sup>4</sup>, **G Schubert**<sup>5</sup>, **L Regli**<sup>6</sup>, **L Remonda**<sup>1</sup>, **S Marbacher**<sup>2</sup>, **L Anderegg**<sup>2</sup>, **H Steiger**<sup>2</sup><sup>1</sup> Division of Neuroradiology, Department of Radiology, Kantonsspital Aarau, Aarau, Switzerland;<sup>2</sup> Department of Neurosurgery, Kantonsspital Aarau, Aarau, Switzerland;<sup>3</sup> Federal Statistical Office, Neuchâtel, Switzerland;<sup>4</sup> Department of Clinical Research, University of Basel, University Hospital Basel, Basel, Switzerland;<sup>5</sup> Department of Neurosurgery, RWTH Aachen University, Aachen, Germany;<sup>6</sup> Department of Neurosurgery, University Hospital Zurich, Switzerland

**Background:** Population-based statistics may overestimate the life expectancy of patients with intracranial aneurysms (IA). This study aims to investigate potential excess mortality of IA patients and compare it with the survival probability of an age and sex-matched general population. Furthermore, causes of death of IA patients are analyzed and the prevalence of cardiovascular risk factors in IA patients is investigated.

**Methods:** Survival and cause of death were studied for 896 patients with 1107 consecutive IAs and compared to a sample of the age and sex-matched general population (1:100). Furthermore, presence of cardiovascular risk factors was evaluated in a retrospective register-based approach.

**Results:** The hazard rate of death upon detection of an unruptured IA was 3.116 [CI 2.291, 4.239] for the study period ( $p < 0.001$ ), mean age of death in these patients being  $73.9 \pm 1.7$  years, in comparison to  $83.6 \pm 0.3$  years for the matched general population. In ruptured IAs, the hazard of death was 46.213 [CI 6.391, 334.178] times higher during the first month after IA rupture ( $p < 0.001$ ), however, no increased mortality persisted thereafter when compared with unruptured IA patients. Cardiovascular deaths were more common among IA patients (34.3%) than in the matched general population (21.3%). Furthermore, cardiovascular risk factors and co-morbidities are overrepresented in IA patients ( $p = 0.001$ ).

**Conclusions:** Patients with an unruptured IA harbor a threefold increased risk of death upon detection of the IA and they die on average 10 years earlier than the general population. IA rupture is associated with increased mortality during the acute phase, however, after the first month, survivors are at similar risk of death as patients with unruptured IAs. These are important factors to consider when indicating treatment. Furthermore, as cardiovascular risk factors and cardiovascular deaths are over-proportionally represented among IA patients, aggressive management of all cardiovascular comorbidities appears of utmost importance in this patient group.

P05

**Augmented Reality for Procedural Targeting****P Reinacher**<sup>1</sup>, **A Stanicki**<sup>2</sup>, **R Roelz**<sup>2</sup>, **N Schallner**<sup>2</sup>, **A Rau**<sup>2</sup>, **B Jürgen**<sup>2</sup>, **T Demerath**<sup>2</sup><sup>1</sup> Kantonsspital St. Gallen KSSG;<sup>2</sup> Medical Center—University of Freiburg, Faculty of Medicine, University of Freiburg, Freiburg, Germany

**Aims:** Augmented reality (AR) is a technological megatrend that is increasingly being applied in many areas. The availability of this technology increasingly prompts the question of meaningful applications in clinical practice. We have investigated various use-cases.

**Methods:** Four AR devices (Magic Leap 1, Plantation, FA, USA) were used in combination with neurosurgical planning software (Elements, Brainlab, Munich) for various applications. Overall, 204 procedures in three intraoperative use-cases were investigated on phantoms regarding feasibility and accuracy in order to compare AR guided procedures to the respective standard methods. On a phantom with intracranial hemorrhage, a total of 60 operations for placement of hemorrhage drains (compared with freehand and stereotactic frame-based placement) were performed by 5 surgeons. Percutaneous placements of a cannula into the foramen ovale for ablation of the gasserian ganglion in trigeminal neuralgia were performed a total of 64 times by 4 subjects (compared with the landmark-based method). 80 placements of a cannula into a defined peridural target point in the lumbar spine were performed by 4 physicians. Placement accuracy was measured using computed tomography and the planning software.

**Results:** In the phantom experiments, compared to freehand applications, AR was significantly more accurate in all cases studied ( $p < 0.001$  in hemorrhage drains,  $p < 0.01$  in ganglion gasseri and  $p < 0.0001$  spinal). Nonetheless, when compared to a stereotactic approach based on frames in the phantom experiment regarding bleeding drains, the Euclidean distance achieved using AR (median 3 mm) was lower, but it was comparable to that achieved using STX (median 1.95 mm;  $p = 0.023$ ). In an emergency situation, this could be offset by the better time efficiency of bedside procedures using AR compared to a stereotactic operation.

**Conclusions:** AR is an interesting technical development that allows intraoperative applications for cases that are performed landmark-based (e.g., puncture of the foramen ovale or spinal punctures) or where bed-side procedures are performed due to urgency (e.g., hemorrhage drainage).

## P06

### Anaplastic Astrocytomas of the Cerebellopontine Angle: A Case Report and Review of the Literature

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**Background:** Anaplastic astrocytomas (AAs) are malignant, diffusely infiltrating, primary brain tumor that may rarely develop in the cerebellopontine angle (CPA). Due to the rareness and anatomical nuances of this critical location, the diagnosis and management of CPA AAs is challenging. The aim of this study was to picture the status of art on diagnosis, clinical presentation and treatment of AAs of the CPA.

**Methods:** We reviewed data from 35 consecutive patients with a diagnosis of CNS AA evaluated at one Institution and searched for those who had their tumor located in the CPA region. Then, a systematic review of the literature according to the PRISMA guidelines was conducted. A comprehensive literature search of the databases PubMed, Ovid MEDLINE and, Ovid EMBASE was designed. Studies were found using the MeSH terms and Boolean operators. The search had no time limitations. The first literature search was performed on 1 December 2023, and the search was updated on 19 February 2024.

**Results:** Including our Institutional case report, a total of 6 patients harboring an AA in the CPA region were identified, 5 males and one female. The median age was 47.5 years (range 3–71). Motor neurological deficits (paresis, gait imbalance, ataxia) were described in the whole cases. Most of the patients underwent STR and, in case of post-operative CHT, Temozolomide (TMZ) was the CMT regimen reported; post-operative RT was performed in 40% of case. Patients were followed-up with a Gd-enhanced MRI. Only one study described a recurrence.

**Conclusions:** The main goal of surgery is to reduce the tumor mass and relieve compression of surrounding nerves to improve neurological symptoms. The standard of care reported in the literature is maximal safe resection followed by radiotherapy and chemotherapy with temozolomide.

P07

### Feasibility of Robot-Guided Cold Ablation Osteotomy for Anterior Clinoidectomy

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**Introduction:** The anterior clinoidectomy is an important but also difficult part of skull base surgery. This surgical procedure provides access to lesions in the central skull base, particularly in the proximal carotid, sellar and parasellar regions. Mechanical removal using a diamond power drill is the most frequently mentioned instrument in the literature. The outcome of the hand-held drill can vary widely. Furthermore, thermal and mechanical damage can occur during mechanical bone removal. Innovations in laser osteotomy are highly desirable in neurosurgery. However, advances in medical laser technology offer potential improvements in the field of anterior clinoidectomy. Laser ablations are contact-free and provide several advantages over conventional instruments. The aim of our study was to test the feasibility and accuracy of the robot-guided Er:YAG laser for the extradural anterior clinoidectomy and optical canal delineation.

**Methods:** The experiment utilized fresh frozen skulls. Preoperative CT scans were performed for designing the laser cutting paths and postoperative CT images for bone ablation analysis. The target structure was reached by performing a pterional craniotomy and extradural preparation. Precise bone ablation was performed with the Er:YAG laser attached to a robotic arm. A navigation system and an OCT laser ensured the required accuracy.

**Results:** A total of four anterior clinoid process were hollowed out with the Er:YAG laser. On average, 63% of the spongy bone of the anterior clinoid process was removed. The intraoperative macroscopic photo documentation confirmed the expected precision of the presented technology.

**Conclusions:** In our preclinical cadaver study, we demonstrated the significant potential of the robot-guided Er:YAG laser for anterior clinoidectomy. The investigated technology achieves a high degree of cutting precision, which can be of great benefit, especially when removing the ACP in the vicinity of neurovascular structures. However, more investigation is needed regarding safety, preoperative planning and workflow.

P08

### Feasibility and Accuracy of Robot-Guided Cold Ablation Osteotomy for Extradural Optic Canal Unroofing

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**Aims:** Optic nerve unroofing, a crucial technique in skull base surgery, focuses on relieving pressure and decompressing the optic nerve for vision preservation and optimal nerve function. Despite its significance, the procedure poses challenges due to limited space,

restricted view, and proximity to critical structures. Advances in medical robotics offer potential solutions. This study explores the feasibility of a robot-guided cold ablation osteotome for optical canal delineation through cadaveric experiments and a systematic literature review. The paper aims to reveal the advantages, risks, and consequences of transitioning to laser technology for specific neurosurgical skull base procedures.

**Methods:** The experiment utilized five fresh frozen skulls, securely fixed in a Mayfield clamp. The NeuroPlan© software guided preoperative planning, accurately segmenting anatomical structures, and creating four trajectories with a 2 mm safety margin from high-risk areas. Entry points were chosen within the intended craniotomy site. Target points were aligned along the optic canal to ensure that connecting two of these points would reveal the canal's outer boundary on the surface. The surgical system equipped a 2940 nm Er:YAG laser with approximately 0.8 mm focal diameter and integrated optical coherence tomography (OCT). Precision in bone ablation was ensured using a navigation system. Access to the target structure was through a pterional craniotomy, preparing the optical canal extradurally.

**Results:** In the immediate postoperative assessment of all five skulls, there is a macroscopically evident clarity in the markings of the optic canal showcasing a notable level of precision in comparison to the preoperative planning. On postoperative CTs, the demarcation remains indiscernible. After the maceration process, a thread representing the nerve was inserted into the canal to verify accuracy. This allowed for a more detailed and nuanced examination of the achieved outcomes under the operating room microscope.

