27th Congress of the European Society for Pediatric Neurosurgery

Oral Presentations

ABSTRACT SESSION 1: Neurotrauma/Intensive Care

OP31

Impaired autoregulation following resuscitation correlates to outcome in pediatric patients

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In the children with traumatic brain injury, time spent with impaired autoregulation correlates with neurological outcome. This pilot study explores if a similar relation exists for non-traumatic hypoxic-ischemic brain injury following resuscitation.

We investigated 16 children after resuscitation. Blood and intracranial pressure (ICP) were monitored with ICM+ software and actively managed to maintain optimal cerebral perfusion pressure (CPP) using the pressure reactivity index (PRx). Outcome was scored according to Glasgow outcome scale.

3 children died within 24h. 3 survivors had unfavorable and 5 favorable outcome. In the first 72h, ICP and CPP were neither different nor predictive of outcome groups. Time dose with PRx ≥ 0.2 was significantly higher in unfavorable outcome. PRx ≤ 0 was associated with favorable outcome in all except one child. Children with unfavorable outcome had areas of ischemic brain in MRI.

Time dose of bad autoregulation within the first 72h, is associated to unfavorable outcome. Prognostic signs for insult severity are initially bad autoregulation plus the inability to restore autoregulation despite active attempts to do so. Limited ischemia, especially in the basal ganglia, cannot be detected by ICP based autoregulation monitoring and may still result in unfavorable outcome despite good global autoregulation.

OP57

NSAIDs in acute head trauma

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Introduction: Nonsteroidal anti-inflammatories (NSAIDs) interfere with platelet function, and arouse concern for bleeding in surgical patients. We have previously documented the safety of administering NSAIDs to pediatric patients after intracranial operations. We sought here to document the safety of NSAIDs in the context of pain management after acute head injuries.

Methods: We reviewed the medical records of a Level I Pediatric Trauma Center to identify patients with a diagnosis of head trauma or bleeding in the head. To limit the scope of this preliminary survey, we selected patients admitted with a diagnosis of bleeding related to head trauma. We reviewed their clinical course, imaging, and medications.

Results: From a total of 6158 identified patients, 214 were admitted with head trauma and an initial cranial bleed. Bleeding was characterized as subdural (N=112, 52%), subarachnoid (86, 40.2%), intraparenchymal (67, 31.3%), extra-axial, not otherwise specified (59, 27.6%), epidural (56, 26.2%), scalp (54, 25.2%), and intraventricular (20, 9.3%). 57 patients (26.6%) underwent a cranial operation during the hospital course, 4 spinal procedures, and 34 non-neurosurgical procedures. 9 patients had associated venous sinus thrombosis. 122 (57%) had NSAIDs administered, intravenous ketorolac and/or oral ibuprofen or aspirin. 44 patients required heparin anticoagulation for sinus thrombosis, vascular injury or for thromboembolism prophylaxis, 19 of them also receiving NSAIDS.

No patient had a medication-related bleeding complication or required operation because of NSAIDS or anticoagulation. 2 or more imaging studies were obtained in 111 children (51.9%). Enlargement of hematoma was noted in 10/35 (28.6%) of patients receiving NSAIDS alone, 6/18 (33.3%) receiving anticoagulants alone, and 6/14 (42.9%) of patients who received both and 12/44 (27.3%) of those receiving neither. One patient had a late evacuation of an epidural.

Conclusion: We conclude that NSAIDS may be safely given in the setting of acute head trauma.

OP85

Paediatric cranioplasty: The Irish experience

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Introduction: To evaluate and describe the experience of the only craniofacial and paediatric neurosurgical teams in Ireland performing paediatric cranioplasties.

Methods: This was a retrospective, chart review. Fifty-seven paediatric cranioplasties were performed on 52 patients, between 2006 and 2018, at Children’s Health Ireland at Temple Street and Beaumont Hospital. Data was collected for age, gender, cause of defect, time to cranioplasty, defect size, cranioplasty implant used, need for intra-operative blood transfusion, duration of surgery, hospital stay, complications, follow-up period and need for revision cranioplasty.

Results: The age range for the patients was 10 weeks to 16 years. There were 34 male and 18 female patients. Causes for the cranial defect were neoplastic (n=4), infection (n=10), cerebrovascular pathology (n=9), trauma (n=22) and craniosynostosis (n=5). The patients with craniosynostosis underwent vault remodelling as infants and presented with contour irregularities requiring onlay
OP96

Pediatric epidural haematomas - a single centre experience

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Introduction: Pediatric epidural hematoma (EDH) represents a neurosurgical emergency. Both, surgical or conservative treatment can lead to a good clinical outcome. The aim of the study was to review our series of pediatric EDH and to determine the clinical and radiologic factors, which can influence the final outcome.

Materials and methods: All children aged from 0 to 16 that have been treated between 2013 and 2017 for a cranial EDH have been included in the study. 17 cases have been treated with surgical evacuation and 13 conservatively. 6 months after the trauma, the outcome was excellent (mRS 0) in 25/30 (83.3%) cases, mild deficits (mRS 1-2) were present in 4/30 (13.3%) and severe deficits (mRS 3-5) in 1/30 (3.3%).

Conclusion: EDH can be managed with excellent outcomes. Even in the presence of bad initial clinical and radiologic conditions, a correct treatment strategy can lead to a good recovery. In our series, only a GCS below 8 at admission was significantly related to the presence of a neurologic deficit at 6 months (p = 0.048).

OP127

Potential impacts of neuroglia on oligodendrogenesis

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Modulation of endogenous white matter regeneration through proliferation and maturation of oligodendrocyte progenitor cell (OPC) could be a therapeutic target after neonatal hypoxia-ischemia. OPC proliferation and maturation has been shown to be influenced by neuroglia but the underlying mechanisms remain unknown. Here we investigate, whether conditioned media (CM) from mixed glia influences OPC proliferation and maturation through the secretion of PDGF-AA.

Brains for mixed glia cultures (MGC) were harvested from post-natal day 1 (p1) Sprague Dawley rats, dissociated mechanically into single cells and incubated for 14 days. To characterize the cell types, flow cytometric and immunocytocchemical analyses were performed after 7 days in culture. CM from MGC (control) and from GD MGC was collected after 17 days to quantify secreted PDGF-AA level via ELISA. To obtain OPCs, cortices of p1 Sprague Dawley rats were isolated and dissociated mechanically into single cells and seeded into multi-well plates after 14 days in culture. Cells were exposed to different concentrations of PDGF-AA as well as CM of GD and untreated mixed glial cells. Proliferation and cell death was measured after 48 h via Edu and Annexin-V/7-AAD assays, respectively.

On protein level, the CM from GD MGC contained 200 times more PDGF-AA than that from non-GD MGC (2,020.1±0,274 vs. 0.01133±0.0058 ng/ml, p < 0.01). We could confirm that PDGF-AA has a critical effect on OPC proliferation and survival; however, the concentration of PDGF-AA inversely correlates with OPC proliferation (0 ng/ml: 25% proliferative cells, 10 ng/ml: 18%, p < 0.001). OPCs also show less cell death when 10 ng/ml PDGF-AA or CM were administered (10 ng/ml PDGF-AA: 25%, 0 ng/ml: 32%, CM: 12.3%, p = 0.021). GD neuroglia may let OPCs go into a ‘resting’ state in vitro, indicated in the lower proliferation rate as well as in the decreased cell death.

OP144

Lipid peroxidation, antioxidant consumption and acute brain injury in children

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Introduction: Lipid peroxidation is a marker of secondary brain injury. Malondialdehyde (MDA), a lipid peroxidation marker, and ascorbate, a marker of antioxidant status, can be considered early indicators of this process in the cerebrospinal fluid (CSF). The aim of this study is to assess the changes in cerebral lipid peroxidation measured ex vivo in children undergoing neurosurgical procedures.

Methods: Thirty-six children (M:F = 19/17, median age 32.9 months; IQR 17.6-74.6) undergoing neurosurgery for brain tumor removal were admitted to the pediatric intensive care unit (PICU) in the postoperative period with an indwelling intraventricular catheter for intracranial pressure monitoring and CSF drainage. Plasma and CSF samples were obtained for serial measurement of MDA, ascorbate, and cytokines.

Results: An early increase in lipid peroxidation was measured, with a significant increase from baseline of MDA in CSF (p = 0.007) but not in plasma. At the same time, ascorbate in CSF decreased (p = 0.05). Systemic inflammatory response following brain surgery was evidenced by plasma IL-6/IL-8 increase (p = 0.0022 and 0.0106, respectively). No correlation was found between oxidative response and tumor site/histology. Similarly, lipid peroxidation was unrelated to the length of surgery (mean 321 ± 73 min), or intraoperative blood loss (mean 20.9 ± 16.8% of preoperative volemia, 44% given hematotransfusions). Median PICU stay was 3.5 days (IQL range 2.5-5.0 d.), and postoperative ventilation need was 24 h (IQL range 20-61.5 h). The elevation in postoperative MDA in CSF compared with preoperative values correlated with postoperative ventilation need (P = 0.05, r 0.2 0168), while no difference in PICU stay was recorded.

Conclusions: These results show that lipid peroxidation increases consistently following brain surgery together with a decrease in antioxidant...
defences. Intraventricular catheterization offers a unique chance of oxidative process monitoring. Further studies are needed to assess the prognostic utility of this test.

**ABSTRACT SESSION 2: Chiari**

**OP6**

The results/rationale from the Brazilian consensus for chiari i deformity

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**Introduction:** This study presents the results of the Brazilian Society for Pediatric Neurosurgery’s (SBNPed) effort to create a guidance panel on each most relevant aspects of Chiari Type I Deformity (DFI) because of the discrepancy of management among many authors on this topic.

**Methods:** The I SBNPed Consensus was held in Londrina – Brazil, in August 2019. The scientific program has been separated into 5 modules with classes and case discussions covering all aspects of DFI. A survey with 27 questions was prepared to assess the knowledge and management variations of all present certified neurosurgeons. Initially, 33 answers were obtained. After having discussed the issues proposed and created a flow-chart, we applied the same survey to check if there was any change in the Chiari I approaches. The controversial cut of the terminal filum which may be an option for surgical treatment was also widely discussed during the sessions.

**Results:** At the end of the Consensus, not only have we developed a flow-chart of DFI diagnosis and treatment, but also we were able to compare the results of the questionnaire. Some responses had significant changes such as: which symptoms should be recognized as being from DFI; change in the management for the follow-up of asymptomatic patients with an incidental diagnosis of DFI; the realization of concomitant duroplasty, after bony decompression.

**Conclusions:** This unprecedented model of discussion and decision making in Brazil proved to be of great educational importance since the surveys showed several changes in the management of those attending the event after classes and discussions. The practice of cutting the terminal filum was considered an experimental procedure and can only help a small group of DFI patients who also have a tethered cord.

**OP76**

Chiari malformation type I: A series of 151 pediatric patients treated by only bone decompression

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**Introduction:** CM1 is a disorder of the para-axial mesoderm that results in underdevelopment of the posterior cranial fossa and overcrowding of the hindbrain. Incidence CM1 in MRI is 0.24-3.6 %, prevalence in children 4%, prevalence symptomatic CM1: 0.007%. The main problem is the indication of surgery, when and which kind of surgery. Very important are clinical and radiological criteria.

**Posterior fossa morphometry analysis: no clear correlation between emiatio and symptoms.**

**Methods:** In a period of 20 yrs we treated 151 patient affected by Chiari type I Malformation with only bone decompression. 73 females, 78 males. The average age at diagnosis was 86 months (min 1 mt-max 358 mts). The average age at operation was 98 months (min 2 max 365).

50 patients (33,11%) had a syrinx at diagnosis, in 27 (54%) pts the syrinx involved only one level in the other patients was extended on 2-3 levels.

In a group of these patients we performed a retrospective morphometric analysis to evaluate the ideal surgical approach and the indication.

**Results:** On 18 patients was necessary perform a second surgery (osteodural decompression and/or tonsillar coagulation) with a different and more invasive approach; due to a subsequent increase or appearance of syringomyelia. These patients was with syringomyelia on 2/3 levels. In patients operated the second time with duro opening, morphometric analysis demonstrated a reduction in the size of the posterior fossa.

**Conclusion:** Bone decompression may be sufficient in symptomat-ic patients with no syringomyelia. Our retrospective posterior fossa morphometric analysis show how this tool may be support for the surgical decision making. Surgery is indicated only for symptomatic patients.

**OP111**

Conservative management of enlarging syrinxes after decompression for Chiari I malformation

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**Introduction:** Chiari I malformations (CMI) often present with syringomyelia (SM). Successful surgical treatment of the CMI leads to improvement in both the symptoms as well as the SM. Persistent SM after decompression has been described, and conservative management may allow for improvement over time. We present four children, who after decompression had enlargement of their SM without further symptoms. Delayed imaging on these patients revealed decrease in the SM to sizes smaller than those seen preoperatively.

**Methods:** 151 children less than 18 years of age with CMI and SM who underwent surgical treatment at our institution were evaluated. All had one of three procedures: bony decompression alone, bony decompression and duroplasty, or bony decompression and duroplasty with fourth ventricular stent. For many, the surgical procedure was dictated by intra-operative ultrasound after bony decompression.

**Results:** Seven patients had an increase in their SM on subsequent postoperative imaging. Three had further surgery because of either worsening scoliosis (1) or worsening pain (2). The other four were watched expectantly. Patient 1 had bony decompression only, Patients 2 and 3 required duroplasty, and Patient 4 required duroplasty with fourth ventricular stent. All four were evaluated intra-operatively with ultrasound. These patients remained clinically stable and subsequent imaging revealed reduction in the size of the SM.

**Conclusion:** Although the majority of SM will improve after CMI decompression, certain patients will have postoperative imaging showing no improvement, and rarely but disappointingly, enlargement of the SM. In these patients, absent any progressive or concerning signs or symp-toms, conservative management may be indicated. In time, the SM may diminish in size, as in these four patients, to sizes smaller than those seen preoperatively.
The ICCC&S taskforce was able to outline guidelines for the management of Chiari and Syringomyelia that will be presented in detail.

OP205

Why do some cranio-vertebral decompressions fail?

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Introduction: The management of Chiari I malformation is often a controversial topic in paediatric neurosurgery, with a cohort of patients that may require revision surgery due to persistent or recurrent symptomatology. We aimed to identify the number of patients with tonsillar ectopia that required revision surgery, the indications, the techniques and intraoperative findings.

Methods: We retrospectively reviewed all revision cranio-vertebral decompressions performed at our institution over a 34-year period (1985-2019). A total of 26 patients were identified (11 females; 15 males), out of a total of 312 patients who had undergone primary cranio-vertebral decompression at our institution over that period. Their operation notes, clinic letters, in-hospital reports, imaging and follow-up data were reviewed.

Results: Out of the 26 patients identified, the majority (n=23) required one revision surgery while 3 of them required two. The mean time to revision was 1.92 years. In this cohort, the most common surgical technique at the primary surgery was bone only cranio-vertebral decompression (65%) whereas at revision surgery it was cranio-vertebral decompression with duraplasty (77%). The most common reason identified for reoperation was presence or worsening of syringomyelia, followed by motor symptoms and...
headaches. 11 out the 16 (69%) patients identified with syringomyelia prior to their primary operation had a persistence or worsening of their syrinx post-operatively. Additionally, 2 patients developed a syrinx after their primary operation. Improvement in syringomyelia was observed in 14 out of 18 patients with syringomyelia (78%) post revision whereas improvement was seen only in 5 out of 16 patients (31%) after the primary operation.