**Conclusions:** In our cadaver study, the robot-guided Er:YAG laser demonstrated significant potential for precise optical canal delineation, reducing injury risks to critical structures. While promising, further investigation is required on safety, preoperative planning, and workflow. Our study serves as preliminary work for future research on laser osteotomes in skull base surgery.

## P09

### Brain-Heart Interaction during Ecstatic Seizures

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**Aims:** Ecstatic epilepsy is a peculiar form of focal epilepsy, marked by seizures accompanied by heightened well-being and an expanded self-consciousness. However, the comprehensive understanding of brain-body physiology during ecstatic events remains limited. Exploring the dynamics of the heart, particularly through the analysis of heartbeat evoked potential (HEP)—a measurable brain response synchronized with the R-peak of the heart rhythm—connected to self-consciousness, and heart rate variability (HRV)—a marker reflecting variations in time intervals between consecutive heartbeats—associated with levels of well-being, emerges as a promising avenue for investigation. We aim to enhance our understanding of the neural and autonomic dynamics associated with ecstatic seizures

and move towards an holistic approach to patient care. We expect that during/after ecstatic auras, there will be: (i) a specific alteration in HEP, and (ii) an increase in HRV.

**Methods:** We considered three patients with drug-resistant ecstatic epilepsy implanted with intracerebral electrodes for epilepsy presurgical evaluation, who manifested reproducible ecstatic auras when electrical stimulation was applied to the right dorsal anterior insula. HEP and HRV were computed after each induced ecstatic aura (1–3 min sequences, mean total duration: 300 s) and compared to sequences of “control” stimulations of same duration. In the three patients, for both conditions, HRV was computed and HEP inspected for all intracerebral electrodes’ contacts (Patient\_1 = 124, Patient\_2 = 175, Patient\_3 = 156).

**Results:** In the “ecstatic” condition, HRV was statistically increased for all three patients ( $p < 0.05$ ). HEP, evaluated in the left insula in two patients and left inferior frontal gyrus in one patient, exhibited a significant reduced amplitude between 200–350 ms ( $p < 0.05$ ).

**Conclusions:** The ecstatic aura represents a distinctive case of alteration in self-related processes. In our patients, this state was associated with a modulation of the heart-brain connection, measured in terms of HEP, showing consistent variations in amplitude ~200 ms after the R peak, and an increase in HRV, indicating heightened vagal tone.

## P10

### 3D-Printed Intraventricular Neuroendoscopy Simulator: Development, Validation, and Future Training Applications

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**Background:** Surgical education and training necessitate continuous refinement of technical skills. Creating safe and effective training opportunities is paramount in neurosurgery, where procedures are technically demanding and caseloads are limited. Contemporary challenges such as resident work-hour restrictions have led to a shift towards simulation based medical education, necessitating innovative training tools. Our study focuses on a point-of-care 3D-printed simulator designed to train neurosurgical residents’ endoscope handling skills. The aim is to develop, describe and validate this model, addressing the demand for accessible and practical training resources in neuroendoscopic education in the years to come.

**Methods:** Medical image processing software was used to segment the healthy ventricle and skull from a patient’s MRI and CT scans. The pathologic ventricle was then artificially modeled using computer aided design software. Hard and soft tissue models were 3D-printed using fused filament fabrication and stereolithography technologies, mimicking the hardness levels of the original tissues. Neurosurgery residents with varying experience levels participated in a trial, performing standardized endoscopic procedures using the simulator. A questionnaire assessed qualitatively participants’ perceptions of the simulator’s teaching efficacy in neuroendoscopic ventricular tumor surgery.

**Results:** The neurosurgeons training on the model were 54% males ( $n = 7$ ) with a mean age of  $30 \pm 3.27$  years and a neurosurgical training time of  $4 \pm 2$  years. The average caseload of the corresponding operations in real-life patients was  $7.5 \pm 3.74$ . Feedback from the questionnaire indicated a unanimous agreement on the effectiveness of the simulator in developing systematic approaches to intraventricular visualization and replicating real surgical settings. Out of the total of the 12 participants 75% ( $n = 9$ ) felt more confident in the use of neuroendoscopic instruments and 91.7% ( $n = 11$ ) expressed increased confidence in future neuroendoscopic procedures after using the model. Analysis of variance showed that mean values do not differ significantly ( $p = 0.28$ ) from each other. Thus, the model was rated equally well with an overall mean Likert score of  $4.27 \pm 0.21$ .

**Conclusions:** The low cost in house 3D-printed simulator presented is an effective tool in neuroendoscopic training. Providing an accessible and practical training opportunity ultimately benefits the technical skills of future neurosurgeons.

## P11

### Accuracy and Safety Assessment of Cervical Pedicle Screw Instrumentation with a Systematic Review

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**Aims:** Cervical pedicle screws (CPS) have biomechanical superior properties when compared to the conventional lateral mass instrumentation of the spine. However, due to the narrow width of the cervical pedicle and its proximity to the vertebral arteries, the spinal cord, and nerve roots, CPS instrumentation theoretically poses a high risk of complications. The aim of this study is to assess the accuracy and safety of CPS instrumentation in a systematic review. Additionally, we assess how different insertion techniques (navigated, non-navigated and template-based) impact instrumentation accuracy.

**Methods:** PubMed, Cochrane and Scopus databases were searched for studies with the keywords: “cervical pedicle screw” AND “accuracy”, “measurement”, “placement”, “evaluation”, “position” and “safety” respectively. Inclusion criteria were clinical studies containing subaxial CPS (C3-C7) in adult human patients that assessed the accuracy of screw placement. In a Full-Text analysis following data was extracted: No. of cervical CPS, cervical level of placed screws, No. of patients, indications for surgery, insertion techniques, accuracy assessment modality, classification of accuracy, breach rate, complication rate and study origin.

**Results:** 72 studies were included in this systematic review, resulting in 13'748 CPS in 3'184 patients. Most studies originate in Asia (54; 75%), followed by Europe (12; 16.7%) and North America (6; 8.3%). A total of 9'529 CPS were placed with non-navigated techniques demonstrating an accuracy rate of 83.12% and a complication rate of 1.10%, 2'657 CPS were placed with navigation-based technology with an accuracy rate of 83.06% and a complication rate of 0.68% and 943 CPS were placed with templates with an accuracy rate of 95.82% and a complication rate of 0.00%.

**Conclusions:** To our knowledge this systematic review is the first to compare the accuracy of different insertion techniques for subaxial pedicle screw placement to this extent. Our findings indicate a high accuracy rate in cervical pedicle screw instrumentation when utilising navigated, non-navigated and template-based insertion techniques. Additionally, the results suggest a low overall complication rate associated with CPS instrumentation. These findings suggest the potential for extended application in spine surgery, particularly given the overall biomechanical superiority of CPS.

## P12

### Early Rehabilitation Using a Mind-Motor Exercise Program for Patients with Traumatic Brain Injuries: A Feasibility Study in the Acute Hospital Setting

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**Aims:** Traumatic brain injury (TBI) is a prevalent issue globally, affecting 50–60 million people annually, with the majority being mild TBIs. Post-TBI, individuals often experience impairments in both motor and cognitive skills, increasing the risk of re-injury and other complications. Preventing further falls and improving motor and cognitive functioning is crucial for minimising morbidity and mortality associated with recurrent TBIs. We analysed the feasibility and safety of a novel dual-task training, “StepIt” (1), as a means of early rehabilitation for such patients after TBI.

**Methods:** During the proposed training method, patients are presented with step patterns that they have to memorise and execute at a set pace. The resulting rhythm-based simultaneous cognitive-motor training enhances balance, step length and coordination while improving cognition. A prospective, one-arm, monocentric intervention trial is conducted at Kantonsspital St. Gallen to assess the safety and feasibility of this training in the acute hospital setting. Patients with any grade of TBI, aged 18 or older, physically capable of standing, and able to provide informed consent are evaluated for eligibility. Patients completing three to ten training sessions are included in the final analysis. Recruitment rate, inclusion rate, attrition rate, adherence rate, compliance rate, safety, patient and therapist satisfaction are assessed.

**Results:** Between November 2023 and January 2024, 87 patients with traumatic brain injuries have undergone eligibility screening. All seven patients fulfilling the inclusion criteria provided informed consent (recruitment rate: 8%, inclusion rate: 100%). One patient dropped out before completing at least three assessments and one patient was discharged early after two assessments (attrition rate: 29%). No adverse events have been reported thus far.

**Conclusions:** Early neurocognitive training is essential in preventing further injuries, yet a standardised training protocol can only be administered to a small cohort of patients during the acute hospital setting. The protocol seems to suit eligible patients, as no patient declined study participation and only one patient dropped out. Training can be safely implemented into daily physical therapy training. This study can serve as a basis for future investigations assessing the impact of the training in specific cohorts.

## P13

### SpineJack Kyphoplasty for the Treatment of Traumatic Thoracolumbar Burst Fractures—Results from a Retrospective Cohort Study

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**Aims:** The aim of this study was to compare the performance of intracorporeal fracture reduction using armed (SpineJack) kyphoplasty for the treatment of traumatic non-osteoporotic complete (A4) and incomplete (A3) burst fractures of the thoracolumbar spine in comparison with dorsal instrumentation.

**Methods:** In this retrospective analysis patients with traumatic burst fractures treated with SpineJack and/or minimal invasive dorsal instrumentation 2018–2022 were included. Operation time, length of hospitalization and radiographic fracture reduction were analyzed.

**Results:** 64 patients were treated with only a SpineJack (n = 14), dorsal instrumentation of the spine (n = 40) or a combination of both (n = 10). Of 34 with A3 fractures 2 were treated

with SpineJack and dorsal instrumentation, 20 with dorsal instrumentation only and 12 with SpineJack only. Rehospitalisation within 30 days following index surgery was necessary in 1 patient in the dorsal instrumentation only group, in 1 patient with dorsal instrumentation and SpineJack group, and none of the patients treated with a SpineJack only. The mean operation time was  $48 \pm 51$  min in the SpineJack only group,  $139 \pm 62$  min in the only dorsal instrumentation group and  $135 \pm 75$  min in the SpineJack and instrumentation group ( $p < 0.05$ ). The mean hospital stay in the SpineJack group was  $9.6 \pm 4.9$  days,  $13.2 \pm 9.8$  days in the only dorsal instrumentation group and  $12.1 \pm 8.1$  days for the dorsal instrumentation and SpineJack group ( $p = 0.39$ ). The mean fracture kyphosis angle correction (preoperative—postoperative) did not show significant differences between groups, with  $6.2 \pm 5.3^\circ$  in those treated with only a SpineJack,  $5.7 \pm 7.9^\circ$  in those treated with dorsal instrumentation only, and  $4.3 \pm 5.4^\circ$  in those treated with a combination of both,  $p = 0.76$ . The mean improvement in anterior vertebral body height was  $8.1 \pm 4.7$  mm in those treated with only a SpineJack,  $10.2 \pm 8.8$  mm in those treated with only dorsal instrumentation and  $11.0 \pm 6.2$  mm in those treated with a posterior instrumentation and SpineJack ( $p = 0.62$ ).

**Conclusions:** With similar radiographic fracture reduction, and complication rates, Spine-Jack Kyphoplasty has significantly shorter operation time when compared to dorsal instrumentation only. Our results demonstrate that SpineJack Kyphoplasty is a viable and safe option for the treatment of traumatic A3 fractures and in combination with short dorsal instrumentation for A4 fractures.

#### P14

### The Impact of Hemorrhage Extension on External Ventricular Drain Associated Infections in Patients with Primary Intracerebral and/or Intraventricular Hemorrhage

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**Background:** Ventriculostomy is a common neurosurgical intervention to treat acute hydrocephalus in patients with primary intracerebral (PICH) and primary intraventricular haemorrhage (PIVH). A variety of risk-factors for external ventricular drain (EVD)-associated infections (EVD AI) have been identified to date, however, how the quantity and distribution of the intracerebral and intraventricular blood impacts EVD AI-rates in this subpopulation of patients remains unclear.

**Methods:** Retro- and prospective single-center cohort study of PICH and PIVH patients who received an EVD between January 2009 and February 2023. Uni- and multivariable logistic regression analysis was used to assess potential predictors of EVD AI, including volumetric measurement of the intracerebral blood volume and the intraventricular hemorrhage (IVH) grading score.

**Results:** A total of 165 patients with PICH and PIVH underwent ventriculostomy, 117 (71%) of which received unilateral and 48 (29%) bilateral EVDs with a median in-situ time of 6 days (IQR 3;10). EVD AI occurred in 13/165 patients (7,8%) with a median onset time of 8 days (IQR 7;10). Diabetes mellitus (OR 4.91,  $p = 0.007$ ), postoperative cerebrospinal fluid (CSF) fistula at EVD entry-side (OR 4.059,  $p = 0.034$ ) and frequency of CSF measuring (OR 1.114,  $p = 0.041$ ) were associated with EVD AI in the univariate analysis, while the use of chlorhexidine dressings (OR 0.206,  $p = 0.012$ ) showed to be a protective factor. Higher IVH score and the intracerebral blood volume, showed no significant association with EVD AI.

**Conclusions:** While comorbidities like diabetes mellitus or complications like fistula, are associated with a higher risk for EVD AI in the subpopulation of PICH and PIVH patients, no increased risk was found for greater blood volume extension in PICH and PIVH. These findings contribute to narrowing risk factors down and refining further research.

P15

### Oxytocin Secretion after Pituitary Surgery and Early Diabetes Insipidus

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**Aims:** Diabetes insipidus (DI) is a well-known complication of transsphenoidal pituitary surgery (TPS) with no definite predictive biomarker to date making it difficult to anticipate. While oxytocin (OXT) was previously suggested as a possible biomarker to predict SIADH-related hyponatremia after TPS, its secretion in patients presenting with DI was never studied.

**Methods:** We measured the urinary output of OXT in 67 consecutive patients subjected to transsphenoidal pituitary surgery.

**Results:** Patients developing DI showed a delay in the increase of OXT secretion after TPS. Moreover, normonatremic patients that did not show normalization of OXT levels at day 4 after surgery tended to develop SIADH later on.

**Conclusions:** Taken together, these results show for the first time that OXT release might help predict DI after TPS and differentiate it from other pathologies of water-sodium balance.

P16

### A Systematic Review of the Metabolism of High-Grade Gliomas: Current Targeted Therapies and Future Perspectives

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**Background:** High-grade glial tumors (HGGs) exhibit aggressive growth patterns and high recurrence rates. The prevailing treatment approach comprises radiation therapy (RT), chemotherapy (CMT), and surgical resection. Despite the progress made in traditional treatments, the outlook for patients with HGGs remains bleak. Tumor metabolism is emerging as a potential target for glioma therapies, a promising approach that harnesses the metabolism to target tumor cells. However, the efficacy of therapies targeting the metabolism of HGGs remains unclear, compelling a comprehensive review. This study aimed to assess the outcome of present trials on HGG therapies targeting metabolism.

**Methods:** A comprehensive search of PubMed, Ovid MEDLINE, and Ovid EMBASE was conducted until November 2023. The search method used pertinent Medical Subject Heading (MeSH) terminologies and keywords referring to “high-grade gliomas”, “metabolism”, “target therapies”, “monoclonal antibodies”, “overall survival”, and “progression-free survival”. The review analyzed studies that focused on therapies targeting the metabolism of HGGs in human subjects. These studies included both randomized controlled trials (RCTs) and non-randomized controlled trials (NRCTs).

**Results:** Out of 284 articles identified, 23 trials met the inclusion criteria and were thoroughly analyzed. Phase II trials were the most numerous (62%). Targeted metabolic therapies were predominantly used for recurrent HGGs (67%). The most common targeted pathways were the vascular endothelial growth factor (VEGF, 43%), the human epidermal growth factor receptor (HER, 22%), the platelet-derived growth factor (PDGF, 17%), and the mammalian target of rapamycin (mTOR, 17%). In 39% of studies, the subject treatment was combined with CMT (22%), RT (4%), or both (13%). The median OS widely ranged from 4 to 26.3 months, while the median PFS ranged from 1.5 to 13 months.

**Conclusions:** This systematic literature review offers a thorough exploration of the present state of metabolic therapies for HGGs. The multitude of targeted pathways underscores

the intricate nature of addressing the metabolic aspects of these tumors. Despite existing challenges, these findings provide valuable insights, guiding future research endeavors. The results serve as a foundation for refining treatment strategies and enhancing patient outcomes within the complex landscape of HGGs.

## P17

### Primary Co-Occurrence of Gonadal and Extragonadal Central Nervous System (CNS) Germ Cell Tumors (GCTs): Case Report and Review of the Literature

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**Background:** The primary co-occurrence of gonadal and extragonadal central nervous system (CNS) germ cell tumors (GCTs) has rarely been reported in the literature. A common opinion on the underlying etiopathogenetic mechanism is lacking. This study aimed to investigate the pathophysiological mechanisms and genetic pathways underlying the primary co-occurrence of gonadal and CNS GCTs.

**Methods:** We reviewed data from 29 consecutive patients with a diagnosis of CNS GCTs evaluated at one Institution over the past 23 years and searched for those who had at least a primary gonadal co-occurrence of GCT. Then, a systematic review of the literature according to the PRISMA guidelines was conducted. A comprehensive literature search of the databases PubMed, Ovid MED-LINE and, Ovid EMBASE was designed. Studies were found using the MeSH terms and Boolean operators. The search was limited to articles published from 2000 to 2023. The first literature search was performed on 8 September 2023, and the search was updated on 10 December 2023.

**Results:** Including our Institutional case report, a total of 7 patients with both testicular NGGCTs and extragonadal CNS GCTs were identified (5 patients with metachronous and 2 patients with synchronous presentation). The average age at the presentation was 17 years old. The cerebral histo-types were mixed GCTs (3 cases; 43%), pure germinomas (3 cases, 43%), and one yolk sac tumor (14%). The reported hypotheses for the etiopathogenesis are syndromic and non-syndromic. Two out of seven cases (29%) were syndromic, one suffering from Down's Syndrome and the other from Testicular Dysgenesis Syndrome. The other 5 patients (71%) were non-syndromic. The mutations of the KIT gene, PI3K pathway, and MAPK pathway have been shown to guarantee the survival of mismigrated primordial cells while suppressor genes allow their resistance against apoptotic death. Aberrant chromosomes have also been reported to be responsible for their oncogenic transformation.

**Conclusions:** There are currently many hypotheses concerning the developing mechanism of primary co-occurrent testicular and intracranial GCTs but genetic factors seem to have a paramount role in their etiopathogenesis. Additional research is needed to elucidate the genetic mechanisms that underlie the growth and differentiation of GCTs in such individuals.

## P18

### Model to Simulate Brain Biopsies Using a Navigated Robotic Guiding System and a Bone Cutting Laser

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**Introduction:** Brain biopsies are necessary in cases of unclear lesions on imaging studies to establish a treatment plan based on the histologic diagnosis. This study explores the application of laser technology and robotic guidance in neurosurgery to enhance the precision and safety of brain biopsies. Leveraging previous findings on lasers creating precise burr holes, the research investigates the feasibility of combining laser ablation with a robotic biopsy needle guiding system.

**Methods:** The brain biopsies with CARLO© (Cold Ablation Robot-guided Laser Osteotome) and its biopsy needle guidance system were performed in an experiment with the following five steps on five fresh frozen heads:

Step 1: Prebiopsy, CT scans were made Step 2: Planning of two biopsies per head, one angled 45° and the other 90°. Step 3: Heads fixation with a Mayfield clamp. Registration was performed to match the head to the prebiopsy CT. The Er:YAG laser ablated a bone canal approximately 2.5 mm in diameter. Insertion of the biopsy needle through the biopsy needle guiding system. Step 4: Post-biopsy, a follow-up CT scan was conducted Step 5: Biopsy accuracy is measured in the biopsy planning software using the pre- and post-biopsy CT scans.