Conclusion: Approximately 1 in 10 patients underwent revision for symptomatic tonsillar ectopia. Our results show that revision surgery resulted in significant improvement in syringomyelia and subsequent symptomatology of patients. Crani-vertebral decompression with duraplasty appears to be an effective technique in this group of patients.

OP216
Management of chiari malformation – individualized treatment and outcome

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Object: The contemporary concept of the so called Chiari malformation (CM) comprises different conditions (CM0, CM1, CM1.5 and CM2). Specific treatment options should be offered according to the individual clinical condition.

Methods: Retrospective study of a consecutive single unit (5 surgeons) series of patients who underwent foramem magnum decompression (2010 - 2019). Patients managed conservatively or with shunting procedure alone were excluded. Demographic data, diagnostic findings, relevant comorbidities, surgical treatment and outcome data are presented.

Results: A total of 96 patients have been operated. Mean age was 10 years (range 0.2 – 60 y; 4 < 1 y; 10 > 18 y). 50 patients were male, 46 female. 48(50%) presented with syringomyelia at time of surgery, 36(37.5%) with scoliosis. 11 patients required secondary surgeries. These subtypes have been treated: CM0(4), CM1(47), CM1.5(27) and CM2(18). Associated syrinx and scoliosis were most often present in CM2 patients (67%, 83%). All CM0 patients underwent intradural management. In the CM1 group 25(53%) received bone only decompression (11[41%] in CM1.5), 23(49%) intradural inspection and dural augmentation (36[49%] in CM1.5), 14(30%) tonsillar shrinking (25[34%] in CM1.5) and additional instrumentation due to instability in 1(2%) patient (8[11%] in CM1.5). In the CM2 group, bone only and 10 intradural procedures (dural augmentation and tonsillar shrinking) in 2 have been performed. The overall complication rate after complete follow up is 8.3%, leading to secondary surgery in 2 cases (CSF collections). Resolution/improvement of symptoms could be observed in all patients, syringomyelia resolution in 11 out 32 patients (CM2 excluded). There was no statistical difference regarding CM type, treatment and outcome. Bone only decompression provides similar results in CM1, CM1.5 and CM2 compared to intradural procedures.

Conclusion: Different CM subtypes require specific treatment. Bone only decompression seems to have similar good results compared to intradural techniques. No severe complications occurred.

ABSTRACT SESSION 3: Spine

OP71
Growing pains: The use of vivigen cellular bone matrix in pediatric posterior cervical spine fusions

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Introduction: Obtaining a bony fusion in the pediatric cervical spine can be challenging due to limited surface area, and adjuncts are frequently needed, such as autograft or fusion-promoting biologics. Bone morphogenetic protein (BMP) is effective, but its use remains controversial, particularly in pediatrics. Other biologic options are needed, and ViviGen Cellular Bone Matrix has been successfully used in the adult population. Our goal is to demonstrate safety and efficacy in the pediatric population.

Methods: The authors retrospectively reviewed 18 pediatric patients who had undergone posterior occipital or occipitocervical spine fusion at Lurie Children’s Hospital using ViviGen Cellular Bone Matrix as a surgical adjunct from 2016 to 2019. Follow up x-rays and CT scans we reviewed to assess for bony fusion. Other factors were noted, including age, sex, diagnosis, number of surgical levels, use of structural or morselized allograft, dose of ViviGen, and postoperative orthosis use.

Results: There were 19 fusion procedures performed in 18 patients. The average age at surgery was 10.2 years (range 1.9 to 17.5 years). Average follow up was six months. There was evidence of fusion on CT after 15 surgeries, and no evidence of pseudarthrosis. One revision surgery was required due to hardware failure. There were no other significant complications, including wound infections.

Conclusion: Initial outcomes using ViviGen in the pediatric population demonstrate that it is a safe and effective adjunct to posterior cervical and occipitocervical spinal fusions, although longitudinal study is needed for further validation.
decompression were performed neurosurgically, cervical spine instrumentation and bone grafting by orthopedics. Revision surgery was performed in 3 patients, 2 for nonunion and 1 for increasing junctional kyphosis. The overall complication rate was 14%, Final solid bone fusion was confirmed in all of the patients, including two patients with asymptomatic hardware failure. Neurological status remained unchanged postoperatively and at last fu.

Conclusion: This series shows that different fusion techniques of the cervical spine can be safely performed by an experienced multidisciplinary team, leading to adequate fixation with high fusion rates and a low morbidity profile.

OP158

From pedicle alignment to pedicle reformation for pediatric hangmans fracture

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Introduction: Advent of intra operative computed tomography and image guidance has revolutionized its treatment. The aim is to demonstrate evolution in management of hangmans fracture from anatomical repair of C2 pedicle to pedicle reformation.

Material and Method: Nine patients operated between September 2011 to February 2019 were included. In 5 patients C2 pedicle screw C3 lateral mass screw and rod fixation was done, in 2 patients C1 C3 lateral mass screw and rod fixation, in 1 patient C1 lateral mass C2 Pedicle C3 lateral mass screw and rod were put and in last patient who had old hangmans fracture with reabsorbed axis pedicle C2 pedicle C3 lateral mass screw and C4 Pedicle screw rod fixation with C2 pedicle reconstruction was done.

Results: Patients age ranged from 14 to 18 years (mean 16.45 years ) with male female ratio of 8:1. Mean follow up was 42.78 months with range of 12 to 81 months. Three patients had no neurological deficit in relation to hangmans fracture out of these I had paraplegia related to dorsal spine fracture who died 1 year later due to bed sore . All 6 patients having neurological deficit have improvement. Two patients had developed kyphosis at C3 C4 level . In both of these fixation was extended. In last patient who had old hangmans fracture with reabsorbed axis pedicle C2 pedicle C3 lateral mass screw and rod fixation and C2 pedicle reconstruction was done . In 6 patients in which C1 was not included C1 C2 rotation was preserved .

Conclusion: We have evolved in the direction of motion preservation at C1 C2 joint by putting C2 pedicle screw and C3 lateral mass screw to pedicle reformation. We have for the first time in world developed technique of C2 pedicle reformation in old hangmans fracture

OP166

Lateral proatlas failure: Fixed torticollis that deserves special attention

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Introduction: Fixed torticollis is often a finding in children after trivial trauma and the cause ranges from a sternomastoid contracture to a rotary subluxation of the atlantoaxial joint. We present a series of 15 cases with fixed torticollis due to failure of the lateral component of the proatlas from developing resulting in absence of lateral elements of the first cervical vertebra, causing a lateral tilt .

Methods: This is a retrospective analysis of 15 children treated with fixed torticollis. All of them had poorly or non-developed lateral masses of the atlas with or without poorly developed occipital condyles on the same side resulting in a lateral tilt with abnormal articulation between the occiput and the lateral mass of the axis. Of the 15 children, 10 were males and 5 females. The age of presentation varied from 11months to 17years. 12 out of the 15 children presented with neurological signs including in 9 cases sphincter problems. Both MRscan and CTScans showed failure of the lateral proatlas development. Also there was rotation of the axis with a fixed atlas as a compensatory attempt to correct the torticollis. All 15 children underwent surgical intervention which varied from C1C2 fixation techniques to occipitocervical fusion depending on the age of the child and nature of the deformity.

Results: 11 out of the 12 patients had improvement after surgery, and 1 remained unchanged. Implant failure occurred in 2 children, both below the age of 18months. The torticollis was corrected in15 children. Sphincter control improved in 6 out of 9 with urodynamic evidence obtained in 5 .

Conclusion: This is a rare type of craniovertebral deformity, but one whose knowledge is important as they all require surgical intervention. This is in contradistinction with the standard rotatory atlantoaxial subluxations with torticollis, the majority of which can be treated conservatively.

ABSTRACT SESSION 4: Hydrocephalus I

OP40

Ventriculomegaly in children: Nocturnal ICP dynamics identify pressure compensated but active paediatric hydrocephalus

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Introduction: Pediatric ventriculomegaly without obvious signs/ symptoms of raised intracranial pressure (ICP), is often interpreted as resulting from relative brain atrophy, shunt independency or “successful” ETV. We hypothesised, that the typical ICP „signature“ found in symptomatic hydrocephalus (increased ICP dynamics and decreased compliance) can be present in oligosymptomatic ventriculomegalic children, indicating chronic, but active hydrocephalus.

Methods: 37children with ventriculomegaly and suspicion of increased ICP underwent computerised ICP overnight monitoring (ONM). ICP and calculated dependent variables were analyzed for nocturnal ICP dynamics: ICP peak, „wave“ and baseline pressures, ICP „wave“ and baseline amplitudes, magnitude of slow waves and RAP index. Depending on ONM’s result, children were surgically treated or assigned to clinical observation. Ventricular width was measured at time of ONM and follow-up.

Results: The ONM recordings of 14 children (Group A) were considered normal with baseline ICP 10.5 mmHg, ICP wave 12.3 mmHg, RAP 0.44 and baseline AMP 1.13 mmHg. In the 23 children with pathologic measurements (Group B), all ICP values, AMP and slow wave were significantly higher. The RAP index did not varied significantly between both groups (p=0.13). Group A children had less nocturnal wave episodes compared to Group B (p=0.001). Group B children received treatment for hydrocephalus, with the frontal-occipital horn ratio being significantly lower after surgery.
Overlapping was important. Muscle responses to DR stimulation were ular, from 2-to-4 roots, with 1 or 2 roots being dominant at each level.

OP28

Muscle responses to radicular stimulation during lumbo-sacral dor- sal rhizotomy for spastic diplegia: Radicular functional anatomy and myotome innervation

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Introduction: Most of knowledge on muscle radicular innervation was from explorations in root/spinal cord pathologies. Direct and individual access to each of the lumbar-sacral -ventral and dor-sal-nerve roots during dorsal rhizotomy for spastic diplegia allows precise study of the corresponding muscle innervation. We report the lumbo-sacral segmental myotomal organization obtained from recordings of muscle responses to root stimulation in a 20- children prospective series.

Methods: Seven key-muscles in each lower limb and anal sphinc- ter were EMG recorded and clinically observed by physiotherapist during L2-to-S2 dorsal rhizotomy. Ventral roots (VR), for topogra-phical mapping, and dorsal roots (DR), for segmental excitabil-ity testing, were stimulated, just above threshold for eliciting mus-cular response.

Results: In 70% of the muscles studied, VR innervation was pluri-radic-ular, from 2-4 roots, with 1 or 2 roots being dominant at each level. Overlapping was important. Muscle responses to DR stimulation were 1.75 times more extended compared to VR stimulation. Inter-individual variability was important.

Conclusion: Accuracy of root identification and stimulation with the used method brings some more precise information to radicular function-al anatomy.

OP94

An illustrated review of operative techniques for selective dorsal rhizotomry

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Introduction: Selective dorsal rhizotomy (SDR) is a procedure undertak-en to relieve spasticity and improve motor function for children with cerebral palsy and other disorders that cause spasticity. Although the procedure has experienced a recent resurgence in popularity, there exists a significant variability in operative techniques between centres and surgeons. Herein, we have systematically reviewed the literature to pro-vide a technical and illustrative review of the operative approaches uti-lized for SDR procedures.

Methods: In August 2019, Ovid Medline, Embase, and PubMed data-bases were searched in accordance with PRISMA guidelines, using the keywords “cerebral palsy”, “rhizotomy”, and/or “selective dorsal rhizot-omy” in combination. Studies written in the English language describing a novel surgical technique were included. The technical details of each approach were recorded, including extent of exposure, bone removal, and selection of nerve roots to divide. The operative technique employed at our institution, The Hospital for Sick Children, is also described.

Results: From a total of 380 manuscripts initially identified, five full-text papers were deemed appropriate for analysis. Operative approaches to SDR varied significantly with regards to level of exposure, extent of laminectomy, and identification of nerve roots. The extent of exposure ranged from a keyhole interlaminar approach to a multilevel laminectomy. At the Hospital for Sick Children a two-level laminoplasty at the level of the conus is employed. As well as illustrating the tech-niques, the merits and limitations of the range of approaches are discussed.

Conclusion: Surgical approaches to SDR vary considerably and have been detailed and illustrated in this review as a guide for neurosurgeons and allied professionals with an interest in the procedure. Ongoing study of the techniques should aim to elucidate their impact on long-term out-comes, including their potential effect on complications such as spinal deformity.

OP131

Dorsal rhizotomy for children with spastic diplegia of cerebral palsy origin: usefulness of intraoperative monitoring

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Introduction: The utility of intraoperative neuromonitoring (ION) re-mains controversial. We performed a prospective study combining ven-tral root (VR) stimulation for mapping anatomical levels and dorsal root (DR) stimulation as physiological testing of metameric excitability in order to evaluate to what extent the intraoperative data led to modific-a-tions in the initial decisions for surgical sectioning and thus estimate its practical usefulness.

Methods: Thirteen children with spastic diplegia underwent the follow-ing surgical protocol. First, a bilateral intradural approach was made to the L2-S2 VRs and DRs at the exit from or entry to their respective dural sheaths, through multilevel interlaminar enlarged openings. Second, stimulation-just above the threshold-of the VR at 2 Hz to establish topog-raphy of radicular myotome distribution, and then of the DR at 50 Hz as an excitability test of root circuitry, with independent identification of muscle responses by the physiotherapist and by electromyographic rec-ordings. The study aimed to compare the final amounts of root sectioning-per radicular level, established after intraoperative neuromonitoring guidance with those determined by the multidisciplinary team in the presurgical chart.

Results: The use of ION resulted in differences in the final percentage of root sectioning for all root levels. The difference between root levels was highly significant, as evaluated by electromyography (p = 0.00004) as well as by the physiotherapist (p = 0.00001). Modifications were decided in 11 of the 13 patients (84%). Decreases were most frequently decided for roots L-2 and L-3, whereas increases most frequently involved roots L-4 and L-5, with the largest changes in terms of percentage of sectioning.
Conclusion: The use of ION during dorsal rhizotomy led to modifications: which DRs to section and to what extent. In this series, ION contributed significantly to further adjust the patient-tailored dorsal rhizotomy procedure to the clinical presentation and the therapeutic goals of each patient.

Keyhole interlaminar dorsal rhizotomy for spastic diplegia in cerebral palsy

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Introduction: The efficiency and safety of dorsal rhizotomies for cerebral palsy lie in the accuracy of radicular identification together with selectivity of root sectioning. Two different exposures are currently in use. The first is extended laminotomy/laminectomy from the upper lumbar level to the sacrum, which allows accurate identification of all L2-S2 roots/rootlets. The second is limited laminotomy exposing the conus/cauda equina at the thoroolumbar junction; this less invasive method limits accessibility to the roots. To optimize the accuracy and selectivity while minimizing invasiveness, we developed a tailored interlaminar procedure targeting the radicular levels involved in the harmful components of spasticity directly and individually.

Methods: Thirty-five patients with spastic diplegia at different levels of the Gross Motor Functional Classification System were selected. In each patient, three interlaminar spaces, preselected according to planning, were enlarged in the “keyhole” fashion, respecting the spinous processes and interspinous ligaments. Ventral root stimulation identified the radicular level. Dorsal root stimulation evaluated its implication in the hyperactive segmental circuits, helping quantify the percentage of rootlets to be cut.