**Results:** In 9 out of 10 biopsies, the laser osteotome demonstrated comparable accuracy to the 1–3 mm deviation achieved with conventional biopsy methods. The experimental results suggest that the combined use of laser ablation and a guidance device enables precise bone ablation and accurate needle guidance for biopsies.

**Conclusions:** The robotic arm ensures sufficient stability and precision for guiding the biopsy needle. The smaller biopsy angle potentially enabling access to brain areas that would be inaccessible using conventional biopsy techniques. These results demonstrate the potential of integrating laser technology and robotics in neurosurgery, potentially enabling less invasive, faster and safer biopsies, ultimately leading to better patient outcomes.

## P19

### Changes in Ventricular Volume after Endoscopic Third Ventriculostomy for Aqueductal Stenosis in Adults

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**Aim:** Endoscopic third ventriculostomy (ETV) is an established neurosurgical intervention for treating aqueductal stenosis (AS). Assessment of ventricular size often relies on linear measurements and indexes such as the Evans Index (EI) and Frontal and Occipital Horn Ratio (FOHR), which can be imprecise and subject to interpretation. Long-term data regarding actual ventricular volume following ETV is scarce. This study aims to analyze the course of the ventricular volume following ETV and evaluate its suitability as a monitoring tool for clinical outcomes.

**Methods:** We retrospectively analyzed radiological images and clinical records of adult patients ( $\geq 18$  years) who underwent ETV for AS between 2010–2020. The primary endpoint was the lateral and third ventricular (LTV) volume change between the different follow-up periods in patients who did not require revision surgery (successful ETV group). Follow-up periods were grouped as <3 months, 3–6 months, 6–12 months, 1–2 years, and 2–4 years postoperatively. Furthermore, the correlation of ventricular volume with improving clinical symptoms was analyzed using logistic regression analysis. Volumetric analysis was performed by a semi-automated segmentation tool (Sectra Workstation IDS7, Sectra, Linköping, Sweden).

**Results:** A total of 238 radiological images from 46 patients (median of 5 images per patient) were analyzed. Thirty-nine (84.8%) patients did not require revision surgery (successful ETV group). Overall, there was a direct postoperative decrease in LTV volume by an average of  $22.8 \pm 22.4$  mL (–16.2%), significantly higher than reductions observed in EI (–5%;  $p < 0.001$ ) and FOHR (–3.3%;  $p < 0.001$ ). In the successful ETV group, LTV

volume decreased by a mean of 20% within 3 months postoperatively, followed by further 11% and 16% reductions after 3–6 months and 6–12 months, respectively. Overall, the preoperative LTV volume was reduced by 39% after 1–4 years postoperatively, after which it stabilized. There was no association between the amount of LTV volume reduction and clinical improvement during the follow-up period (OR 1.03, [95% CI 0.99–1.07];  $p = 0.186$ ). **Conclusions:** The volumetric analysis provides a more accurate representation of ventricular size changes following ETV for AS. It demonstrates a continuous reduction in LTV volume during the first year after surgery, whereafter, the volumes remain stable in most cases. These novel insights could guide clinical follow-up protocols after ETV for AS.

## P20

### SpineJack Reconstruction with Cement Augmentation vs. Conventional Balloon-Kyphoplasty or Vertebroplasty for Stable Vertebral Fractures: A Comparative Study

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**Aims:** The optimal treatment for stable vertebral fractures is yet unclear. This retrospective monocentric observational study aims to compare the outcomes and safety profiles of patients undergoing treatment with the SpineJack System versus conventional methods of vertebroplasty and balloon-kyphoplasty.

**Methods:** We analyzed 36 patients (median age: 75.3 years) with 40 stable vertebral fractures due to trauma or osteoporosis (AO classification A1–A4, osteoporotic fracture classification OF 1–OF 5) treated at our Department of Neurosurgery at Kantonsspital Aarau since 2022. Treatment included vertebroplasty, balloon-kyphoplasty or SpineJack implantation with cement augmentation. The primary outcome measure was pain reduction assessed using the visual analogue scale (VAS). Secondary outcomes included the Oswestry Disability Index (ODI), reduction in kyphotic angle, operative duration and complications.

**Results:** After SpineJack implantation, pain reduction reached 66%, compared to 60.5% in the vertebroplasty group (VP) and 66.2% in the balloon-kyphoplasty (BK) group. Pain reduction was statistically significant within each group ( $p < 0.0001$ ), with no difference between groups ( $p = 0.16$ ,  $p = 0.41$ ). Accordingly, a 68% improvement in ODI was observed in the SpineJack group (VP 73.2%, BK 78%), also with no statistical significance between the groups. However, kyphotic angle reduction was greatest after SpineJack implantation (SJ 48%, BK 33%, VP 15.2%;  $p = 0.0219$ ). Operative duration was comparable (mean 39.8 min vs. 34.5 min vs. 44.2 min;  $p = 0.41$ ). Adjacent fractures were observed in 20% of the SpineJack group, but not in the conventional groups.

**Conclusions:** This study demonstrates the effectiveness of all three treatment modalities, particularly in pain relief, which represents the main treatment goal. Restoration of height and improvement of kyphotic angle with SpineJack reconstruction and augmentation resulted in a higher risk of adjacent fractures. Further data collection and analysis are warranted to refine individualized treatment strategies, potential benefits and risks.

## P21

### CAR Macrophages for Brain Tumor Immunotherapy

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**Aims:** Glioblastoma is the most malignant primary brain tumor. While immunotherapies have improved prognosis in many other cancer types, success in GBM remains scarce.

We want to target immunosuppressive glioma-associated myeloid cells by genetically engineering macrophages with a chimeric antigen receptor (CAR).

**Methods:** We transduced the acute monocytic leukemia cell line THP-1 with a lentiviral vector to achieve stable CAR expression targeting the GBM-specific antigen EGFRvIII. We used phorbol-12-myristate-13-acetate, interferon- $\gamma$ , and lipopolysaccharide to differentiate our THP-1 monocytes into macrophages and performed in vitro phagocytosis assays to test the effector capacities of our CAR macrophages (CAR-Ms).

**Results:** Differentiated CAR-Ms showed upregulation of typical macrophage markers CD11b and CD80. Anti-EGFRvIII CAR-Ms significantly increased uptake of BFP-labeled EGFRvIII+ U251 tumor cells (M: 2.51%, SD: 1.06) compared to an off-target anti-CD19 CAR (M: 0.59%, SD: 0.25) ( $t(14) = 4.972, p = 0.0002$ , two-tailed), suggestive of increased phagocytosis. Importantly, no difference in phagocytosis was seen between CAR-Ms in co-culture with EGFRvIII-U251 (M: 0.75%, SD: 0.46) ( $t(14) = 0.84, p = 0.41$ , two-tailed), demonstrating CAR specificity.

**Conclusions:** Here, we show the feasibility of an in vitro THP-1-derived CAR-M model that specifically targets and phagocytoses tumor cells expressing EGFRvIII. Translation to primary macrophages and subsequently NSG mice are the next steps in the preclinical evaluation of CAR-M for GBM immunotherapy.

## P22

### Continuous Intrathecal or Intra-Arterial Nimodipine Administration as Rescue Therapy for Refractory Vasospasm in Patients with Aneurysmal Subarachnoid Haemorrhage Is Safe and Effective

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**Background:** Delayed cerebral ischaemia (DCI) due to cerebral vasospasm (CVS) after aneurysmal subarachnoid haemorrhage (aSAH) is associated with significant morbidity and mortality. Despite optimal conservative management, a significant patient subgroup suffers from symptomatic, therapy refractory CVS and develop DCI. We aimed to investigate the safety and efficacy of intrathecal and/or continuous intra-arterial application of nimodipine.

**Methods:** We performed a single-centre, retrospective observational study including all patients diagnosed with therapy refractory CVS after aSAH treated at our tertiary centre between January 2018 and December 2021 who received either continuous intrathecal or intra-arterial nimodipine. For continuous intrathecal nimodipine application, a catheter was inserted in the carotid cistern via supraorbital craniotomy. For intra-arterial application, an endovascular microcatheter was placed in the petrosal segment of the internal carotid artery for continuous administration of nimodipine. Primary outcome was measured by the modified Rankin Scale (mRS) at 6 months. Secondary outcomes included treatment related complications.

**Results:** In total, 21 patients were included. Fifteen patients received continuous intrathecal nimodipine, and five patients received continuous intra-arterial nimodipine. One patient received both intrathecal as well as continuous intra-arterial nimodipine. Clinical outcomes after 6 months were excellent in both groups (mRS 1). Eight patients (53%) treated with intrathecal nimodipine suffered from symptomatic CVS and additionally received bolus intra-arterial spasmolysis. In the continuous intra-arterial nimodipine group, intra-arterial treatment was discontinued due to thrombus obstruction of the catheter in three patients (60%). In all of these patients, the catheter had to be retrieved and bolus intra-arterial

spasmolysis was performed. Complications associated with intrathecal and intra-arterial catheter insertion were rare. One patient in the intrathecal nimodipine group developed acute subdural hematoma, which had to be treated surgically.

**Conclusions:** Continuous intrathecal and intra-arterial application of nimodipine for treatment of therapy refractory CVS appeared safe and seems to reduce the development of DCI. Prospective studies evaluating the effect of these nimodipine applications are warranted.

## P23

### Transforaminal Lumbar Interbody Fusion with or without Posterior Release of the Anterior Longitudinal Ligament—A Single-Center, Retrospective Observational Cohort Study

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**Aims:** Transforaminal anterior release (TFAR) is a technical extension of the transforaminal lumbar interbody fusion (TLIF) procedure with deliberate release of the anterior longitudinal ligament (ALL). It allows for a greater correcting of the sagittal balance but it technically more challenging and potentially more harmful. There are only few reports on this technique, especially in the lower lumbar spine.

**Methods:** We conducted a single-center, retrospective cohort study, including consecutive adult patients undergoing TLIF surgery at the levels L4/L5 and/or L5/S1 between 01/2018–12/2022 for degenerative disc disease or deformity. The TFAR group was compared to a normal TLIF group (without ALL release). We compared demographic and surgical characteristics, adverse events (AEs), clinical outcomes and spinopelvic radiological parameters before and until 12 months postoperative.

**Results:** Of  $n = 438$  patients,  $n = 18$  with TFAR  $n = 18$  and  $n = 90$  undergoing a normal TLIF were included. Baseline demographic data were largely similar, but the TFAR group had more deformity indication, more prior spine surgery and TLIFs were more open at the L5/S1 level (all  $p < 0.05$ ). TFAR procedures were more often part of extensive, anterior-posterior or multilevel fusion procedures with longer surgery time and higher blood loss. The rates of intraoperative medical AEs were higher in TFAR procedures (16.7 vs. 3.3%,  $p = 0.027$ ) but surgical AEs were similar (16.7 vs. 12.2%,  $p = 0.822$ ). At time of discharge, 90 days and 12 months postoperative, the rates and severities of surgical AEs, as well as reoperation rates and clinical outcomes were similar (all  $p > 0.05$ ). TFAR allowed for an increase in total lumbar lordosis of  $16.1^\circ$  and in lumbar lordosis between L4-S1 of  $16.3^\circ$  at discharge, which was maintained during follow-up. In both the uni- and multivariable models, patients undergoing TFAR were as likely as patients undergoing normal TLIF to experience any complication (adjusted OR 1.20, 95% CI 0.33–4.43), any reoperation (aOR 0.64, 95% CI 0.15–2.77) or excellent/good clinical outcome at 12 months (aOR 2.58, 95% CI 0.66–10.1).

**Conclusions:** The TFAR technique has a safety profile which is comparable to the normal TLIF procedure, but it allows for a much greater restoration of lumbar lordosis at the L4-S1 levels. We suggest considering the TFAR technique in selected patients with mobile spines and sagittal imbalance.

## P24

### Anterior Column Realignment via Minimally-Invasive Lateral Thoracic and Lumbar Interbody Fusion with Expandable Interbody Spacers—Considerations, Complications & Outcomes

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**Background:** Anterior column realignment (ACR), using a lateral lumbar or thoracic interbody fusion (LLIF) approach to release the anterior longitudinal ligament (ALL), is a powerful technique to increase segmental lordosis. Our experience with the use of expandable LLIF spacers in the context of ACR is reported.

**Methods:** Retrospective, single-center observational cohort study including consecutive patients treated by LLIF using an expandable titanium interbody implant at our joint neuro-ortho spine center between 09/2018 and 01/2024. Patients with ACR (deliberate ALL release) were compared to patients without ACR. Outcome measures include adverse events (AEs), radiological (segmental sagittal Cobb angle, spinopelvic parameters) and clinical outcomes (excellent, good, fair, poor) until 12 months postoperative.

**Results:** We identified 503 patients, in which we performed LLIF at 732 levels. In 63 patients (12.5%) and 70 levels (9.6%) an expandable spacer was used. Of those, in 30 patients (47.6%) and 30 levels, the ALL was released (42.8%). Age (mean 61.4 years), sex (57.1% female), comorbidities and further demographic features were similar, but patients in the ACR group had a higher anesthesiologic risk, were more frequently operated for degenerative disk disease/deformity and had a more severe dysbalanced spine (all  $p < 0.05$ ). ACR was most frequently performed at L3/4 (36.7%) and L4/5 (23.3%) but included all levels in the thoracolumbar region up to T11/12, entailing multilevel fusions in 50% (3–7 levels) and long constructs in 26.7% (> 7 levels). Surgeries were longer for ACR procedures (mean 434 vs. 298 min,  $p < 0.001$ ) but estimated blood loss was similar. Intraoperative AEs occurred in 3.3% (ACR) and 3.0% (no ACR;  $p = 0.0945$ ; none related to the spacer). In ACR cases, mean segmental lordosis changed from  $-2.8^\circ$  (preoperative) to  $16.4^\circ$  (discharge;  $p < 0.001$ ),  $15.0^\circ$  (3 months;  $p < 0.001$ ) and  $16.9^\circ$  (12 months;  $p < 0.001$ ), whereas this change was less in non-ACR cases ( $4.3^\circ$  vs.  $10.5^\circ$  (discharge;  $p < 0.05$ ),  $10.9^\circ$  (3 months;  $p < 0.05$ ) and  $10.4^\circ$  (12 months;  $p > 0.05$ )). Rates of AEs and clinical outcomes at 3 and 12 months were similar (all  $p > 0.05$ ) and no pseudarthrosis at the LLIF level was noted.

**Conclusions:** Data in this series suggest that ACR with placement of an expandable LLIF interbody implant was safe and restored significantly more segmental lordosis compared to LLIF without ALL release, which was maintained during follow-up.

## P25

### Unveiling Self-Related Deficits in Neurosurgical Patients: Insights from the Self-Other Voice Discrimination Task as a Neuropsychological Tool

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**Aims:** Neurosurgeons frequently confront the challenge of managing personality changes and self-related deficits in patients undergoing brain resection [1]. The comprehensive understanding of these issues requires the inclusion of specialized and objective neuropsychological tools. Given the role of self-voice in identity, a paradigm integrating self-voice perception could be promising for detecting self-related abnormalities. Self-Other voice discrimination task has experimentally proven effective in targeting the perceptual and neural mechanisms of self-voice perception [2,3]. In this work we aim at defining the clinical potential of the Self-Other Voice Discrimination (SOVD) task as complement to the standard neuropsychological assessment to discriminate distinct self-voice deficits in neurosurgical patients.

**Methods:** We considered 17 patients eligible for neurosurgery (2 epileptic lesions, 5 astrocytoma, 1 glioma, 6 glioblastoma, 1 oligodendroglioma, 1 meningioma and 1 metastasis). During SOVD task, patients were asked to distinguish whether a presented voice stimulus belonged to them or someone else. The accuracy in discriminating self and other voice was standardized according to statistical analyses commonly used in neuropsychological psychometrics [4]. The links of SOVD performance with other neuropsychological scores and with lesion localization were further investigated.

**Results:** The SOVD task demonstrated clinical discriminatory capacity, revealing impairments in self-voice perception in three patients, not predictable by other neuropsychological deficits. Impairments in other-voice perception correlated with inhibitory neuropsychological anomaly, indicating a potential association with executive deficits in voice recognition. Preliminary results on the three patients with self-voice deficits suggested the involvement of orbitofrontal and parietal brain regions.

**Conclusions:** Although a large cohort of patients, with homogeneous lesion-location is needed to understand the brain areas more representative of self-related processes, this exploratory study underscores the clinical value of the SOVD task. It opens new avenues for improved diagnoses and tailored treatments for self-related impairments in neurosurgical patients.

## P26

### Radiomics for Differentiation of Pediatric Posterior Fossa Tumors: A Meta-Analysis and Systematic Review of the Literature

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**Background:** In this study, we performed a systematic review and meta-analysis to better define the overall performance of the current radiomics-based models for the discrimination of pediatric posterior fossa tumors.

**Methods:** A comprehensive literature search of the databases PubMed, Ovid MEDLINE, Ovid EMBASE, Web of Science, and Scopus was designed and conducted by an experienced librarian. We estimated overall sensitivity (SEN) and specificity (SPE). Event rates were pooled across studies using a random-effects meta-analysis, and the  $\chi^2$  test was performed to assess the heterogeneity.

**Results:** Overall SEN and SPE for differentiation between MB, PA, and EP were found to be promising, with SEN values of 93% (95% CI = 0.88–0.96), 83% (95% CI = 0.66–0.93), and 85% (95% CI = 0.71–0.93), and corresponding SPE values of 87% (95% CI = 0.82–0.90), 95% (95% CI = 0.90–0.98) and 90% (95% CI = 0.84–0.94), respectively. For MB, there is a better trend for LR classifiers, while textural features are the most used and the best performing (ACC 96%). As for PA and EP, synergistic employment of LR and NN classifiers, accompanied by

geometrical or morphological features, demonstrated superior performance (ACC 94% and 96%, respectively).

**Conclusions:** The diagnostic performance is high, making radiomics a helpful method to discriminate these tumor types. In the forthcoming years, we expect even more precise models.

## P27

### Intraoperative Mixed Reality and Recalibration Based on Signature Vessels: Two Series of 11 Consecutive Cases

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**Aims** Using mixed reality (MR) as an intraoperative tool is modifying the neurosurgery perception, aiming intraoperative safety. It allows to integrate 3D-images to the surgical field thanks to the projection of images in microscope eyepiece. We describe how we use MR to measure navigation inaccuracies. Navigation inaccuracies are corrected by digital recalibration using skin, bone and cerebral landmarks as « signature structures » specific to each phase of surgery.

**Methods** Preoperative planning is performed by the surgeon on the iPlannet program. Skin surface and skull are segmented as reference objects preoperatively. Characteristic vessel segments possibly visible in the operative field are segmented as signature vessels (SV). Reference objects are characterized as having a unique shape and being easily identifiable in the surgical field. Recalibration is performed by adjusting models to the real world. The distance of the adjustment is measured in three axis: the X axis is the horizontal line on the microscope field, the Y axis is the vertical line and the Z axis is the orthogonal to the surgical field, which is adjusted using autofocus laser. 11 consecutive cases were operated from January 2018 to November 2019, using MR recalibration. Data are then compared with a second sample of 11 patients who are being operated in 2024.

**Results** Analyzing the first sample, of 11 patients, 4 patients were males (36.4%) and 7 females (63.6%), with an average age of 59 years old. Patients were operated for vascular (63.6%) and oncologic (36.4%) pathologies. The MR skin error needing intraoperative correction was of  $1.3 \pm 1$  mm for X axis,  $2.4 \pm 1.8$  mm for Y axis and  $4.9 \pm 9.2$  mm for the Z axis. During the bone phase the average correction was of  $0.5 \pm 0.9$  mm for X axis,  $2.3 \pm 4.0$  mm for Y axis and of  $1 \pm 1.2$  mm for Z axis. The target phase is characterized by a correction of  $1.5 \pm 1.6$  mm in X axis,  $4.3 \pm 4.2$  mm in Y axis and  $1.8 \pm 1.4$  mm in Z axis. During each phase, we performed multiple recalibrations in order to maximize MR accuracy. In skin phase we performed an average of 2 recalibrations, in bone phase just one and in target phase the average number of recalibration was  $3.7 \pm 1.8$ . The second group will be composed of 11 patients operated for several cranial pathologies in 2024.