Results: There were neither wound-related nor general complications. At three-year of follow-up, X-ray examination did not reveal kyphosis or instability. In all children, the excess of spasticity was reduced. The Ashworth score decreased from 3 on average to 1 postoperatively. Regarding the functional status at three-year of follow-up for the twenty-one ambulatory children, the Gillette ability-to-walk score increased from 3/10 on average to 7/10 postoperatively. For the fourteen patients lie in the accuracy of radicular identification together with selectivity of root sectioning. Two different exposures are currently in use. The first is extended laminotomy/laminectomy from the upper lumbar level to the sacrum, which allows accurate identification of all L2-S2 roots/rootlets. The second is limited laminotomy exposing the conus/cauda equina at the thoroolumbar junction; this less invasive method limits accessibility to the roots. To optimize the accuracy and selectivity while minimizing invasiveness, we developed a tailored interlaminar procedure targeting the radicular levels involved in the harmful components of spasticity directly and individually.

Conclusion: Keyhole interlaminar dorsal rhizotomy (KIDr) offers direct intradural access to each of the ventral/dorsal roots, thus maximizing the reliability of anatomical mapping and allowing individual physiological testing of all targeted roots. The interlaminar approach minimizes invasiveness by respecting the posterior spine structures.

Selective dorsal rhizotomy in patients with GMFCS level IV

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Introduction: Most of the evidence of Selective dorsal rhizotomy (SDR) has been proven on patients with spastic diplegia with GMFCS I, II and III. There is limited data available showing its effectiveness in patients with GMFCS level IV.

Methods: Data have been prospectively collected about all patients undergoing SDR in our centre in the period between 2012-2019. Data collected included demographic, length of follow-up, surgical details, GMFM, MAS, MRC, CPChild/PQoL, PEDI, Abilhand, CCHQ, VAS. We also collected, when possible, GMS, FMS, TUG, 6MWT. Measures were collected pre-operatively, and post-operatively at 3, 6, 12, 24 months.

Results: We performed 30 patients with pre-operative GMFCS IV with a predominant lower limb spastic diplegia. All procedures were carried out with intra-operative monitoring by the same neurosurgeon and all patients received 3 weeks of equivalent inpatient post-operative physiotherapy. The mean follow-up was 15 months. All patients showed a significant improvement in most domains, in particular MAS, MRC, CPQoL, PEDI, Abilhand and the results were consistent at longer follow-up. Painful spasms were treated successfully in all patients. We also noticed a significant improvement in speech and urology function. We didn’t experience any post-operative complication or adverse event.

Conclusion: SDR is effective and safe in reducing spasticity in GMFCS IV and effective in improving supra-segmental functions. The results are consistent at longer follow-up.

Selection criteria for SDR-Cape Town experience

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Introduction: The modern version of the technique of selective dorsal rhizotomy was pioneered by Warwick Peacock in the 1970’s at Red Cross Children’s Hospital in Cape Town. We are currently following up this 35yr group of patients and results are frequently published by Langerak and Fieggen. Lessons learned from such a long-term follow up period, as far as selection criteria goes, is invaluable.

Methods: In this presentation we will present the area’s of focus when deciding on selective dorsal rhizotomy in a developing country, like South Africa. The evaluation process and criteria that we use will be described.

Results: Various area’s of future research area’s will be highlighted, as there is still clinical equipoise regarding indications and selection criteria and procedure techniques

Conclusion: This workshop and presentation series will stimulate much needed interest and discussion among the various role players all over the world who are looking after children with spasticity. The criteria that are used in Cape Town will be discussed and are open to input from all attendees.
refractory pain. These surgeons noted a reduction in muscle tone associated with the operation. When Sherrington then published his Nobel prize-winning work on the corticospinal tract and its role in the neuromuscular system in the 1890s, the course was set for modifying spasticity by aiming surgery at the dorsal roots. This procedure underwent multiple modifications through the next century and today it is, arguably, the most commonly performed operation to treat cerebral palsy children with spasticity.

**Methods:** In this presentation the author will present segments from their published paper on the topic of SDR and its historical evolution and modern variations

**Results:** Historical timelines will be drawn and variations in the techniques, and motivating factors behind these changes will be presented.

**Conclusion:** Selective dorsal rhizotomy is a technique that still teaches us a great deal about neurophysiology on a daily basis and it is thanks to the pioneers, described in this article, that we have this tool in our armamentarium.

**OP157**

Selective dorsal rhizotomy in GMFCS II and III: Results of a multicentre study

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**Introduction:** Selective Dorsal Rhizotomy (SDR) is an irreversible surgical procedure involving cutting of selected sensory nerve roots. Reduction of spasticity in the lower limbs and improvement of motor function is the main aim. Three randomised controlled trials conducted over 20 years ago gave limited evidence relating to SDR.

**Methods:** Five paediatric neurosurgery units were commissioned in England to perform SDR on children aged 3-9 years with spastic diplegic cerebral palsy and Gross Motor Function Classification Scores (GMFCS) II or III over a period of 20-months to provide evidence on safety and outcomes.

**Results:** One hundred and thirty-seven children underwent SDR during the commissioning period with a mean age of 6.0 years. Mean Gross Motor Function Measure score and Quality of Life measures increased overall following SDR at a follow-up of 2 years. Results were statistically significant. Complication rate was 12% with no severe morbidity. More outcome measure have been collected and will be discussed.

**Conclusion:** This national prospective data collection confirms selective dorsal rhizotomy to be effective and safe in children with cerebral palsy with GMFCS levels II and III.

**OP170**

Intraoperative stimulation-evoked EMG responses during selective dorsal rhizotomy in children with cerebral palsy

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**Introduction:** Selective Dorsal Rhizotomy (SDR) consists of a microsurgical partial deafferentation of sensory nerve roots (L1-S2), aimed at decreasing spasticity in young cerebral palsy (CP) patients.

Intraoperative neuromonitoring (IOM) is an essential part of the surgical decision-making process, designed to improve functional results. Spinal reflexes reorganize in CP, producing hyperreflexia and spasticity. CP is more common in male than female infants. In this retrospective study, we examine gender differences in laterality and the occurrence of higher-graded EMG responses at the various segmental levels.

**Methods:** IOM was used to pinpoint the rootlets most responsible for exacerbated stimulation-evoked EMG patterns recorded from lower-limb muscle groups. Responses were graded according to an objective response-classification system, ranging from no abnormalities (Grade 0) to highly abnormal (Grade 4+), based on ipsilateral spread and contralateral involvement. Non-parametric analysis of data was used in investigating the frequency distribution of EMG responses according to the various grades. Over 7,000 rootlets were stimulated, and the results for 65 girls and 81 boys (treated between 01/2007 and 12/2014) were evaluated, with prior permission (EA1/138/11) from the local ethics committee.

**Results:** Stimulation-evoked EMG response patterns revealed significant differences along the segmental levels and varied according to laterality and gender. Higher-graded EMG responses were markedly more frequent in the boys and at lower segmental levels (L5, S1), resulting in a typical rostro-caudal anatomical distribution. Left-biased asymmetry in higher-graded rootlets was also more noticeable in the boys and in patients with GMFCS level I. A close link was observed between higher-grade assessments and left-biased asymmetry.

**Conclusions:** In view of its prophylactic potential, SDR should be carried out at an early stage in all CP patients. The detailed insight into the patient’s initial spinal-neurofunctional state prior to deafferentation could be of potential importance in adjusting the SDR-IOM intervention to suit the specific individual constellation.

**OP173**

Selective nervous soleus neurootomy as a treatment method in plantar flexion spasticity in cerebral palsy

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**Introduction:** Selective soleus neurootomy (SSN) is a treatment method for the ankle spasticity in spastic hemiplegic or diplegic patients. Main muscles involved in ankle plantar flexion during stance phases of gait cycle are gastrocnemius and soleus. They are active during midstance, terminal stance, and pre-swing phases of gait. To avoid complications of this entity, a normal foot contact has to be achieved.

**Methods:** The study was performed on 34 cerebral palsy patients (hemiplegic:21; diplegic:13) presented with spastic equinovarus foot (SEF) between 2005-2018 (age:2-17; male/female:22/12). Preoperative and
postoperative examinations included Modified Ashworth Scale (MAS) scoring and motion analysis (MA) for evaluation of spasticity. Diagnostic soleus nerve block was performed to decide for SSN. Active physiotherapy started on the same day of surgery. Patients were mobilized and discharged the next day. There were no long-term surgical complications in the follow-up periods.

**Results:** All patients were examined and scored with the MAS, 3 months postoperatively and videos were recorded. Following 12 months after the surgery, patients were evaluated with MA. Preoperative MA graphics demonstrated increase in ankle plantar flexion range of motion (ROM) during whole gait phases. In contrast, postoperative ankle plantar flexion ROM reduces to normal range 12 months after SSN. Static parameters of MA showed improvements in double support, stride width and stride length. Comparing the results of MAS and MA before and after the operations, statistically all patients' spasticity regressed and they improved clinically. This method is very effective in SEF spasticity patients without contractures in the joints.

**Conclusion:** Although tibialis nerve is involved in planter flexion and inversion movements, soleus is much more effective in planter flexion motion. Therefore, SSN should be preferred for the treatment of ankle spasticity.

**ABSTRACT SESSION 7: SDR II**

**OP129**

Selective dorsal rhizotomy—the Leeds experience over our first 124 cases

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**Introduction:** SDR aims to improve spasticity associated with cerebral palsy, improving limb function and mobility through the reduction of abnormal tone. It aims to reduce spasticity by decreasing sensory stimulation whilst preserving voluntary movement. We present Functional and Quality of Life (QoL) outcomes from 124 cases performed in our centre over the past seven years and reflect on our experience of developing this service.

**Methods:** We prospectively have collected data for children undergoing SDR over the past seven years. Data collected spans from October 2012 to November 2019. Standardised patient selection criteria were applied. SDR is performed via a single-level laminectomy, using intra-operative neurophysiology. Approximately 66% dorsal rootlets are cut from L1–S1. All patients had standardised pre- & postoperative assessments with 3D Gait Analysis, GMFM-66, Ashworth grading, muscle power & range of movement. QoL was assessed using the CPQoL questionnaire.

**Results:** 124 patients with a male:female ratio 81:43. Mean age: 6.38 years (range 2.6–14.4). 58 patients (46.8%) were GMFCS 2, 66 patients (53.2%) patients were GMFCS 3. Follow-up data has been collected on only 110 patients (14 patients are still within 6 months of their SDR procedure). 5-year follow-up data is available for 35 patients, 2-year data is available for 85 patients, 1-year data is available for 102 patients and >6 month data is available 110 patients. Over time the patient pathway has improved with shorter operation duration & hospital stays, better patient information, improved analgesia and developments in physiotherapy. All patients have reduction in tone after SDR and GMFM-66 results clearly demonstrate improvement. QoL improved in all domains and there were no significant complications have occurred.

**Conclusion:** SDR is a safe and effective treatment for appropriately selected patients with spastic diplegic cerebral palsy. Our service has developed and grown as we have gained experience having now completed over 120 cases.

**OP176**

Functional posterior rhizotomy: It is not a “selective” but “functional” surgery

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**Introduction:** Rhizotomy is a neurosurgical procedure to reduce harmful spasticity in children with cerebral palsy. Selective dorsal rhizotomy (SDR) is the most common name of the procedure. We prefer to use functional posterior rhizotomy (FPR) instead.

**Methods:** The author has operated on more than 200 rhizotomies since 1996. Peacock’s original procedure, which enables to identify each root level exactly at the root exit zone, was the choice of surgery. Threshold intensity of each root, distribution range and pattern of muscle contraction on EMG was checked first before rootsectioning. The same was followed for rootlets of the selected root, which were cut if the EMG record was judged highly abnormal. Preoperative GMFM score was considered for the total amount of root cutting as well as a preoperative report of the child condition.

**Results:** When the first 100 cases were operated, we noticed that L5 and S1 tended to be cut more than L2 and L3. It was especially true in children with mild spasticity (GMFCS 1 & 2) whose cutting rate of L2 and L3 were less than 10-20% in average. We introduce modified (limited) procedure that expose only L4 to S1 roots if spasticity predominantly located at the ankle joint in children with mild spasticity. We noticed that the amount of root cutting could correlate with the severity of spasticity. A simple formula of preoperative estimation of the root cutting could be: Cutting rate of root = 100 – preoperative GMFM score

**Conclusion:** It would be good opportunity to think about what is the “less invasive” in rhizotomy. Less cutting of root with optimal outcome is ideal. If it is achieved with “less invasive” surgical approach, it would be the best. It should be reminded that rhizotomy is, after all, a functional surgery.

**OP186**

Orthopaedic surgery requirements after selective dorsal rhizotomy

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**Introduction:** Orthopaedic surgery is commonly required to treat contracture and deformity in children with cerebral palsy. We present its requirement after Selective Dorsal Rhizotomy (SDR) in the 110/120 patients with >6-month follow-up treated in our centre. We evaluate and report the frequency, timing and type of orthopaedic procedures that patients have required after SDR surgery.

**Methods:** Prospective data collected on children undergoing SDR since October 2012. All patients were GMFCS Level II or III. Data collection included timing, and type of orthopaedic surgery, and was subdivided according to GMFCS level. Quality of Life has also been monitored but not part of this review.

**Results:** In total, 110 patients have completed >6-month follow-up. Thirty (27%) underwent orthopaedic procedures post-SDR – average age 7.2 years (4.4-13.8), M:F ratio 1.8:1. The median time between SDR & orthopaedic surgery was 9-months (1-61). Summaries for each GMFCS group are below. No patients have required spinal surgery after SDR. GMFCS Level II: 10/50 patients required orthopaedic surgery at a mean of 16.3 months post-SDR surgery. Mean age at orthopaedic surgery 6.9 years. Four patients required combined bone and soft-tissue surgery, and 6 only
needed soft-tissue surgery. GMFCS Level III: 20/60 patients required orthopaedic surgery at a mean of 12.3 months post-SDR surgery. Mean age at orthopaedic surgery was 7.4 years. Eight patients required combined bone and soft-tissue surgery, and 12 only needed soft-tissue surgery. Conclusion: This data provides initial insight into orthopaedic surgery requirements after SDR. GMFCS Level II children appear to require less additional surgery. The young average age at orthopaedic surgery requires longer-term follow-up to examine whether patients require re-operation later in life. Multidisciplinary care of patients after SDR remains important to optimise outcomes. These data provide some insight regarding potential orthopaedic requirements after SDR.

OP222
Walking efficiency after selective dorsal rhizotomy in children with spastic cerebral palsy

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Introduction: This prospective study aimed to assess changes in walking economy after selective dorsal rhizotomy (SDR) in children with cerebral palsy (CP).

Patients and methods: Participants were 15 children with spastic cerebral palsy (age range 6-17yr; Gross Motor Classification System (GMFCS) I n=1, II n=13 and III n=1). Walking economy was assessed at 1 and 2 year after SDR by measuring oxygen consumption during 6-min of walking at comfortable speed. Walking economy was defined as the energy expenditure expressed by meter (energy cost in J/kg/m). In addition, gross motor function was assessed using the Gross Motor Function Measure (GMFM). Differences between pre-assessment and 1 and 2yr post-SDR assessments were evaluated with paired samples t-tests. Linear regression was used to assess whether energy cost and GMFM score at baseline were predictors of changes in walking economy.