**Conclusions:** To maximize surgical safety using MR the navigation has to be recalibrated using reference objects and in particular SV. In this work we measured and report the accuracy of MR with intraoperative recalibration.

## P28

### Hydrocephalus in Surgically Treated Glioblastoma Patients—To Treat or Not to Treat?

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**Background:** Due to overall poor prognosis in glioblastoma patients, the decision whether and how to treat hydrocephalus is challenging. The aim of this study is to analyze the

indication and decision-making as well as functional outcome, and overall survival of hydrocephalus treatment in glioblastoma patients.

**Methods:** We retrospectively analyzed consecutive patients who underwent surgery for GBM between October 2009 and October 2023 at our department. The indication for treatment and treatment method were recorded. Further, patient and tumor characteristics, radiological features, overall survival, as well as functional outcome based on mRS and Karnofsky index were assessed. Outcome measurements in the treated group before and after treatment, as well as clinical outcome and overall survival between the treated group and the group not receiving treatment were compared.

**Results:** Out of 781 consecutive glioblastoma patients, we identified 28 patients (3.6%), who developed hydrocephalus during the course of treatment. Overall, 15 (54%) patients received treatment for hydrocephalus, of which nine (60%) patients were treated with ventriculoperitoneal shunt (VPS), three (20%) with endoscopic third ventriculostomy, two (13.3%) with external ventricular drainage, and one (6.6%) with hematoma evacuation. The indication for treatment in most patients was somnolence or CSF-leakage, while reasons for non-treatment were mostly poor prognosis due to tumor progress, surgeon-decision, or patients' wish. Mean mRS significantly improved after treatment of hydrocephalus (from  $4 \pm \text{SD}$  to  $3 \pm \text{SD}$ ,  $p = 0.005$ ) at a median of 25 months [4;50] follow up. In 88% of the cases, hydrocephalus treatment led to an improvement of the symptoms. In four patients (14%) complications occurred, all within the group receiving VPS implantation. Hydrocephalus treatment prolonged survival by 154 days (480 [60;676] vs. 326 [232;634] days), without a significant difference.

**Conclusions:** The decision when to treat hydrocephalus in GBM patients depends on various factors and remains challenging. Treatment seems to non-significantly prolong overall survival, lead to a relief in symptoms, and improve functional outcome.

## P29

### Identification of Plasma-Derived Diagnostic and Prognostic Biomarkers including SERPINA3 for Glioma and Glioblastoma

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**Aims:** Advancement in the diagnosis and surveillance of gliomas has been limited posing both diagnostic and therapeutic challenges. Definitive diagnosis, distinction of progression versus pseudoprogression and prognosis assessment still depend on invasive neurosurgical biopsy procedure. Minimally-invasive plasma sampling could minimize the risks associated with invasive tissue sampling. Therefore, we aimed to identify specific plasma protein patterns of low- and high-grade glioma patients, compared to healthy individuals and investigated whether different plasma-derived protein signatures were associated with survival in glioma patients.

**Methods:** Plasma samples were from patients with glioma grades I to IV collected during tumor removal and from healthy controls donating blood were processed for Liquid Chromatography Mass Spectrometry (LC/MS) proteomics after depletion of the 14 most abundant plasma proteins, in order to specifically detect low-abundant tumor-derived proteins.

**Results:** Overall, 646 proteins were measured across 104 plasma samples from glioma patients and 57 plasmas from the healthy cohort. Principal component analysis showed 2 clusters of samples, one containing low- and high-grade glioma samples and the other containing healthy and some grade IV (GBM) plasma samples. Interestingly, a spatial analysis of tumor location by MRI associated the GBM samples separated from healthy samples with subventricular vicinity. 26 differentially expressed proteins (DEPs) were identified

discriminating between glioma and healthy samples and 30 DEPs discriminating GBM and healthy samples. The top most overexpressed proteins in gliomas vs. controls were SERPINA3, F13A1, and TKT. Multivariate analysis identified SERPINA3, PPBP and MYH9 as strong discriminators of healthy vs. GBM but also of low-grade vs. GBM, indicating that these proteins may represent specific plasma biomarkers for GBM. SERPINA3, MYL1 and CLU were associated with poor survival in GBM.

**Conclusions:** In conclusion, we describe sets of plasma derived proteins, in particular SERPINA3, as predictive biomarkers that could be used to assess tumor progression allowing patient-centered treatment options. Currently, we are validating our results in an external validation cohort, providing a solid base for the future diagnosis and prognostication of GBM patients.

### P30

#### Adverse Events in Neurosurgery: Validation of the Therapy-Disability-Neurology (TDN) Grade Using an International Survey-Based Assessment

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**Aim:** Neurosurgical adverse events (AE) are frequent and may have dramatic consequences on quality of life. The lack of a standardized classification of their severity hinders evaluation and improvement of the safety of neurosurgical procedures. The Therapy-Disability-Neurology (TDN) grade was introduced in 2021 and proposed a patient-centered approach that overcomes the limitations of previous grading systems by addressing the severity of neurologic and disabling AEs. It was validated on 6071 interventions and was consistent with clinical and economic consequences of AEs. The aim of the current study is to assess the reliability, validity and applicability of the TDN grade.

**Methods:** We conducted an online survey study among participants with various degrees of expertise in neurosurgery. Participants received 16 case vignettes and had to determine the TDN grade as well as to review the validity, interpretability, logicity, and simplicity of the grading system.

**Results:** The inter- and intra-rater reliability of the TDN grade was substantial ( $\alpha = 0.66$  and  $\alpha = 0.79$ ). Most participants recommended to report the TDN grade along its separate dimensions, for which the inter- and intra-rater was substantial to almost perfect ( $\alpha = 0.74$  and  $\alpha = 0.85$ ). The use of online calculation tools significantly increased agreement and participants' score. Among participants, the dimensions of the TDN grade were considered a very valid measure of the severity of AEs, and the grading system fairly useful, while remaining very logical, fairly simple to use, and to interpret.

**Conclusions:** The TDN grade demonstrated substantial inter- and intra-rater reliability while being considered very logical, fairly simple to use and to interpret. Neurosurgical AEs

should be systematically assessed and reported, and surveyed neurosurgeons recommend the use of the TDN grade along with its separate dimensions for this purpose.

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### P31

#### Virtual Surgical Planning and Customized CAD/CAM Cranial Implants: Preoperative and Intraoperative Strategies for Temporal Intraosseous Meningioma Resection

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**Background:** Primary intraosseous meningioma (PIM) are a rare subtype of extradural meningiomas, with indication for surgical resection in most cases. One of the main issues when operating in the sphenoidal region is incision, detachment, and consecutive atrophy of the temporal muscle, leading to masticatory difficulties and unsatisfying cosmetic results. With increasing demand for efficient workflows with optimal functional and cosmetic results, techniques for bone reconstruction after resection are developing rapidly.

**Methods:** The authors present two cases with one stage cranioplasty after resection of PIM, using 3D technology for pre-planned patient-specific implants. In the first case a pre-manufactured patient-specific PEEK implant was used for reconstruction, in the second case a three-dimensional (3D)-based pre-manufactured silicon mold was used to produce a customized PMMA implant intraoperatively.

**Results:** Both techniques enabled the surgeons to achieve optimal intraoperative fit of the implant after craniectomy, leading to satisfying functional and cosmetic results.

**Conclusions:** The use of 3D technology such as Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) for production of patient specific implants can optimize one-stage cranioplasty.

### P32

#### Management of Recurrent Cerebrospinal Fluid Rhinorrhea Caused by Sequential, Anatomically Separated Skull Base Defects—A Case-Based Systematic Review

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**Aims:** Recurrent cerebrospinal fluid (CSF) rhinorrhea caused by sequential, anatomically separated skull base defects are rarely reported in the literature. Neither management nor etiology are sufficiently investigated. We herein present an illustrative case and a systematic review of the literature regarding etiology, diagnostics, and management of this rare phenomenon.

**Methods:** A systematic literature search looking for articles reporting sequential CSF-leaks with multiple skull base defects was performed. Data from included articles was descriptively reported, the quality of the included studies was assessed with GRADE.

**Results:** A 71-year-old female patient with posttraumatic rhino- and left-sided otorrhea due to a left-sided longitudinal fracture of the petrous bone presented at our institution. After initial surgical repair and a ten-week symptom-free interval, CSF-rhinorrhea reoccurred.

Imaging review revealed a pre-existing contralateral meningoencephalocele of the lateral sphenoid recess causing recurrent CSF-rhinorrhea most likely after initial traumatic laceration. The defect was successfully treated. Literature search identified 366 reports, six of which were included in the systematic review with a total of ten cases. Quality was deemed good in 8/10 cases. The most common location for primary and sequential CSF-leaks was along the sphenoid bone (4/10 and 5/10 patients, respectively). All publications except one reported the presence of a meningo (encephalo)cele as cause of the sequential CSF-leak.

**Conclusions:** Occurrence of recurrent CSF-rhinorrhea due to an anatomically separated sequential skull base lesion remains a rare yet described phenomenon. Reassessment of imaging studies and a structured diagnostic work-up to detect sequential CSF-leaks independent of the primary lesion should therefore be considered.

### P33

#### The SAIF (Stent-Screw Assisted Internal Fixation) Technique: A Treatment Option for OF5 Osteoporotic Vertebral Fractures—A Case Series

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**Introduction:** The OF5 type of vertebral osteoporotic fracture (AO Spine-DGOU classification) represents a three-column lesion and as such is considered as highly unstable. These lesions, however, tend to affect elderly, frail patients, in whom invasive management options are limited. The stent-screw-assisted internal fixation (SAIF) technique has previously been reported as a minimally invasive treatment for osteoporotic and neoplastic vertebral fractures. Here, we sought to assess the safety and efficacy of the SAIF technique in a retrospective series of patients with thoracic OF5-fractures.