Results: Walking economy improved from 9.8±4.2 J/kg/m (206±74% of age-matched controls) pre-SDR to 8.4±3.3 J/kg/m (184±60%) at 1-year (n=14, p<0.01) and 7.4±3.4 J/kg/m (169±62%) at 2-year follow-up (n=10, p<0.001). Improvements in walking economy after SDR were associated with walking economy (R2=0.77) and GMFM ( R2=0.45) at baseline, showing larger improvements in those with more severe involvement.

Conclusion: SDR has a beneficial effect on the walking efficiency after one year, with improvements continuing in the second year post-SDR. This favorable change is also present when corrected for maturation effects. Within this relatively high-functioning group, more severely affected children with lower walking economy or GMFM scores pre-SDR have a larger potential for improving walking economy.

ABSTRACT SESSION 8: Vascular
Flash Presentations

OP12
Hydrocephalus in children with ruptured cerebral arteriovenous malformation

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Object: Hydrocephalus is a strong determinant of poor neurological outcome after intracerebral hemorrhage (ICH). In children, ruptured brain arteriovenous malformation (bAVM) are the dominant cause of ICH. In a large prospective cohort of pediatric ruptured bAVM, we analyzed the rates and predictive factors of hydrocephalus requiring acute external ventricular drainage (EVD) or ventriculo-peritoneal shunt (VPS).

Methods: Single center retrospective analysis of the data from a prospectively maintained database of children admitted for a ruptured bAVM since 2002. Admission clinical and imaging predictors of EVD and VPS placement were analyzed using uni- and multivariate statistical models.

Results: Among 114 patients (Mean age: 9.8 yrs), with 125 distinct ICH due to ruptured bAVM, EVD and VPS were placed in 55 (44%) and 5 patients (4.4%), respectively. Multivariate nominal logistic regression model identified low initial Glasgow Coma Scale (gGCS), hydrocephalus on initial computerized tomography scan, the presence of intraventricular haemorrhage (IVH) and higher modified Graeb score (mGS) as strongly associated with subsequent need for EVD (all p<0.001). All children who needed a VPS had initial hydrocephalus requiring EVD and tended to have higher mGS.

Conclusion: In a large cohort of pediatric ruptured bAVM, almost half of the patients required EVD and 4.4% permanent VPS. A low iGCS and the semiquantitative mGS of IVH burden may be of critical help for decision making in this setting.

OP64
Evolution of the approach to cerebral revascularization in children with moyamoya disease

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Introduction: We aimed to describe evolution of our surgical approach to cerebral revascularization in pediatric moyamoya disease (MMD).

Methods: From 2008 to 2019 in our hospital 53 children with MMD had revascularization surgery for MCA territory (86 operated hemispheres). Median age at surgery was 8 years (2-17). We started from direct-only (STA-MCA bypass only - 5 hemispheres) OR indirect-only procedure (EDAS - 27 hemispheres) and moved to combined direct and indirect revascularization for most patients since 2014. Double (16) or triple (1) bypass was increasingly utilized. For indirect procedure, temporal muscle (11-EDAMS; 8-EDMS) in combination with multiple burr holes (15) was used recently to cover more territory than it was allowed by EDAS or EDS previously. Two-tailed Fisher’s exact test was used for group comparisons.

Results: Functioning direct anastomosis compared to indirect-only procedure was associated with lower rate of immediate postop ischemic events (TIA or stroke 24% vs. 52%; p=0,01) and higher rate of immediate improvement in NIHSS score (17% vs 0% p=0,03). Median follow-up was 22 months (range 3-84, available for 77% of patients). At last visit NIHSS score improved in 100% after direct in 71% after
combined and in 50% after indirect procedure. Angiography showed extensive synangiosis formation in 92% after indirect-only and in 67% after combined procedure. Direct bypass patency was confirmed in all cases after direct and in 94% after combined procedure. ASL MRI perfusion improved in 63% after indirect and in 81% after combined procedure.

**Conclusion:** Combined procedure compared to single indirect synangiosis provides better protection from perioperative ischemic events and sometimes gives advantage of immediate improvement. Broad indirect augmentation advantageous in the follow up, although not in every patient. Direct bypass as single procedure is successful in selected cases but may be not adequate for small children or advanced disease with compromised cortical collaterals.

OP206

The treatment of cerebral and medullary cavernomas. Our experience in a paediatric series from 2001 to 2019

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**Introduction:** We report our surgical experience in the treatment of 58 children with cerebral and medullary cavernomas cavernomas. The median of age at surgery is 11.7 years (range 8 months to 18 years; median 17.7). Clinical symptomatology was dominated by the haemorrhage in 27 cases (46%) followed by seizures as first symptom in 12 symptoms. In 13 cases were multiple cerebral cavernomatosis which were hereditary in 7 cases. The localisation was supratentorial in 37 cases (63.8%), at the level of the posterior fossa in 16 cases (27.6%) and medullary in 5 cases (8.6%). All the children had initial MRI workup before surgery.

**Results:** Complete removal was possible in all cases, even for brainstem or motor region locations. For supratentorial cavernomas the outcome was good in all cases. 4 patients with brain stem cavernomas presented neurological deficits: 2 cases with VII nerve paresis (one complete) and one with persistent cerebellar syndrome. Epilepsy control was obtained in all cases and allowed withdrawal from antiepileptic treatment for all but one patient with cavernomatosis.

**Conclusions:** Our experience shows that the surgical treatment is a safe option and, excepting brainstem localisation, has a low morbidity with a good control in cases of epilepsy.

**ABSTRACT SESSION 9: Neuro-oncology I**

OP30

Immunotherapy in pediatric malignant brain tumors

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**Introduction:** We report our surgical experience in the treatment of 58 children with cerebral and medullary cavernomas cavernomas. The median of age at surgery is 11.7 years (range 8 months to 18 years; median 17.7). Clinical symptomatology was dominated by the haemorrhage in 27 cases (46%) followed by seizures as first symptom in 12 cases. In 13 cases were multiple cerebral cavernomatosis which were hereditary in 7 cases. The localisation was supratentorial in 37 cases (63.8%), at the level of the posterior fossa in 16 cases (27.6%) and medullary in 5 cases (8.6%). All the children had initial MRI workup before surgery.

**Results:** Complete removal was possible in all cases, even for brainstem or motor region locations. For supratentorial cavernomas the outcome was good in all cases. 4 patients with brain stem cavernomas presented neurological deficits: 2 cases with VII nerve paresis (one complete) and one with persistent cerebellar syndrome. Epilepsy control was obtained in all cases and allowed withdrawal from antiepileptic treatment for all but one patient with cavernomatosis.

**Conclusions:** Our experience shows that the surgical treatment is a safe option and, excepting brainstem localisation, has a low morbidity with a good control in cases of epilepsy.
Brainstem blood-brain barrier disruption and enhanced drug delivery with an unfocused ultrasound device – A preclinical study in healthy and tumor-bearing mice

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**Introduction:** The recent advancements in the molecular biology of pediatric malignant brain tumors (PBTs) have allowed a better classification of these tumors, but still there is a poor prognosis of most types of PBTs and there is a need for looking for new treatments. Immunotherapy emerges as an option, usually in combination with other approaches.

**Methods:** Two phase I clinical trials with immunotherapy has been run in PBTs in our hospital. One with oncolytic adenovirus DNX-2401 for naïve DIPG patients, and a second one with dendritic cell vaccines for recurrent malignant solid brain tumors. Clinical and radiological data were collected.

**Results:** 10 patients with DIPG have been treated with the virus following the trial, so the virus was injected before starting radiotherapy. 4 patients with recurrent malignant brain tumors were treated with dendritic cell vaccine in combination with the salvage treatments. Additionally, 5 patients received the virus outside the trial, as a compassionate use, because they had a recurrent DIPG. Median age of these patients was 8.5 y, there were no grade 3-4 adverse events related with the novel therapists. Steroids were reduced to the minimum dose in every patient to avoid immunosuppression.

**Conclusion:** We present our experience with an oncolytic adenovirus in DIPG and dendritic cells vaccines in PBTs showing that they are safety tools in children with a high tolerability. Phase II trials are needed to identify the best candidates to immunotherapy and the best combinations with other treatments.

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**OP107**

Implementation of high-throughput drug screening into routine workflow for pediatric brain tumors – a single center experience in personalized neuro-oncology

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**Introduction:** We have previously established and validated a highly specialized, semi-automated high-throughput drug screening (HTS) pipeline for pediatric brain tumors. Here we describe our experience in implementing this pipeline into routine workflow at a dedicated pediatric neuro-oncology center.

**Methods:** The pipeline is based on semi-automated devices, the D300e Digital Dispensers (Tecan Trading AG, Switzerland), that enable randomized distribution of active ingredients onto microtiter lines for pediatric brain tumors. Here we describe our experience in implementing this pipeline into routine workflow at a dedicated pediatric neuro-oncology center.

**Introduction:** Diffuse Intrinsic Pontine Gliomas (DIPGs) have a dismal prognosis. The blood-brain barrier (BBB) plays a major role in the failure of medical treatments by preventing drugs from reaching therapeutic concentrations in the infiltrated tissue. The purpose of this study was to assess the feasibility and safety of US-induced BBB disruption (US-BBBD) in the brainstem of healthy and tumor-bearing mice with an unfocused ultrasound device (SonoCloud®) in association with microbubbles and evaluate drug delivery to the brainstem.

**Methods:** BBBD was assessed in healthy nude mice and in orthotopic xenograft models of DIPG. Sonifications were performed with the SonoCloud® device at a frequency of 1.05 MHz. Acoustic pressures varied from 0.3 to 0.5 MPa. BBBD was evaluated with Evans blue dye and 70 kDa fluorescent dextrans. Clinical parameters were monitored. Histological analysis of the brainstem parenchyma and tumor tissue was performed. The pharmacokinetics of irinotecan and panobinostat in plasma and brainstem were assessed, with or without BBBD, in tumor-bearing mice and healthy nude mice, respectively.

**Results:** A significant blue coloration and fluorescence of healthy brain and tumor tissue were observed in the sonication field, demonstrating the BBBD. Sonifications were well-tolerated and did not induce histological lesions at 0.3 MPa. In CDOX mice, irinotecan concentrations were significantly higher in sonicated pons at 30 and 120 minutes after treatment (concentration ratios 4.3, p<0.001 and 2.8, p<0.05, respectively, two-way ANOVA). A significant increase in panobinostat concentration in sonicated pons compared to non-sonicated pons of healthy nude mice was observed three hours after treatment (concentration ratio 1.41, p<0.05, two-way ANOVA).

**Conclusion:** US-BBBD with the SonoCloud® device was obtained in brainstem of healthy and tumor-bearing mice. Sonifications were clinically well-tolerated without histological lesions. US-BBBD allowed for increased delivery of irinotecan and panobinostat in murine DIPG CDOX model and healthy brainstem. Grant from "The Cure Starts Now"
Results: Tumor samples (solid specimens and/or ultrasonic aspirator filtrate) of 164 primary tumors and 14 recurrent tumors were collected in the neurosurgical operation room and immediately transferred to the on-site laboratory, where processing and cultivation was performed. The main histological entities were pilocytic astrocytoma (N=31, 17%), medulloblastoma (N=28, 16%), glioblastoma (N=27, 15%) and ependymoma (N=21, 12%). Of these cases, 107 tumor cell cultures were established successfully and HTS was subsequently performed. Patient-specific drug screening results were categorized into absent/non-selective and selective activity of tested established chemotherapeutic agents and novel anticancer compounds.

Conclusion: The HTS pipeline was successfully implemented into our clinical routine workflow for pediatric brain tumors. As the tested drugs were selected for HTS based on clinical applicability, i.e. they were at least previously investigated in phase III and IV studies, personalized treatment options could be provided for 60% of pediatric brain tumors in the framework of future clinical studies.

OP136

The use of 5-aminolevulinic acid to assist gross total resection of pediatric posterior fossa tumours

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Background: There is growing interest in the use of 5-aminolevulinic acid (5-ALA) in the paediatric population. The potential benefit of 5-ALA guided resection motivated our unit to offer the established adult protocol as off label use.

Objective: To determine if 5-ALA guided resection was routinely useful and offered increased gross total resection (GTR) results.

Methods: Nineteen patients harbouring a posterior fossa tumour underwent surgery between January 2018 and October 2019. The mean age was 5 years (range 2 to 12 years). A dose of 20mg/kg of 5-ALA (Gliolan®) was given 4 hours pre-operatively. Fluorescence status was compared with histopathological classification and grade, Ki-67 index, gross total resection rate, and a subjective determination of "usefulness" was determined.

Results: The case series included ependymoma grade II (n = 6), ependymoma grade III (n=4) and medulloblastoma grade IV (n=9). For the combined cohort the strong fluorescence rate was 68% (n=13), the heterogenous fluorescence rate was 26% (n=5) and the completely negative fluorescence rate was 5%(n=1). The strong fluorescence rate of 90% found in the combined ependymoma group compared to the 45% strong fluorescence rate in the medulloblastoma group was statistically significant (p=0.05). Within the medulloblastoma group the Ki-67 index was found to be significantly higher in the strongly fluorescent group as opposed to the patchy or non-fluorescent group (77.5% vs 40%, P=0.016). Fluorescence was determined to be useful in 63% of all cases. There was no significant relationship between fluorescence and GTR. The relationship between perceived usefulness and resection was not statistically significant. No adverse drug reactions were recorded.

Conclusion: 5-ALA guided resection was found to be useful in the majority of cases but this did not correlate with GTR status. Ependymomas reliably fluoresce in 90% of cases and 5-ALA guided resection should be considered when a pre-operative diagnosis of ependymoma is suspected.

OP159

Paediatric brain tumours: Validating surgical outcomes and operative morbidity

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Introduction: There are few published series on paediatric neurosurgical morbidity. Our objective was to quantify resection outcomes and operative morbidity in paediatric brain tumour surgery using existing scales, assessing their suitability for the task.

Methods: Literature review identified the Clavien-Dindo (CD) scale1 and the Drake classification2 as suitable tools. Through retrospective review of a prospectively maintained database, we identified all paediatric patients receiving a biopsy or craniotomy for an intracranial tumour in a single tertiary paediatric neurosurgery centre between January 2008 and December 2018. Complications up to day 30 post op were retrospectively graded using the CD and Drake tools.

Results: There were 459 operations: 92 biopsies and 367 craniotomies comprising 166 infratentorial and 292 supratentorial tumours. Median
age was 9, and 56% of patients were male. The surgical goal was achieved or exceeded in 94% of cases. Thirty day mortality was 1.31% with all deaths related to disease burden, and none related to surgical complications. The overall CD score was 1 in 10.9% of cases, 2 in 18.9%, 3A in 1.7%, 3B in 11.8%, and 4 in 1.1%. There was no operative morbidity in 54% of cases. Using the Drake classification, meningiomas were seen in 3.92% of cases, seizures in 3.92%, neurological deficit (that persisted at 30 days) in 8.5%, CSF leak in 5.01%, haemorrhage managed medically in 1.53%, haemorrhage managed surgically in 0.22%, wound infection in 1.96%, shunt infection in 1.53%, shunt block in 0.65%, medical complications in 2.4%, and other complications in 3.05%.

Conclusions: This is the largest series presenting outcomes and morbidity from paediatric brain tumour surgery, and the first to validate the CD scale. Our morbidity on the Drake scale was comparable with other series. There is a need to develop an improved tool to quantify morbidity in this small volume but high-risk specialty.

ABSTRACT SESSION 10: Neuro-oncology II

OP34

Skull base surgery for tumors in children: Long-term clinical and functional outcome

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Introduction: Skull base tumors (SBT) in children are rare but require complex approaches with potential morbidity to the developing craniofacial skeleton. Primary tumors are varied and are particularly challenging to pediatric neurosurgeon with few papers in literature describing evolution, complications and outcome.

Methods: A retrospective analysis was undertaken of children undergoing surgery at a single institution between 1994 and 2019 for benign and malignant SBT. Patients with craniopharyngioma, pituitary tumors, optic glioma, congenital lesions, and bone fibrous dysplasia were excluded. We analyzed data regarding patient age, histology, tumor location, extent of resection, postoperative complications, and adjuvant therapies. Additionally, a literature review was carried out describing a total of 267 children operated for SBT. Functional and cognitive outcome was assessed prospectively using the Late Effects Severity Score (LESS).

Results: Seventeen children ranging in age from 3 months to 17 years (mean age 9 years) underwent skull base approaches during the study period. The median follow-up was 72 months. Tumor types included meningioma, schwannoma, chordoid chordoma, mature teratoma, epidermoid cyst, rhabdomyosarcoma, Crooke’s cell adenoma, fibroma, and chordoma. Gross total resection was achieved in 6 (35%). 12 patients (70%) had benign histology and 5 (30%) had a malignant tumor. The median hospital stay was 11 days. Nine children (52%) had residual neurological deficit at last follow-up evaluation. Three (17.6%) of 14 surviving patients received adjuvant therapy. Recurrence rate or progression of the lesion were 17.6%. The majority of the patients remain in mainstream education and 11 of the 14 surviving children have an LESS of 3 or lower.

Conclusions: Pediatric SBT presents a therapeutic challenge because of their complexity and heterogeneous histologic and can lead to considerable morbidity and mortality. The mainstay of the treatment of skull base tumors is still the surgical resection that in many cases does not require adjuvant treatments.

OP36

Cystic craniopharyngioma in children and adolescents—the place of stereotactic treatment

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Objective: Treatment for cystic craniopharyngiomas is still under debate particularly for the young population. We here present for the first time tumor control and functional outcome data after stereotactic (STX) and conventional surgery.

Methods: We identified pediatric/adolescent craniopharyngioma patients treated between 1990 and 2019. Treatment decisions in favor of microsurgery (transcranial/transsphenoidal) or STX were made interdisciplinary. STX included aspiration of cystic formation and/or implantation of an internal shunt for continuous up- (ventricular system) and downstream (basal cisterns) drainage. Study endpoints were progression free survival (PFS), time to radiation and functional outcome. Crossover rate from STX to microsurgery over time was analyzed. Functional outcome included ophthalmological, endocrinological and body-mass index (BMI) data.

Results: 36 patients (median age 9.9 yrs) were analyzed including 33 (3)cystic (solid) tumors. STX was applied in 16, transsphenoidal (transcranial) microsurgery in 7 (13) tumors. Tumor volume reduction was achieved with either method (median 82 to 9cm³; p<0.001). Improvement of visual dysfunction was achieved in all patients independent of treatment. Overall, 5-year PFS was 49% (median FU 81 months). 5-year PFS was 33%, 60%, and 67% after STX, transsphenoidal and transcranial resection, respectively (p=0.2). 5-year crossover rate from STX to transcranial resection was 40% (median 106 months). 5-year probability for radiation was 5% (median 155 months) after initial treatment and not different among applied treatments. Endocrinological worsening/BMI increase was worst in patients undergoing radiation (100%/8kg/m2), in-between after open tumor resection alone (63%/6kg/m2) and best in patients undergoing exclusively STX (22%/3kg/m3) (p=0.001). In multivariate analyses radiation was associated with hypothalamic dysfunction (p=0.005).

Conclusion: STX is a minimal invasive treatment option for cystic craniopharyngiomas and associated with the lowest rate of functional deterioration. STX enlarges the therapeutic platform for predominantly cystic tumors. Personalized localized treatment options have the potential to withhold radiation therapy in the vast majority of patients.

OP78

Surgery of tumors of the fourth ventricle in children. Impact of surgical route on the outcomes and post-operative cerebellar mutism in a single-institution series of 92 patients

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Management of NF2-associated vestibular schwannomas in adolescents and young adults: Influence of surgery and bevacizumab treatment on tumor volume, growth rate and hearing

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Introduction: Hearing preservation and growth control are major goals in the treatment of neurofibromatosis type 2 (NF2) associated vestibular schwannoma (VS), particularly in adolescents and young adults. Treatment strategies to pursue these goals are predominantly microsurgery and therapy with bevacizumab (BVZ). This study investigates tumor volume, growth rate and hearing function before and after surgery and therapy with bevacizumab (BVZ). This study investigates tumor volume, growth rate and hearing function before and after surgery and therapy with bevacizumab (BVZ). This study investigates tumor volume, growth rate and hearing function before and after surgery and therapy with bevacizumab (BVZ).

Methods: Tumor volumetry, based on ~900 MRI scans, and hearing data were collected in a prospective multicenter study from 2005 to 2017. The cohort included 92 consecutive pediatric patients with NF2-associated VS. Tumor volume was measured before surgery and BVZ treatment, and at follow-up intervals of 6 months. The primary outcomes were tumor volume, growth rate, and hearing function before and after surgery and BVZ treatment.

Results: Tumor volume before surgery and BVZ treatment was significantly lower (p < 0.001). Functional hearing was maintained in 82% of ears and the further course equaled that of 20 non-operated, less aggressive control tumors. In BVZ treated tumors/ears, growth rate and hearing deterioration were less in the BVZ-treatment periods. Differences were not significant to pre-treatment because variations were large.

Conclusion: Primary BERA guided surgery with decompression of IAC and partial resection stabilizes tumor growth and hearing and thus enables a post-ponement of the BVZ treatment. Response to postoperative BVZ seems to be heterogenous and possibly less effective than in untreated tumors, due to surgically reduced tumor volumes.

OP137

Preoperative prediction of postoperative cerebellar mutism syndrome

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Introduction: Cerebellar mutism syndrome (CMS) is a complication that may occur after pediatric fossa posterior tumor surgery. Liu et al. developed a prediction model to estimate CMS risk pre-operatively. Zhang et al. found that measures on MRI that were predictors for CMS. The goal of this study was to validate the model of Liu et al. and the measurements from Zhang et al.

Methods: In this study, 121 children with a fossa posterior tumor who underwent surgery at ErasmusMC/ Sophia Children’s Hospital, the Netherlands between 2004 and 2018 could be included. Twenty-six percent of their developed CMS. MRI’s were scored using the Liu et al. model and the measurements of Zhang et al. A new risk prediction model was created based on results from uni- and multivariate logistic regression analysis.

Results: The Liu et al. model reached an accuracy of 78%, a sensitivity of 58%, and a specificity of 84% in our cohort. All but one of the Zhang et al. measurements showed statistically significant differences between the CMS and non-CMS group. Variables that were included in the new risk prediction score are tumor location, radiological diagnosis, brainstem invasion, middle cerebellar peduncle invasion and bilateral compression, superior cerebellar peduncle invasion and the measurement d(sagittal) (depth of tumor invasion/ compression into the brainstem). The new model reached an accuracy of 87%, a sensitivity of 97% and a specificity of 84% in our patient group.

Conclusion: The Liu et al. model didn’t provide an as accurate risk prediction in our cohort as was expected. Utilizing an additional measurement from Zhang et al., we created a new risk prediction model that reached high model accuracy in our cohort.

OP221

Clinical presentation of the cerebellar mutism syndrome: preliminary results from a prospective multicenter study

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Objective: The cerebellar mutism syndrome (CMS) is one of the most disabling adverse events after neurosurgery for a posterior fossa tumor in childhood. The reported incidence varies substantially in previous studies between 8 and 39% with different definitions of the syndrome used. Most agree CMS involves mutism, emotional lability, hypotonia and ataxia. This sub-study of...
the Nordic study of CMS aims to investigate the incidence and clinical presentation of the cerebellar mutism syndrome to present a diagnostic model.

**Materials and methods:** We included 446 children aged 7.6 years (4.0;10.9) (median, Q1;Q3) with a tumor in the posterior fossa with intent of surgery or open biopsy. The children were included between 2014 and 2019 in 26 centres in ten European countries in this prospective multicenter cohort study. Inclusion is still running. Focus for this study was the pre-operative assessment and the post-op follow-ups at two weeks and two months. Data involved demographics, speech status and neurological examination.

**Results:** Preliminary data suggest postoperative mutism occurring in 41 (13.4%) of the children. Postoperative ataxia occurred in 81%, hypotonia in 50% and emotional lability in 52% of the mute. In comparison (Chi-square) 38% of non-mute children had ataxia (p<0.0001), 9% hypotonia (p<0.0001) and 30% emotional lability (p=0.02).

**Conclusion:** With 446 patients included, this study is the largest prospective cohort study of CMS world-wide. Most children with post-op mutism also have ataxia, whereas hypotonia and emotional lability are seen in half of the children.

**Funding:** Child Cancer Foundation (DK), Swedish Childhood Cancer Fund, Danis Cancer Society, The Brain Tumour Charity, The Dagmar-Marshall foundation, Kin Christian IX and Queen Louise’s anniversary grant

### ABSTRACT SESSION 11: Ethics / New Practice

#### OP38

**Robotic in pediatric neurosurgery—where are we going?**

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**Introduction:** The use of robotic in surgery has been researched in the last thirty years and has been progressively used in the procedures. Robotic assistance have effectiveness, security, precision of a good deal of neurosurgery pediatric procedures: such as biopsy, neuroendoscopy, deep brain stimulation, stero-electroencefaphalography and several neurosurgery procedures. Pediatric neurosurgery are a delicate subspeciality, with special demands of delicate procedures, then robots are an important tool for this patient group

**Methods:** The research was performed using the Pubmed database targeting all English language publications available involving robotic in pediatric neurosurgery. Then, in this study we will discuss a review of robotics in pediatric neurosurgery and present our experience using the NeuroMate robot. We have an experience with 25 cases of pediatric neurosurgery with robotics.

**Results:** The literature search, conducted via PUBMED. The research results showed the benefits to robotic surgery in pediatric neurosurgery, such as faster than no robotic and more accurate. Surgery time is faster than conventional surgery, likewise previous studies. Our experience with 25 patients, who participated in epilepsy neurosurgery, deep brain stimulation and oncological neurosurgery was the mean age of, 10 years, median of 12, in which were 48% male and 52% female. In this case series we have shown 9 cases of epilepsy surgery (36%), 7 cases of movement disorders (28%) and 9 cases of oncological neurosurgery (36%). Then, we had 24 cases of positive results, representing 96% of all cases. Overall, We had no complications during surgery.

**Conclusion:** The result of this advancement of technology, the possibility of better results is increasingly possible. For instance, Robotic neurosurgery can assist in this accuracy, agility, fewer complications, and excellent results. In addition, our experience shows that the way is right and that the neurosurgeon can use robotic neurosurgery in pediatric neurosurgery.

**OP60**

**The prevention of shaken baby syndrome: The lille experience**

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**Introduction:** Non-accidental head injuries (NAHI), in particular the Shaken-baby syndrome (SBS) are by far the largest cause of traumatic death and heavy handicap in infants. This man-made disaster is a major healthcare issue; it can be prevented, as shown by the Canadian experience.

**Material and methods:** We have registered prospectively all cases of NAHI diagnosed in our institution since 2002. Since 2015, the non-profit organization les maux/les mots pour le dire has organized conferences and training programs aimed at healthcare, social care, and justice professionals. Since 2018, we initiated in Lille a prevention program based on the “Crying plan” in maternity wards, under the patronage of the University Sainte-Justine in Montreal. We compared the incidence of NAHI before and after the intro-

| Parameter                              | Symptomati c IC (n=2) | TCS Only (n=7) | Asymptomati c IC (n=4) | No IC or TCS (n=28) |
|----------------------------------------|-----------------------|----------------|------------------------|---------------------|
| Mean GA at fetal surgery               | 25.8                  | 23.5           | 24.4                   | 24.7                |
| Mean GA at delivery                    | 36.9                  | 33.3           | 35.3                   | 35.1                |
| Highest level of lesion                | L3, L5                | L1, L2, L3, (3), L4, L5 | L1, L2 (2), L5         | T11, L1, L2 (6), L3 (10), L4 (9), L5 |
| Skin Repair (%)                        | Primary: 2 (100)       | 6(85.7)        | 3(75)                  | 17(60.7)            |
|                                        | Inlay: 0              | 0              | 0                      | 8(28.6)             |
|                                        | Graft: 0              | 1(14.3)        | 1(25)                  | 17(60.7)            |
|                                        | Tubularization of spinal cord (%) | 2(28.6) | 1(25)                  | 17(60.7)            |
|                                        | Syrinx (%)            | 0              | 5(71.4)                | 6(21.4)             |

*All dura was approximated primarily. Primary refers to primary skin closure, inlay refers to primary skin closure with supporting material of Alloderm or Duragen underneath skin repair. Graft refers to a sutured in Alloderm graft to the skin.

IC=Inclusion Cyst

TCS=Tethered Cord Syndrome

GA=Gestational Age
dution of the crying plan. We also compared cases originating from the Lille metropolis (the focus of our prevention activities) with the accrual from other population basins.

**Results:** We collected 369 cases of NAHI. Since 2018, the incidence decreased from 18.8 to 13.6 cases/year; during the same period, the contribution of the Lille area decreased from 29.2% to 19.2% of the total (NS). 28 children died of NAHI before 2018, compared with only one since (NS).

**Conclusions:** Although not statistically significant, these results are encouraging for the extension of this experience to other regions. SBS should be tackled through a multi-pronged approach, in order to lobby institutional healthcare providers for funding of the prevention plan. Pediatric neurosurgeons should be at the forefront of this endeavor.

**OP3**

Moral distress in pediatric neurosurgery: Discussing the withdrawal of a shunt in the context of severe traumatic brain injury

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**Introduction:** The decision to operate or not a child with a severe neurological disease can generate moral distress in pediatric neurosurgery routines. One of the most frequent situations is shunting or not a seriously compromised young patient.

**Methods:** Case report: An 11 years-old girl was admitted to the hospital with a history of traumatic brain injury by a gunshot over the right parietal bone. Initial Glasgow coma Scale(GCS) was 6, with orotracheal ventilation, S02 of 98% and blood pressure of 150x80 mmHg. Both pupils react to the light. A Computed tomography of skull revealed the trajectory of the bullet crossing the midline at the level of splenius of corpus callosum. There was evidence of moderate brain swelling and the patient was moved to operate room for treatment of entry site injury, with cleaning of trashes, craniectomy and local duraoplasty.