**Methods:** Retrospective identification, in a prospectively maintained database, of patients with OF5-fractures treated with SAIF. Intra- and post-operative complications were reported. Clinical outcome using NRS pain scale and Patient's Global Impression of Change (PGIC), and radiological outcome, with local kyphotic angle (LKA) correction were analyzed.

**Results:** N = 22 patients were identified. All fractures were situated in the thoracic spine. No procedural complications occurred, although hospitalization-related complications did occur in 2 patients (9%). There was a statistically significant pain reduction on follow-up. The mean postoperative LKA correction was 7.5°, which was maintained at last follow-up.

**Conclusions:** The SAIF technique appears to be a viable alternative in the management of OF5-fractures. Although it does not address all elements of OF5 instability, it appears that the stabilisation of the anterior and middle vertebral columns, coupled with the stabilising effect of the ribcage in the hypomobile thoracic spine, are biomechanically sufficient to treat OF5-fractures in this section of the spine.

### P34

#### Anticipating the Clip: Analyzing VR-Guided Clip Placement in Preoperative Planning for Intracranial Aneurysms—A Pilot Study

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**Background:** With increasing complexity and decreasing exposure to aneurysm surgery, innovative technologies facilitating planning, teaching, and preparation of the surgery are emerging. Virtual Reality (VR) enables immersive exploration of patient-specific anatomical structures, facilitating visualization of intricate vascular networks and potential clipping scenarios. We aimed to analyze the degree of predictability of the clip when fully planned in VR, comparing it with the actual postoperative images as a control.

**Methods:** A total of 5 UIA clipping cases from 2022–2023 were randomly selected for analysis. Utilizing SpectoVR, we generated fully immersive 3D VR models. Mesh models of the original Yasargil-Clips were integrated, allowing their incorporation at true-to-life proportions. Three raters placed the clips in VR, assessing the aneurysm intra- and extraluminally and performing precise point-to-point measurements of the 3D anatomy. Different parameters, such as size, type, configuration, and the position of the clip in three-dimensional space, were assessed. Subsequently, these parameters were retrospectively compared to corresponding modalities in actual postoperative imaging data. The comparison of a composite score (number of clips, length, type, expected dog ear) of the clipping was chosen as the primary endpoint.

**Results:** In retrospective comparison, the average composite scoring was 2.8 ( $\pm 1.23$ ) out of 4, with a full score (4 out of 4) in 40% ( $n = 6$ ) and 3 out of 4 in 20% ( $n = 3$ ) when comparing the planning to the actual clipping. The clip length was within 1 mm in 53% ( $n = 8$ ), and the clip type matched in 40% ( $n = 6$ ) of the planned case. Image fusion could accurately display the orientation of the planned and real clip in all three dimensions. The average time for clip planning in VR was 3.4 ( $\pm 1.67$  min) per case.

**Conclusions:** Our preliminary results show that clip choice and placement in VR correlate well with the actual intraoperative clip placed and chosen. Further prospective studies to underline these findings are warranted.

P35

### First-Pass eTICI: Comparison between the Single and the Dual Stentriever Techniques for Thrombectomy

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**Aims:** For thrombectomy, some stroke centres have started to use two stentrieverers simultaneously instead of only one to achieve better recanalization rates, i.e., a double stentriever (DS) technique. The first observations regarding this new technique are promising. We aim to report our experience in DS at the acute phase of stroke, compare with the single stentriever technique.

**Methods:** We included consecutive individuals undergoing mechanical thrombectomy in the setting of acute ischemic stroke associated to a large vessel occlusion (LVO) or medium vessel occlusion (MeVO) in the anterior circulation. Individuals were included between 01.2022 and 07.2023. We excluded individuals less than 18 years old, those who were treated beyond 24 h from last proof of good health and those who were not treated with stentriever as a first-line recanalization strategy. We compared patients undergoing double-stentriever (DS) technique for first-pass strategy vs. single-stentriever (SS) technique for first-pass strategy. For the primary outcome analysis, we assessed first-pass complete recanalization (eTICI 2c-3) applying ordinal regression analyses using other prognostic co-variates. Secondary safety outcomes included procedure-related complications, early neurologic deterioration of ischemic origin (ENDi) and symptomatic intracerebral bleeding (sICH). Secondary functional outcomes included 24 h-NIHSS and 3 month modified Rankin Scale

(mRS). Complications such as procedural perforation, dissection, bleedings, embolization, access complication and/or reocclusion were also assessed as a dichotomized variable.

**Results:** Among 187 consecutive people (median age 76 (IQR = 65–83), 97/187 (52% female, median admission NIHSS 14 (IQR = 7–19)), 39 (26%) were treated with first pass DS and 148 patients (74%) with first pass SS. Within the SS group, 16 patients had rescue DS. First-pass complete recanalization (eTICI 2c-3) was achieved in 29/39 (74%) individuals treated with DS technique compared to 63/148 (43%) receiving SS technique. Procedural complications were seen in 5/39 (13%) in the DS group vs. 39/148 (26%) with SS. ENDi was evidenced in 3/39 (8%) with DS compared to 18/148 (12%) with SS. sICH was seen in 2/39 (5%) in DS compared to 8/148 (5%) in the SS group.

**Conclusions:** The rate of first pass eTICI 2c/3 dramatically increase with DS compared to SS, without more complication rate during DS technique. Prospective randomized controlled trials are needed to support our conclusions.

### P36

#### Emergency Endovascular Treatment of Stroke Due to Cervical Artery Dissection—Impact of Periprocedural GP IIb/IIIa Inhibitor Use on Clinical Outcome

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**Aims:** Endovascular treatment (EVT) for large intracranial vessel occlusion or symptomatic hypoperfusion due to cervical artery dissection (CeAD) became the standard therapy in recent years [1]. Stenting is frequently required to secure the dissection with subsequent need for GP IIb/IIIa inhibitors to prevent stent occlusion [2]. However, a potential concern of antithrombotic therapy in acute stroke is the increased risk of intracerebral hemorrhage. The aim of the present study was to assess the impact of the administration of a GP IIb/IIIa inhibitor on 90-day clinical outcome and postinterventional intracranial hemorrhage on imaging during endovascular treatment for acute ischemic stroke caused by CeAD.

**Methods:** This single-center retrospective cohort study enrolled CeAD patients treated with EVT from January 2015 to August 2022. We analysed the impact of different variables including postinterventional hemorrhage, revascularization success and the use of GP IIb/IIIa Inhibitors (eptifibatide) on 90-day favorable clinical outcome (mRS 0–2). NIHSS Scores were evaluated at different time points in relation to the 90-day clinical outcomes.

**Results:** 52 patients were included in the study. 34 out of 52 patients (65.4%) had a favorable 90-day clinical outcome (mRS 0–2), among them 38.2% received eptifibatide. 5 patients showed radiologically significant bleeding: 2 of these patients were treated with eptifibatide and 3 were not. The rate of successful reperfusion (TICI 2b-c) in the favorable 90-day outcome group was significantly higher than in the unfavorable 90-day outcome group.

**Conclusions:** In this study, the use of a GP IIb/IIIa inhibitor (eptifibatide) during endovascular treatment of cervical arterial dissections does not result in a higher incidence of unfavorable clinical outcome or intracranial hemorrhage. Successful reperfusion significantly correlated with favorable clinical outcome.

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P37

### **Risks and Error Detection in Interventional Neuroradiology: Proposal for a Systematic Categorisation of Error Sources**

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Interventional neuroradiology is a dynamic discipline characterised by innovative technical solutions and a constant expansion of therapeutic approaches. However, every neuroendovascular intervention has risks which are often of a critical nature. The ex-ante risk assessment consists of assessing the risks before an operation opposed to the ex-post evaluation where we look back at the risks that were taken and identify potential errors that occurred.

This work proposes a systematic characterisation of neuro-interventional error types. Furthermore, we highlight errors in the post-hoc analysis of medical errors that hamper meaningful conclusions.

Medical errors may come from various sources: the individual, the group, the system, or device-related technical.

Considering the individual as the source of error, a distinction between a competence error and a performance error can be made. A competence error occurs when the practitioner simply does not have sufficient skills to ensure a successful intervention and therefore a mistake is made. A performance error occurs when a competent doctor is unable to correctly call upon their competencies in the given situation and thus commits a performance error. Group errors are due to group dynamics. The social choice theory deals with the idea of collective intelligence, whereby group decisions are more accurate than those of any group member under certain conditions. However, the same mechanism can lead to group decisions that are less accurate than those of any group members. In addition, there are well-known group errors such as the expert bias or so-called cascading effects that can negatively influence group decisions.

Systemic errors occur when established protocols lead to bad outcomes. Such errors require either a further elaboration of existing (guideline) protocols, the introduction of additional protocols, or even just the acceptance that standardised protocols cannot always be the optimal.

Even if source of error is identified, there are several evaluation errors that prevent learning from that error: Outcome bias refers to the situation where an operation ended well even if several critical situations could have resulted in severe complications, but these “near-misses” are not further evaluated. Hindsight bias describes the tendency to view past events as more predictable, especially when it comes to negative consequences, than they are. Both evaluation error types distort error analysis.

P38

### **Differentiation of Responders from Non-Responders among Glioblastoma Patients after First-Line Treatment Using the Peak-Enhancement Derived from GRASP Dynamic Contrast-Enhanced MRI**

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**Aim:** The purpose of our study was to investigate whether the kinetic parameters of the signal intensity time curve extracted from Golden Angle Radial Sparse Parallel Dynamic Contrast-Enhanced MRI (GRASP DCE-MRI) might differentiate responders from non-responders between glioblastoma patients in different time-windows after radiochemotherapy according to the new RANO 2.0 criteria.