**Results:** The patient remained 03 months in intensive care unit(ICU) where after withdrawal of sedative drugs maintained GCS of 4. Serials CT scans showed progressive dilation of ventricular system and bulging of cranietomy site. The multi-professional team of ICU brought up questions concerning about the patient age, media pressure( involvement with drug trafficking) and neurological prognosis. Initially an External ventricular derivation(EVD) was inserted with no changes at GCS score. After an opportunity of clear communication with the parents the team decided for remove the EVD. The patient died after 04 days.

**Conclusion:** In cases with ethical dilemma the choice of the best therapeutic option can raise a moral suffering for the health practitioners. Avoid put a shunt in a young patient with poor neurological prognosis is a difficult decision. Palliative care education, multi-professional discussion and better communication process are helpful to overcome those problems and facilitate the decision-making process.

**OP112**

Neonatal outcomes in prenatal and postnatal repair of myelomeningocele

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**Introduction:** Prenatal surgery selected cases of myelomeningocele began in the United Kingdom in 2018. In order to appropriately counsel parents for such treatment, it is essential to provide contemporary data on the management and early outcomes of infants treated by prenatal surgery and conventional postnatal surgery.

**Methods:** A retrospective study of infants who underwent prenatal or postnatal myelomeningocele closure between July 2011 to September 2019 was performed. Primary outcomes include the presence of Chiari II malformation, the rates for shunt placement and neonatal complications. Secondary outcomes include the rates of urological complications, urological intervention and neonatal surgical interventions.

**Results:** From July 2011 to September 2019, cases were reviewed including 19 prenatal and 62 postnatal closure infants. Chiari II malformation was confirmed on MRI in 26% of infants in the prenatal repair group compared to 56% in postnatal group (P = 0.035). In the prenatal repair group, 26% required shunt placement compared to 69% in postnatal group (P = 0.001). There were no significant differences between the two groups in the rates of urological complications, but cerebrospinal fluid leak was significantly higher in the postnatal group (31% versus 0%) (P = 0.004). Lastly, although prematurity was significantly higher in prenatal group (P <0.001), the need for second neonatal surgical intervention was significantly lower (21% versus 68%) (P = 0.001).

**Conclusion:** renal repair surgery for myelomeningocele reduced the incidence of Chiari II malformation at birth and decreased the need for shunt placement at 3 months of age, as well as the rates of neonatal surgical intervention, but was associated with preterm labour. Our findings are in keeping with the Management of Myelomeningocele Study (MOMS).
Impact of microneurosurgical neural placode tubularization on reducing spinal cord tethering and incidence of inclusion cyst following 60 fetal in-utero myelomeningocele repairs

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Objective: The Management of Myelomeningocele Study (MOMS) trial showed improved hydrocephalus and motor/cognitive outcomes in the prenatal repair group compared to the postnatal group. Reports of spinal cord tethering and increased rates of inclusion cysts (IC) were reported in the literature. Closure technique used during MOMS trial did not include placode tubularization. We evaluated the impact of tubularization on tethering and IC rates as well as wound dehiscence rates.

Material-methods: We retrospectively reviewed charts for technique of fetal MMC repair, gestational age (GA) at time of repair and birth, dehiscence at repair site and spinal MRI findings.

Results: 60 females underwent prenatal MMC repairs between 20 and 26 weeks GA. All MMC defects underwent successful in-utero repair, with progression of pregnancy (average GA at birth: 34+4/7 weeks). 58 babies have been born, 56 are alive (2 neonatal mortalities due to prematurity, one excluded for lack of research consent). From the remaining 55 patients, 9 patients (16.3%) developed clinical signs of tethered cord syndrome (TCS) requiring microsurgical detethering. When comparing the patients with and without TCS, we trended towards statistical significance when looking at rates of placode tubularization at time of fetal MMC repair. This occurred in only 2/9 (22.2%) of the TCS group and occurred in 21/36 (58.3%) of the non-tethered group, (p=0.071). Of 45 patients with MRI data, 6 patients (6/45=13.3%) had an IC. 2 (33%) of them required detethering while 4(66%) remain asymptomatic. At birth, 16/55 (29%) had superficial skin dehiscences managed conservatively with local wound care and positioning restrictions. Five patients (5/55=9%) required secondary repair after birth due to dehiscence/CSF leak.

Conclusions: This is the first cohort in the post-MOMS trial era to suggest microneurosurgical placode tubularization during fetal MMC repair can lower rates of early spinal cord tethering and IC formation. Superficial skin dehiscences at birth following fetal MMC repair could be managed conservatively.

### Table 2 Operative Data (N=45)

| Parameter                        | Symptomatic IC (n=2) | TCS Only (n=7) | Asymptomatic IC (n=4) | No IC or TCS (n=28) |
|----------------------------------|----------------------|----------------|-----------------------|---------------------|
| Mean GA at fetal surgery         | 25.8                 | 23.5           | 24.4                  | 24.7                |
| Mean GA at delivery              | 36.9                 | 33.3           | 35.3                  | 35.1                |
| Highest level of lesion          | L3, L5               | L1, L2, L3     | L1, L2 (2), L5        | T11, L1, L2 (6), L3 (10), L4 (9), L5 |
| Skin Repair (%)                  | 2 (100)              | 6(85.7)        | 3(75)                 | 17(60.7)            |
| Primary                          | 0                    | 0              | 0                     | 8(28.6)             |
| Inlay                            | 0                    | 1(14.3)        | 1(25)                 | 17(60.7)            |
| Graft                            | 0                    | 2(28.6)        | 1(25)                 | 17(60.7)            |

*All dura was approximated primarily. Primary refers to primary skin closure, inlay refers to primary skin closure with supporting material of Alloderm or Duragen underneath skin repair. Graft refers to a sutured in Alloderm graft to the skin.

IC=Inclusion Cyst
TCS=Tethered Cord Syndrome
GA=Gestational Age

### ABSTRACT SESSION 12: Hydrocephalus II

**OP135**

3D volumetry and 2D area determination of cerebrospinal fluid and brain volume in paediatric hydrocephalus: implementation and clinical course after intervention

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Background: In childhood hydrocephalus both, CSF and brain volume are relevant for developmental prognosis and therapy monitoring. Since classical planar measurements of ventricular size are limited, imprecise and neglect brain volume, 3D volumetry is gold standard. We implemented the segmentation algorithms of FSL-toolbox software for volumetric MRI assessment
before and after therapy and investigated 2D area determination in a single plane in correlation to volumetry.

**Methods:** 138 true-FISP MRI sequences (1 mm) were analyzed in 68 pediatric hydrocephalus patients. 38 patients were followed before and after surgical treatment (VP shunt n=22, ETV n=16). 3D-datasets were skull-stripped to determine inner skull volume. A 2-class segmentation into brain and CSF was performed and volumes of CSF (VCSF) and brain (VBrain) calculated. An ac-pc oriented plane at foramen of Monro level was manually identified, areas of brain (ABrain) and CSF (ACSF) calculated in cm² and used for correlation analysis.

**Results:** The method was successfully applied in an automated fashion. After VP shunt, VCSF decreased (p<0.001) and VBrain increased (p=0.001). Following ETV, VCSF decreased (p=0.012) and VBrain expanded (p=0.02), although changes were significantly less than following shunt. There was a strong positive correlation between ACSF to VCSF (r=0.895) and ABrain to VBrain (r=0.846). The prediction equations for VBrain and VCSF on the basis of area were highly significant.

**Conclusion:** A reliable automated segmentation of CSF and brain volumes could be achieved. The method detected significant quantitative differences in CSF and brain volumes after shunting and ETV. Planar area determination correlates excellently with both VCSF and VBrain. Thus areas, which are faster to calculate, can serve as surrogate markers for total brain and CSF volumes. This opens the avenue to quantitated objective tracking of treatment effects in childhood hydrocephalus.

**OP140**

**Telemetric intracranial pressure measurement in CSF circulation disturbances: a retrospective single-center study**

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**Introduction:** Hydrocephalus treatment in children is still linked to relevant risk of complications. To optimally manage over- and under-drainage, is still a matter of debate. The development of telemetric intracranial pressure measurement (TICPM) modalities has introduced new perspectives in the diagnosis and treatment of hydrocephalus. We retrospectively describe our experience with the Neurovent-P-tel (P-TEL) and the Sensor-Reservoir (SR), nowadays the most common used TICPM devices.

**Methods:** The data of 21 consecutively treated patients (age range 10-39.5 years) in our Pediatric Neurosurgical Unit with TICPM device were retrospectively reviewed. Indications of TICPM was ICP assisted shunt adjustments (P-TEL n=8; SR n=8) and diagnosing ICP alterations for possible shunt indication (SR n=6). Technical handling, ICP measurements and treatment strategies as well as possible complications and clinical outcome are evaluated.

**Results:** TICPMs were carried on in the outpatient clinic. Among the P-TEL group, complications consisted of one infection and one postoperative seizure, while in the SR group an infection case was described. Among the shunted subpopulations, the shunt survival in the P-TEL group was 44.4% (77.9 months) versus 83.3% (42 months; p<0.05) in the SR group. TICPM and consequently tailored shunt adjustments correlated with a clinical improvement in 7 patients in the N-TEL group and 7 patients in the SR group. In the stand-alone subpopulation, TICPM data indicated for shunt treatment in 4 cases.

**Conclusions:** TICPM appears to be of potentially beneficial to aid the management of challenging hydrocephalus cases of shunt treatment. Further technical advancements, with regard to implantation time, measurement modalities, as well as data analysis are still necessary in order to use the technology on a broader basis.

**OP142**

**Non-invasive assessment of intracranial pressure and ventricular size in pediatric neurosurgery using combined ultrasound measurement of the optic nerve sheath (ONSD) and third ventricle diameter (TVD)**

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**Objective:** Many neurosurgical pathologies are associated with increased intracranial pressure (ICP). ICP increase can be caused by hydrocephalus, idiopathic intracranial hypertension (IIH) or brain edema. Non-invasive diagnostics to assess ICP and differentiate between hydrocephalus and other entities are needed in pediatric and adult patients. This study investigates the combined use of ultrasound-measured ONSD and TVD to assess ICP and ventricular size in pediatric patients.

**Methods:** This prospective study includes 278 patients (median 7 years) diagnosed with hydrocephalus (53%), IIH (22%), tumor (8%) and other intracranial pathologies (17%). Binocular ONSD was measured transorbitally using a 12MHz linear probe. TVD was quantified with a transtemporal approach using a phased-array 1-4MHz transducer placed at the temporal window. All measurements were done with patient in supine position.

**Results:** 175 patients presented increased ONSD (mean 5.9±0.6mm) and TVD (mean 7.86±5.86mm) and underwent hydrocephalus therapy. Both ONSD (mean 5.1±0.6mm) and TVD (mean 2.86±5.86mm) decreased significantly to normal values after therapy (p<0.01). In 103 ONSD was measured before/after ICP decreasing therapy and in 121 without intervention. The mean ONSD was higher in patients with therapy (5.75±0.82mm) than without (4.84±0.49mm), p<0.001. The best ONSD cut-off value for detecting clinical situations with relevant ICP increase was 5.26 mm (sensitivity 82.5%, specificity 73.5%, AUROC 0.821, OR 9.4)

**Conclusion:** Transorbital ONSD is a reliable method to assess ICP and can be combined with transtemporal TVD for identification of possible ICP increases. Changes of ONSD and TVD over time can be used for diagnosis of clinically relevant ICP changes and ventricular enlargements in pediatric patients.

**OP175**

**Dural venous sinus anatomy and widened cortical subarachnoid spaces associated with macrocrania in children: Analysis of a series of 75 patients**

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**Objective:** To evaluate the anatomical variations of dural venous sinuses in children with progressive macrocrania and widened subarachnoid spaces and compare these findings with a control group to ascertain the role of restriction to venous outflow in the pathophysiology of pericerebral collections in children.

**Methods:** Phase-contrast brain magnetic resonance venography (PC MRV) was performed in 75 patients (61 males, 14 females) who were diagnosed with progressive macrocrania and widened subarachnoid spaces at an average age of 7.32 months (range 2-20). Reduction of
CSF infusion tests in shunt-naive children facilitate shunt decision making: a two-centre study

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Objective: Decision making for children with suspected hydrocephalus can be difficult often requiring extended observation and/or overnight ICP monitoring. We report our two-centre experience of using CSF-infusion studies to aid decision making where hydrocephalus or failed endoscopic third ventriculostomy (ETV) is suspected.

Materials and Methods: Infusion studies are performed via lumbar needle or ventricular reservoir. Young children receive sedation during the study. Baseline ICP recording is established and then a constant rate infusion is started until an ICP plateau (ICPpl) is reached. The resistance to CSF outflow (Rout) is calculated.

Results: 58 children (29F, 29M) aged 0.3 to 16 yrs (mean 6.4 yrs) underwent 64 infusion studies between 2003 and 2017. Underlying diagnoses included aqueductal stenosis (10), congenital ventriculomegaly (12), tumour (9), post-haemorrhagic (6), post-infectious (3) and other diagnoses (18). 28 children underwent infusion study after ETV. 30 (54%) were shunted including 14 children who underwent brain MRI with angio MRV sequences over a 36 month period for reasons other than macrocrania or hydrocephalus.

Conclusion: The rate (78.67% vs 15.09%, P<0.001) and the grading (2 vs 0, P<0.001) of intracranial abnormal venous pathways were significantly higher in patients group than in control group. A significant association (P<0.001) was detected between the grading of venous drainage alterations and diagnosis of the condition but almost no correlation was found between the severity of vascular anomalies and the widening of subarachnoid space (SAS) (P=0.02) (figure 1) and ventricular dilatation (P=0.84).

Conclusion: Infants with macrocrania and widened subarachnoid spaces present anatomical patterns of venous drainage that are significantly different from control group. Impact of dural sinuses anatomy on pathophysiology of pericerebral collection in children is discussed.

Endoscopic aqueductoplasty and stenting: A 20-year single-institution experience

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Introduction: We performed a retrospective analysis of our 20-year single-institution experience of endoscopic aqueductoplasty and stenting in the treatment of isolated fourth ventricle (IVF).

Methods: Twenty-nine children with symptomatic IVF and membranous aqueductal stenosis underwent endoscopic aqueductoplasty alone or combined with stenting of the cerebral aqueduct. The median age of the patients at the time of surgery was 7 months, with a 70% of preterms. The mean duration of follow up was 60 months. IVF was mainly due to post-infective hydrocephalus (18%), post-haemorrhagic (43%) or a combination of both (28%). We had also 3 cases of IVF following posterior cranial fossa surgery for tumors. A precoronal burr hole was performed in all patients but two, who received a suboccipital approach. The trajectory was planned with the aid of the neuronavigation system.

Results: Signs and symptoms of intracranial hypertension resolved in all cases. Stent placement was successful in all cases, resulting in clinical and neuroradiological improvements in the IVF. Thirteen patients received a stent connected to a temporary device (mostly EVD). 30% of these patients presented no recurrence of IVF after EVD removal. Hydrocephalus was controlled by a single shunt in 18 patients (62%) and by a double shunt in 10 patients (35%); in one case pure endoscopic treatment was successful. In 5 patients the stent was removed (accidental in two cases) after a mean time from implantation of 3 months: all of these had to be replaced.

Conclusions: Endoscopic placement of a stent in the aqueduct is effective in preventing the repeated occlusion of the aqueduct and should be indicated as the initial treatment.