**Materials and Methods:** We performed a retrospective study, approved by the local Ethics Comitee, in patients with glioblastoma between 01/2017–12/2021 who had undergone surgery and radiochemotherapy (RCT) and developed new or enlarging contrast-enhancing lesions suspicious of progressive disease and had GRASP DCE- MRI. The patients were classified in two groups the responders and the non-responders group and analysed in different time-windows after completion of RCT (1–2 months or RANO 2.0 Baseline, 3–4 months, 5–6 months and > 6 months). A descriptive analysis and a diagnostic accuracy analysis was performed using the Area Under the Receiver Operating Characteristics Curve to evaluate the accuracy of the kinetics parameters differentiating responders from non-responders.

**Results:** 70 patients with glioblastoma (mean age 59 years  $\pm$  13 [standard deviation], 45 men) with multiple follow-up were analysed. In total 145 DCE-MRI scans were analysed and classified in two groups: the responders-group (n = 67) and the non-responders-group (n = 78) according to the contrast-enhancing lesion outcome on serial MRI, histology and PET-CT. In the responders group the peak-enhancement (PE%) was consistently lower than in the non-responders groups in all time windows 29% IQR [26, 37] vs. 53% IQR [44, 69] when considering all follow-ups together, independent of the time-window after completion of radiochemotherapy. The best threshold to differentiate the responders from non-responders was 41% (Sensitivity 87%, Specificity 87%, AUC 0.9). At the RANO 2.0 Baseline, (1–2 months after RCT completion) the threshold was 48% (Sensitivity 72%, specificity 95%, AUC 0.9).

**Conclusions:** When distinguishing between responders and non-responders among glioblastoma patients following first-line treatment, the peak enhancement extracted from GRASP DCE-MRI appears to have the highest diagnostic accuracy across all time windows with a threshold of a 41% increase in the initial up-slope of the signal intensity time curve with a Sensitivity 87% and a Specificity of 87%.

P39

### Radiomics for Differentiation of Gliomas from Primary Central Nervous System Lymphomas: A Systematic Review and Meta-Analysis

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**Background:** Numerous radiomics-based models have been proposed to discriminate between central nervous system (CNS) gliomas and primary central nervous system lymphomas (PCNSLs). Given the heterogeneity of the existing models, we aimed to define their overall performance and identify the most critical variables to pilot future algorithms.

**Methods:** A systematic review of the literature and a meta-analysis were conducted, encompassing 12 studies and a total of 1779 patients, focusing on radiomics to differentiate gliomas from PCNSLs. A comprehensive literature search was performed through PubMed, Ovid MEDLINE, Ovid EMBASE, Web of Science, and Scopus databases. Overall sensitivity

(SEN) and specificity (SPE) were estimated. Event rates were pooled using a random-effects meta-analysis, and the heterogeneity was assessed using the  $\chi^2$  test.

**Results:** The overall SEN and SPE for differentiation between CNS gliomas and PCNSLs were 88% (95% CI = 0.83–0.91) and 87% (95% CI = 0.83–0.91), respectively. The best-performing features were the ones extracted from the Gray Level Run Length Matrix (GLRLM; ACC 97%), followed by those obtained from the Neighboring Gray Tone Difference Matrix (NGTDM; ACC 93%), and shape-based features (ACC 91%). The 18F-FDG-PET/CT was the best-performing imaging modality (ACC 97%), followed by the MRI CE-T1W (ACC 87–95%). Most studies applied a cross-validation analysis (92%).

**Conclusions:** The current SEN and SPE of radiomics to discriminate CNS gliomas from PCNSLs are high, making radiomics a helpful method to differentiate these tumor types. The best-performing features are the GLRLM, NGTDM, and shape-based features. The 18F-FDG-PET/CT imaging modality is the best-performing, while the MRI CE-T1W is the most used.

#### P40

### Clustering fMRI Time-Series in Glioblastoma Characterization: A Review of the Evolution, Applications, and Potentials

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**Background:** In this paper, we discuss how the clustering analysis technique can be applied to analyze functional Magnetic Resonance Imaging (fMRI) time-series data in the context of glioblastoma (GBM), a highly heterogeneous brain tumor. Precise characterization of GBM is challenging and requires advanced analytical approaches.

**Methods:** We have synthesized existing literature to provide an overview of how clustering algorithms can help identify unique patterns within the dynamics of GBM.

**Results:** Our review shows that the clustering of fMRI time-series has great potential in improving the differentiation between various subtypes of GBM, which is pivotal for developing personalized therapeutic strategies. Moreover, this method proves to be effective in capturing temporal changes occurring in GBM, enhancing the monitoring of disease progression and response to treatment. By thoroughly examining and consolidating the current research, this paper contributes to the understanding of how clustering techniques applied to fMRI data can refine the characterization of GBM.

**Conclusions:** This article emphasizes the importance of incorporating cutting-edge data analysis techniques into neuroimaging and neuro-oncology research. By providing a detailed perspective, this approach may guide future investigations and boost the development of tailored therapeutic strategies for GBM.

#### P41

### Persistent Diffusion-Restriction Lesions in Post-Stroke Patients

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**Aims:** Our goal was to highlight the persistence of diffusion restrictions (pDWI) characterized by enduring low apparent diffusion coefficient (ADC) values in chronic brain stroke patients. These pDWI patterns deviate from the typical post-stroke normalization observed in diffusion-weighted MRI (DW-MRI) and raise concerns about potential acute stroke misdiagnosis.

**Methods:** Over five years, we retrospectively analyzed clinical and neuroimaging data from eight stroke patients with pDWI. We reviewed DW-MRI, T1, T2, and FLAIR scans to assess pDWI duration and volume in affected brain regions from the onset to a minimum of 45 days post-stroke. We also analyzed demographic and clinical data, including stroke subtype and therapy.

**Results:** We observed pDWI lesions persisting for up to two years in regions associated with the initial stroke event. These lesions were found in both supra- and subtentorial brain areas, with the body of the caudate nucleus most frequently affected ( $n = 5$ ). While pDWI volume decreased over time in most patients, two cases showed an increase. Additionally, the ADC threshold of  $<0.6$  mL was not suitable for mesencephalic acute stroke core assessment. The largest and increasing pDWI lesions were observed in a patient with a history of global hypoxic encephalopathy.

**Conclusions:** Neuroradiologists should be vigilant about the risk of acute stroke misdiagnosis due to observed deviations from the established ADC normalization timeline. Caution is imperative when assessing patients without recent neurological symptoms yet presenting with regions of low ADC values. This approach can prevent potentially unnecessary mismanagement, preserving patient quality of life and reducing healthcare costs.

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### Cigarette Smoking and Intracranial Aneurysms: A Pilot Analysis of SNPs in the CYP2A6 Gene in the Italian Population

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**Background:** Cigarette smoking is a modifiable risk factor associated with the formation and rupture of intracranial aneurysms (IAs). Cytochrome P450 2A6 (CYP2A6) is the main enzyme implied in the catabolism of nicotine and xenobiotics, giving rise to oxidative stress products. Our study investigated the associations between specific single-nucleotide polymorphisms (SNPs) in the CYP2A6 gene, sporadic IAs in a cluster of Italian patients, and their rupture regarding cigarette smoking habit.

**Methods:** Three hundred and thirty-one Italian patients with sporadic IAs were recruited in a single institution. We recorded data on clinical onset with subarachnoid hemorrhage (SAH) and smoking habit. Genetic analysis was performed with a standard procedure on peripheral blood samples: CYP2A6 \*1B2, CYP2A6 \*2, and CYP2A6 \*14 SNPs were analyzed in the study group along with 150 healthy control subjects. Statistical analysis was conducted according to genetic association study guidelines.

**Results:** In the patient cohort, the frequency of aSAH was significantly higher in current smokers ( $p < 0.001$ ; OR = 17.45), regardless of the pattern of CYP2A6 SNPs. There was a correlation between IA rupture and cigarette smoking in patients with the heterozygous CYP2A6 \*1B2 allele ( $p < 0.001$ ; OR = 15.47). All patients carrying the heterozygous CYP2A6 \*14 allele had an aSAH event (100%), regardless of smoking habit, although this correlation was not statistically significant ( $p = 1$ ).

**Conclusions:** According to our findings, a cigarette smoker carrying a fully active CYP2A6 enzyme (heterozygous \*1B2 allele) may have an increased risk of IA rupture compared to those with functionally less active variants: further investigation on a larger sample is needed to verify this result. The role of the heterozygous CYP2A6 \*14 allele in aSAH is yet to be clarified.

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### Rescue Stenting Outcomes after Failed Reperfusion in Medium/Distal Vessel Occlusions: A Retrospective Analysis of the BASEL ICAD-Registry

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**Aims:** Investigate clinical outcomes, mortality and sICH of patients undergoing rescue stenting (RS) for the treatment of medium/distal vessel occlusions (MDVO) refractory to conventional endovascular treatment.

**Methods:** An observational study with a retrospective collection of stroke patients with a Large Vessel Occlusion (LVO) or a Medium/distal vessel Occlusion (MeVo) treated with RS from 2019 until 2023 at the University Hospital Basel, Switzerland was performed. The Blood pressure and Antiplatelet medication management after reScue angioplasty after failed Endovascular treatment in Large and distal vessel occlusions with probable IntraCranial Atherosclerotic Disease (BASEL ICAD) registry. The data collection document is sent to more than 100 European and international EVT centers, which will collect and fill in the information. Out of this collective we will use for this project the subpopulation which presented with a MDVO. Inclusion criteria for the study are acute stroke patients older than 18 years with a MDVO who underwent RS after failed reperfusion between 2019 and 2023. Primary outcome will be dependency and disability at 90 days after treatment.

**Results:** No results from a statistical analysis are yet available. At the moment we have collected 260 Patients of which we have identified 22 MDVO cases (1/4 of participating centers have send their data) The Registry will close on 15.03.2024. Taking into consideration, that those cases are relatively rare and that the aim is to describe the outcomes without any comparison to other groups, no major statistical analysis is needed. We aim until the end of April 2024 to have analyzed the data and to be able to present the results.

**Conclusions:** The cases with a MDVO who underwent RS are considerably rare, but not insignificant according to our experience and observations. Important to note is that there is no available literature on this topic. Our aim is to provide a first insight to this clinical entity and treatment option. We aim to include at least 20 patients in the registry to assess predictors of outcome in RS patients. Based on the collected variables we will describe the outcomes to those Patients.

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