Endoscopic third ventriculostomy and choroid plexus catarization versus endoscopic third ventriculostomy alone in the treatment of neonatal hydrocephalus: a retrospective cohort study

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Endoscopic third ventriculostomy (ETV) is a well-established method for treating infantile hydrocephalus and can delay or avoid ventriculoperitoneal shunt (VPS) insertion. Supplementation of ETV with choroid plexus catarization (ETV-CPC) has been described, and may be associated with reduced shunt dependence. We present our experience of ETV-CPC and how this compares to standard ETV in the neonatal population. A single-centre retrospective cohort analysis was performed by review of case notes on our regional clinical portal. 24 neonates (aged <3 months) underwent ventriculosity between August 2013 and November 2019. 11 underwent flexible ETV-CPC and 13 underwent standard rigid ETV alone. Underlying causes included aqueductal stenosis (11), arachnoid cyst (6), intraventricular haemorrhage (5), meningitis (3), Blake’s pouch cyst (2) and Dandy-Walker Syndrome (2). 11 underwent additional procedures including cyst fenestration (5), septal fenestration (2), aqueductoplasty (3) and evacuation of intraventricular haemorrhage (1). Age range at time of surgery was 9 days-10 weeks in the ETV-CPC group, with 5/11 born up to 11 weeks prematurely. In the ETV group, age range was 3 days-11 weeks, with 7 born up to 12 weeks prematurely. All other children were born at term. In most cases, the ETV Success
Score was low, with just 1/11 having a medium score in the ETV-CPC group and 4/13 in the ETV group. At time of analysis, 6/11 ETV-CPC patients achieved the goal of no progression to VPS, or no additional VPS in cases of multiloculated hydrocephalus. In the ETV group, this goal was achieved in 2/13. In those that went on to VPS, this was performed on average 31 days post-operatively in the ETV-CPC group (range 6-70 days), and 28 days post-operatively in the ETV group (range 2-97 days). One ETV-CPC was complicated by intraventricular haemorrhage, and one standard ETV was complicated by CSF leak. Flexible ETV-CPC may offer a greater chance of shunt independence than ETV alone in the neonatal population.

OP113
The influence of HIV status on ventriculoperitoneal shunt complications
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Introduction: Complications of ventriculoperitoneal shunts (VPS) continue to be a source of morbidity for patients undergoing the procedure despite multiple prevention measures. According to United Nations AIDS Agency (UNAIDS), there are 360 000 children from age 0 to 14 years in South Africa living with HIV. There are 2.4 million HIV orphans under the age of 17.

Methods: A standardized protocol containing infection reducing measures was implemented for patients undergoing VPS placement at Tygerberg Neurosurgery department in Cape Town, South Africa. A descriptive before-and-after study was performed over the course of 4 years. The aim was to reduce the post-shunt infective complications. Risk factors for the development of infective and mechanical complications were investigated. Each of the risk factors were analyzed.

Results: There was 83 children under the age of 13 in the retrospective and 109 in the prospective study groups with a median age of 0.83 years. The most common indication for VPS placement included: symptoms of raised intracranial pressure, blocked shunt, increasing head circumference and failed endoscopic third ventriculostomy. The underlying conditions causing hydrocephalus included Tuberculous Meningitis (TBM), post-meningitis, myelomeningocele, aqueduct stenosis, congenital hydrocephalus, intraventricular haemorrhage or tumours. One of the risk factors for the development of complications included HIV exposed infants (p-value 0.00013). HIV exposed infants were found to have a 95% complication rate (20 of 21 patients). There were infective complications in 33.33% and mechanical complications in 61.9% of the cases. The development of mechanical complications was statistically significant (p<0.01).

Conclusion: The increase of HIV/AIDS in South Africa is having a major impact on the health of patients. There are many children who were HIV exposed, and they have become a new subset of patients with different pathology, physiology and an altered response to treatment in all disciplines of medicine.

OP119
"Flow-controlled/regulated" valves – a technical nonsense term
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Introduction: In 1987 Sainte Rose coined the term “flow-controlled valves” for the Orbis-Sigma (OSV). Inspite of 33 years clinical use the clinical as well the lab literature is extremely limited. In 2018 PubMed shows 30 OSV-papers only Material: 1988-2010 we tested 18 valves (3 designs) with “flow-control”, 31 new probes, 3 explanted, 12 OSV, 4 OSV II, 2 Cordis NPH, The specimen were submitted up to 35 subtests which lasted to a maximum of 500 days.

Results: No valve showed a flow-sensor. All were exclusively controlled by differential pressure (DP). In contrast to normal physiology, Antisiphons or gravitational valves the body position has no influence on the hydraulics. The pressure-flow-graphs are flat, similar to sticking slit-valves (e.g. Holter). Critical in OSV is the tiny slit (0.08 mm!) of central cylinder vs. the ruby ring, which trends to frictions, extreme temperature- and protein-sensitivity. However, real flow-controlled shunts are technically possible as demonstrated by multiple patents (US 7,309,330 and 7,825,742) or concept studies. There are two unsolved problems. 1. The CSF-production rate is not constant, but varies from newborn (0.1 ml/min) to young adults (0.48 ml/min) and decreases in age (Silberberg 2000). In addition there are circadian, individual and vascular induced variations. A few patients only are 100% shunt-dependent, most have residual CSF absorption capacities. 2. The desired shunt-flow is unknown and speculative. Valves or CSF-pumps controlled by electric flowsensors are feasible, but need energy and effort. For safety a pressure-controlled monitoring is obligatory.

Conclusions: The introduced “flow-controlled” valves have neither flowsensors nor flow-regulations and work DP-controlled. Real flow-controlled shunts are technically possible, but extremely complexe and costly.

Conclusions: CSF-pumps controlled by electric flowsensors are feasible, but need energy and effort. Unclear is the desired flowrate. A pressure-controlled monitoring is necessary.

OP124
Surgical management of children with arachnoid cysts: A thirteen year retrospective review
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Introduction: Patients with arachnoid cysts can present with symptoms related to raised intracranial pressure or local mass effect, or alternatively the cysts are identified incidentally. The mode of presentation can in large part determine treatment decisions. We reviewed the treatment data for patients presenting to our neurosurgical centre who have received surgical intervention to treat their arachnoid cysts.

Methods: Retrospective analysis reviewing the outcome data for consecutive children who underwent procedures for arachnoid cysts at a single institution between December 2006 and November 2019. Data was collected on patient demographics, the type of intervention performed and treatment outcomes.

Results: 48 patients underwent 84 surgical procedures in total following their identification of arachnoid cysts. We excluded patients who were treated conservatively. 35 patients were male (72.9%) and 13 patients were female (27.1%). The average patient age was 5.3 years (median age 3.4 years, age range 1 month to 16 years). 2 patients had spinal arachnoid cysts, and 46 patients had intracranial arachnoid cysts. 5 patients underwent ICP monitoring prior to definitive treatment (10.9%). Within the cranial cohort, for primary treatment, 31 patients (67.4%) underwent endoscopic cystic fenestrations, 13 patients (26.2%) underwent open cystic fenestrations and 2 patients (4.4%) underwent fluid diversion procedures (shunt). Both spinal patients underwent open cystic fenestration. From the cranial cohort, 1 patient (2%) developed a post-operative infection, 8 patients (17.4%) required CSF diversion and 13 patients (26.2%) required re-operations to treat the cysts. No complications were observed in the spinal cohort.

Conclusion: We have reviewed the treatment data on patients undergoing surgical treatment over the past thirteen years in a single
centre. The majority of cranial patients (67.4%) underwent primary endoscopic fenestration procedures. We have highlighted the high frequency for re-operation following the primary surgery, which was required in more than a quarter of the cranial cohort.

**OP197**

"Shunt malfunction" - The tip of the iceberg in pediatric hydrocephalus management

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**Introduction**: CSF diversion for hydrocephalus is associated with a lifetime risk of revision surgery. Even more common than actual shunt revisions are the attendances to hospital with a possible blocked shunt. Investigating possible shunt failures is costly due to the high number of attendances, radiological investigations and costs of overnight stays. To date this aspect of hydrocephalus management would appear to have been largely ignored but may be important in determining the cost-effectiveness of long-term indwelling ICP monitors. We attempt to establish the ratio of true shunt dysfunction to query shunt malfunction and quantify the costs associated with these “shunt malfunction”.

**Methods**: We used prospectively collected data on all patients attending our hospital’s open-door policy for “shunt malfunction” over a 7-month period and analysed the costs associated with the investigation of this cohort of patients.

**Results**: In the study period, there was a total of 95 attendances by 66 patients who used the "shunt malfunction" pathway. The ratio of the number of shunt malfunction to the number of non-malfunctioning shunts was approximately 1:5. Eighty percent of patients underwent some form of investigation and the total expenditure in this cohort of unoperated patients over the 7 months was £77,496 (€87,028 or $97,567). Clinician cost and overnight stays making up almost 80% of total expenditure and the average cost per attendance was £816 (€910 or $1022).

**Conclusion**: Shunt failure necessitates urgent surgical intervention. However, only 20% of patients attending our “shunt malfunction” pathway actually had a malfunctioning shunt. The majority of patients usually undergo investigations due to the risk of misdiagnosis but this comes at significant health and social costs. Recent development of telemetric systems may change the management of hydrocephalic patients but there needs to be significant improvement in long-term reliability for their use to become routine.

**OP207**

Validation of a Predictive Scoring System for the development of hydrocephalus following surgical resection of posterior fossa tumours in children

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**Introduction**: A proportion of children develop permanent hydrocephalus as a result of their cranial tumours. Frequently, this requires CSF diversion (ventriculoperitoneal shunt or endoscopic third ventriculostomy (ETV)). We perform an external validation of the modified Canadian Preoperative Prediction Rule for Hydrocephalus (mCPPRH), which aims to stratify patients into two groups (low and high risk of developing hydrocephalus) to facilitate patient selection for prophylactic ETV.

**Methods**: A retrospective review of all paediatric patients with posterior fossa tumours operated on in our department between 2005 and 2019 with at least 6 months’ follow up was performed. Age at time of diagnosis, presence of moderate/severe hydrocephalus, transependymal oedema as well as preoperative radiological diagnosis were recorded. Patients were stratified as low or high risk as per the mCPPRH. Patients with recurrent tumours, pre-existing shunts, or lack of adequate data were excluded.

**Results**: 83 patients were included in the analysis (m=51, f=32) with a mean age of 6.3 years (range 2 months – 17.9 years). A total of 13 patients (15%) developed persistent hydrocephalus post-operatively, of which 8 had scored as low risk and 5 as high risk according to the mCPPRH. In addition, 21 patients who scored as high risk, did not develop hydrocephalus post-operatively. Testing the mCPPRH with our patient cohort showed the area under the characteristic receiver operator curve was 0.634 (SE 0.061). The scoring system therefore failed to reliably predict the development of hydrocephalus following tumour resection in our patient cohort (p=0.02).

**Conclusion**: Testing the mCPPRH with data from our 14-year patient cohort showed that the scoring system failed to predict whether our patients would go on to develop hydrocephalus. We surmise that prophylactic endoscopic third ventriculostomy is not indicated based on this prediction score alone, and clinical judgement remains of utmost importance for managing hydrocephalus pre- and post- tumour resection.

**OP211**

Ventricular volume change following resective surgery in children with hydrocephalus secondary to posterior fossa tumours

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**Introduction**: We reviewed the changes in ventricular volumes in children with hydrocephalus secondary to posterior fossa (PF) tumours, who did not require CSF diversion following tumour resection. The study aim was to profile the change in ventricular morphology over time after relieving the obstructive hydrocephalus, and identify significant variables affecting that profile.

**Methods**: Retrospective review of children with PF tumours and hydrocephalus who underwent resection between 2007 and 2019. Pre and
immediate post-operative scans were analysed, as well as at 4 and 9 months post operatively. Automated segmentation was used to calculate the volume of the ventricular system data was normalised for the age and sex (xN). Patients who required a ventriculoperitoneal shunt insertion during this period were excluded.

**Results:** Full data were available for 41 patients with average age 5.2 years (range 4 months - 17 years). Average pre-operative ventricular volume was 146.11 cm³ (7.6 xN), 90.9 cm³ immediately post operatively (4.8xN) and 59.6 cm³ (3.12xN) and 58.5 cm³ (3.04xN) at 4 and 9 months respectively. Volumes were significantly bigger in the external ventricular drain group at all time points (p<0.05). Average initial post-operative volume reduction was 38% followed by another 22% at 4 months and then ventricular volume remained almost stable with a very minimal further reduction (3%). Age was significantly negatively associated with normalised final volume (p=0.02) while pre-operative ventricular volume was not.

**Conclusion:** Ventricular volumes in children with hydrocephalus secondary to PF tumours who do not require CSF diversion, rapidly decrease in the immediate post-operative period, followed by a further small decrease at 4 months before stabilising, remaining abnormally large. Nearer to normal final volumes are more likely to be seen in older children, potentially due to the increased brain compliance in the younger age group who remain asymptomatic despite much bigger ventricles.

**OP10**

**Pineal region tumors: an entity with crucial anatomical nuances**

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**Introduction:** Intra-axial “pineal region” tumors include pineal, tectal, and aqueductal tumors. All three tumor subgroups cause obstruction of the aqueduct; however, they differ in radiological nuances, pathology, differential diagnosis, and treatment. The goal of this manuscript is to describe the radiological, clinical, and pathological nuances that differentiate between these subgroups.

**Methods:** All patients with intra-axial BBNRT were analyzed retrospectively, including demographics, radiological characteristics, pathology, treatment, and outcome.

**Results:** 49 patients (1-69 years of age) were included: 19 pineal, 10 tectal, and 10 aqueductal. The 3 subgroups differed in various radiological and anatomical nuances. Age and gender did not differ between groups. Other factors that did not differ between groups included: T1 and T2 signal, presence of blood products, a normally located (non-displaced) tectum, anterior tectal displacement, thalamic involvement, and presence of hydrocephalus. The pathological spectrum differed between the 3 subgroups, as well as the surgical treatment, and outcome.

**Conclusions:** Despite sharing a close anatomical location, as well as all causing obstruction of the aqueduct with secondary hydrocephalus, the differential diagnosis, diagnostic methods, and possible treatment and surgical options differ between the 3 subgroups. Anatomical nuances are described to better delineate the various tumor subgroups and recommend specific treatment approaches.

**OP62**

**5 years experience with intraoperative MRI in pediatric neuro-oncology**

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**Introduction:** Since 10 years we gained experience with the intraoperative 1.5 Tesla MRI in Linz. We operate on different kind of brain tumors, mostly deep seated and gliomas. 5 years ago we started with the pediatric population. From literature we know that higher resection rates are possible with intraoperative MRIs and a higher resection rate is the most important prognostic factor, especially in pediatric Neuro-oncology. We want to share our 5 year experience.

**Methods:** All our patients under 18 years suffered from brain tumor and had an operation with the intraoperative MRI were reviewed retrospectively. The most important factor we looked for was if the MRI showed a non expected tumor remnant and led to further resection and the gross total rates.

**Results:** Between 2015 and 2019 we operated on 22 patients from 3 to 18 years (mean 12). That was 25 % of all pediatric brain tumors. We needed 1 to 2 intraoperative MRIs per operation. There were no technical problems and no specific morbidity due to the setting. In 10 patients, 45%, we saw unexpected tumor remnants possible for resection. We had a planned resection rate of nearly 100 %.

**Discussion:** Our data shows that in nearly half of the cases we had unexpected remnants and further resection could be performed immediately. The intraoperative MRI helps us to reach higher resection rates leading to better Outcome.

**OP66**

**Longitudinal assessment of ataxia in children following surgical resection of posterior fossa tumours**

Helen Hartley¹, Conor Mallucci¹, Barry Pizer¹, Ram Kumar¹, Steven Lane²
**Introduction:** Ataxia is the most common motor problem in children with posterior fossa tumors (PFT), though the natural history of ataxia is poorly understood. The aim of this study was to report the natural history of ataxia in the first three years following surgical resection of PFT.

**Methods:** 30 children (median age 9) who had undergone resection of a PFT were assessed using the Scale for the Assessment and Rating of Ataxia (SARA), Brief Ataxia Rating Scale (BARS) and the Pediatric Evaluation of Disability Index (PEDI) at the following time points; pre-operative, initial post-operative, then at 3-months, 1, 2 and 3 years post-operatively.

**Results:** Assessments demonstrated an increase in ataxia initially post-operatively (median pre-operative score 5, median initial post-operative score 7.5) then a rapid improvement in ataxia between initial and 3-months post-operative assessments, quantified by both the SARA and BARS (mean reduction in scores 4.6, 4.5 respectively). There were gradual improvements at 1 year (mean reduction SARA 1.0, BARS 0.3), 2 years post-operatively (mean reduction SARA 0.7, BARS 0.7) and 3 years post-operatively (mean reduction SARA 0.8, BARS 0.6). Return of function behaved similarly, quantified by a rapid increase in PEDS scores between initial and 3-month assessments (mean increase in score 24) and gradual increases at 1, 2 and 3 years post-operatively (mean increase 2.1, 0.9, 2.1 respectively). There was a trend for children with medulloblastoma to demonstrate higher ataxia scores than children with low grade gliomas throughout the 3 year period.

**Conclusions:** The largest change in ataxia scores and functional mobility scores (PEDI) is demonstrated within the first 3 months post-operatively. Only a small improvement was noted after 3 months and children with medulloblastoma continue to demonstrate more ataxia. This may impact upon participation and has implications for rehabilitation for children with PFT.

**OP69**

Is methylation profile sub grouping really a strong prognostic indicator for pediatric posterior fossa ependymomas? A single surgeon, single center experience

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**Introduction:** The definitive treatment of posterior fossa ependymoma is surgical excision and adjuvant radio-chemotherapy. In this study, we aimed to investigate prognostic effects of age, methylation subgrouping, extent of resection, radiation treatment (RT), MIB-1 index, WHO grade, ATRX and H3K27M mutations in pediatric PFE patients.

**Methods:** Forty-two pediatric patients with PFE operated in our institution during the ten last years were included in this retrospective study. Patient demographics, treatment information and resection rates were obtained from patient notes and radiological investigations. Formalin-fixed paraffin-embedded tumor samples were evaluated for H3K27me3 immunostaining, MIB-1 index, WHO grade, ATRX and H3K27M mutations.

**Results:** Tumor samples with global H3K27me3 reduction were grouped as posterior fossa ependymoma group A (PFA), whereas tumor samples with H3K27me3 nuclear immunopositivity were grouped as posterior fossa ependymoma group B (PFB). We evaluated 5-year progression free survival (PFS) and overall survival (OS) results of the cohort.

**Conclusion:** Nine tumor samples had ATRX mutations. One patient within PFA showed H3K27M mutation. Age, WHO grade, methylation subgroups, RT had no effect on PFS and OS of patients. Patients with total surgical excisions had significantly better PFS and OS rates. Multivariate cox regression analysis revealed that, the extent of surgical resection was the only prognostic indicator.

**Conclusions:** Extent of surgical excision is the most important prognostic indicator in PFEs. Prognostic effect of methylation subgrouping may be minimized with more aggressive surgical strategy in PFEs.

**OP92**

Adult outcome after treatment of posterior fossa ependymoma in childhood: A single consecutive (1945-2014) institutional series of 22 patients with longer than 5-year survival

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**Introduction:** Adult outcome after treatment of posterior fossa ependymoma (PFE) in children have previously not been reported.

**Methods:** Retrospective analysis of outcome from children operated for PFE in the period from 1945-2014, and surviving >5 years.

**Results:** 58 children were operated in this period, 22 children (median age at surgery 3 years, range 0-18) survived >5 years. No patient was lost to follow-up. Sixteen patients received adjuvant radiotherapy. Six children had either no adjuvant treatment (n=3) or only chemotherapy alone (n=3). Eight patients (36.3%) are dead after 6 to 55 years follow-up (median 25 years); six of these died after tumor progression and repeated resections up to 34 years after initial treatment. Two patients died from secondary meningiomas after 49 and 55 years. Fourteen patients (median age 28 years, range 8-78) are alive at median follow-up of 22 years (range 5 to 65 years); thirteen of them (93%) without residual/recurrent tumor. One patient have a known residual tumor and 65 years of event-free survival. Nine patients underwent repeated resections for residual/recurrent tumor: four underwent one whereas five patients had three or more resections within 15 years after initial surgery. Five patients who needed second surgery are dead after further follow-up 6-13 years after the second procedure. The other four are tumor-free on the latest follow-up 6-27 years after the last resection. Six out of eight patients with >20-year survival are in a good clinical condition; five of them in full-time work and one in part-time work.

**Conclusion:** There is marked risk for local recurrence among the 5-year survivors after gross total resection and postoperative radiotherapy of PFE. Repeated resections and radiotherapy appear to improve tumor control in some patients. Although the majority of children with PFE die from their tumor, some survive for >50 years, with excellent functional outcome.

**OP167**

Cerebello pontine angle (CPA) ependymomas in children: Our experience for the ten last years

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CPA ependymomas are rare in children. Literature is scarce about these tumors. This retrospective study reports our experience about diagnosis, treatments and quality of life during the follow up. We focused about surgical complications and post operative quality of life. Clinical data for children treated from 2009 to 2019 by a single surgeon were reviewed.

All had histologically verified CPA ependymomas with a large majority of anaplastic types. There were 24 children (2years -10 years). 4 presented with recurrent disease and 3 were operated before in another hospital. One child had 4 surgeries during the period. All had a predominant intra CPA ependymoma.

6 children presented with minor post operative complications such as: transitory facial palsy, difficulty for swallowing and meningocoele. 9 children suffered from major complications such as: Facial palsy grade 4, deafness, deglutition disorder for more than 1 month. 1 child dies at Day 45. 7 children benefitted of a tracheostomy and 9 of a gastrostomy. Total removal was achieved in 18 /20. 3 children had staged surgeries to achieve total removal. The average FU is 5years. 7 children had recurrences during this period. All were reoperated associated with a second line treatment (Chimiotherapy/Radiotherapy). 88% of recurrences occurred in the first 2 years after surgery. The overall survival in our series is 65% (13/20).

Neuromonitoring must be important to decrease post operative complications. Quality of life is considered normal or satisfactory by parents for all survivors except 1. Total removal of CPA ependymomas in children is mandatory. High rates of lower cranial nerves deficits were experienced but generally compensated during the following year. A delicate dissection of these structures is mandatory. Intra operative neuromonitoring must help to decrease these deficits.

OP208

Review of management of child medulloblastoma in Lyon in the last 18 years. Is a monocentric study still valuable in the modern molecular era?

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Introduction: The new molecular criteria for classification of medulloblastomas renders more difficult the evaluation of the management of these lesions. We reviewed our series and analyzed the results in the light of the new risk stratification for the children age group.

Patients and method: Sixty-four patients (22F and 44 M) were operated on between 2010 and 2018 for a medulloblastoma. The median age of patients was off 7.4 years with an average of 7.9 years (range 1.1 to 17.6 years). The 5 years old threshold was used to define low age (group 1; n=44) and a high age group (group 2; n=20). For 29 patients (45,3%) an endoscopic ventriculo-cisternostomy was needed in emergency for hydrocephalus before tumor resection. All patient benefitted from a pre- and postoperative crano-spinal MRI (less than 72h).

Results: Surgical removal was complete in all but 6 patients with a small infiltrative residue at the floor of the 4th ventricle (less than 1.5 cm2). A metastatic disease was present in 7 patients (11%). The complementary treatment was chemotherapy for 11 patients (median 3.3 years) and by radio-and chemotherapy for 47 (median 7.8 years). Overall survival was off 75% and the PFS was of 68,75% with an average follow-up of 8,9 years (range 9 months to 17,4 years; median 7,8). The age group of less than 5 years was the most exposed to recurrence with a mortality of 50% even in patients with SHH+. Risk stratification showed a high rate of recurrence even in the low risk group.

Conclusion: The risk stratification was no correlated with survival for the low age group (group 1). For the other group the results were concordant. The main factor associated with survival were age >2 years and complementary treatment with radiotherapy. In our experience, the undifferentiated forms had the best results.

OP209

Posterior fossa ependymomas in children: Still a challenge for pediatric neurosurgeons and oncologists
Introduction: We reviewed in 31 cases of posterior fossa ependymoma in children operated on between 2000 and 2018 with analysis of outcome.

Patients and methods: From 47 children ependymomas operated between 2010 and 2018, 31 were located at the level of the posterior fossa. The average age in this group was of 5.8 (range from 9 months to 18 years, median of 4.7). The initial clinical picture was dominated by the intracranial hypertension found in 17 patients, 6 had a stiff neck and 4 balance troubles. All the children underwent preoperative cranio-spinal MRI. In 12 cases, a ventriculocisternostomy was needed for hydrocephalus before direct surgery. All patients benefited from complementary treatment with chemotherapy in low age an even radiotherapy for low age children from 2010. A complete removal was performed in all except 2 cases with a second look in 5 patients. Eleven patients had post-operative chemotherapy (6 neoadjuvant and 5 at recurrence) and 25 radiotherapy (23 neoadjuvant and at recurrence for 3).

Results: Global OS was of 82.6% taking in account patients with recurrence with first surgery before 2000. For the same group, the PFS was of 65% with an average follow up of 8.4 and median of 9 years (range from 1.5 to 13.5 years). Thus 4 patients deceased from recurrence despite complete removal and complementary treatment. The morbidity was represented by facial palsy in 4 patients, swallowing problems in 3 and transitory cerebellar in 4 patients. Long term analysis showed 15 patients with normal schooling.

Conclusion: This series confirms that ependymoma is an aggressive tumor especially in the posterior cerebral fossa location. Despite advances in molecular studies no evident therapeutic target emerged yet. Therefore, surgery with complete removal remains the most important prognostic factor even if there is a greater risk for post-operative deficit.

ABSTRACT SESSION 15: Epilepsy

OP75

Real time MRI-guided laser interstitial thermal therapy (LITT) for hypothalamic hamartoma: a case series and study management strategy

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Introduction: Twenty eight (28) patients with epilepsy and recurrent seizures and a diagnosis of hypothalamic hamartoma (HH) have been treated in the past by the senior author (JH) using different techniques: microsurgery, transventricular endoscopic assisted disconnection, and radiosurgery. Real time MRI-guided Laser Interstitial Thermal Therapy (LITT) has been used in the treatment of gliomas, mesial sclerosis or very recently in the EU in hypothalamic hamartomas ablation.

Methods: The Visualase Thermal Therapy System (Medtronic Inc.) integrates a 15-W, 980-nm diode laser and cooled laser applicator system with an image-processing workstation to provide for real-time MRgLITT. 5 patients have been treated in our institution from April to October 2019 with a diagnosis of intractal epilepsy and HH. All of them presented with gelastic and/or dacrystic seizures together with different types of generalized seizures refractory to medical treatment. Ages ranged from 5 to 17 years and they all harboured HH types II and III according to the Delalande classification. Patients were evaluated in a multidisciplinary basis at the Epilepsy Surgery Unit. Trajectory was planned with Voxtm software and the target centered on the lesion to achieve complete disconnection from hypothalamus and mammillary bodies. Screw, catheter & fiber insertion was achieved with the NeuromateTM surgical robot. Thermal ablation was performed under real time MR thermometry. As an average , a total of 6-10 ablations through 3-5 pull-outs were delivered.

Results: Follow-up varies from 2 to 8 months. All patients are seizure-free. One patient suffered a transient memory and seizure impairment (first case). In one patient, there was a minor transitory hemiparesis due to water-pump failure.

Conclusion: LITT is a safe procedure for thermal ablation in selected pediatric patients with hypothalamic hamartomas. Type II and III (Delalande) are best candidates. Anterior trajectories are recommended. Long follow-up is needed to evaluate its outcome and efficacy.

OP184

Disconnection techniques in pediatric epilepsy surgery: Indications and results in a single center

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Epilepsy surgery improved seizures outcome in selected children. Anatomic and functional definition of the epileptogenic zone (EZ is the goal for presurgical work up). Some children exhibited a large or multi focal EZ. Large multilobar resections have complications such hydrocephalus and secondary cranoysynostosis, subdural collections and cortical hemosiderosis.

The concept of cortical disconnection was first introduced for functional hemispherectomy with the aim to avoid brain siderosis and secondary contralateral epilepsy in children treated with hemispherectomy. We report our experience with cortical disconnection techniques tailored with frameless Stereoelectroencephalography (SEEEG). We have performed 104 frameless SEEEG in children. 7 benefited from a tailored supra insular partial hemispherotomy (TSIPH a new disconnection technique described in our department), 5 benefited from Temporo Parieto Occipital disconnection (TPO disconnection), 1 benefited from a temporo occipital disconnection (TO disconnection), 2 benefited from a callosotomy and 1 child benefited of a endoscopic hypothalamic hamartoma (HH) disconnection. Averag follow up is 56 months. All the children who benefited of a TSIPH are seizure free (7 children). The 5 children who benefited of TPO disconnection are seizure free (5). The child who benefited of TO disconnection is seizure free. For the 2 children who benefited of callosotomy, 1 is improved (Engel 3) and the second one exhibited no effect (Engel 4). HH is still Engel 4.
There was no unexpected complications in children who benefited from TSIP, TPO or TO disconnections. One patient who benefited from callosotomy had fever for 7 days without infection in the cerebral spinal fluid.

The girl with HH presented with a right inferior limb paresia for 6 months. None of these children suffered from post-operative hydrocephalus.

The modern disconnections techniques improved dramatically seizure outcome in selected children. Pre-operative SEEG allows to define accurately the ZE and allow to choose accurately the best disconnection technique.

**ABSTRACT SESSION 16: Craniofacial**

**OP56**

Increased intracranial pressure and impaired cerebral perfusion in infants with non-syndromic craniosynostosis at the time of surgical correction

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**Introduction:** While it is commonly known that children with syndromic craniosynostoses often suffer from increased intracranial pressure (ICP), it still remains unclear if elevated ICP - and if so impaired cerebral perfusion - exists in infants with non-syndromic craniosynostosis and should therefore be defined as target of treatment. This prospective study investigates ICP and cerebral perfusion in infants with non-syndromic synostosis at time of surgery.

**Methods:** Thirty-five infants < 15 months were included. Patients underwent perioperative measurement of ICP and cortical perfusion with epidural ICP and tissue perfusion probes before and after surgical decompression. Intraoperative anesthesiological parameters with possible influence on ICP and arterial blood pressure were standardized for age.

**Results:** Twenty infants were treated with biparietal decompression for sagittal synostosis. Frontoorbital advancement was performed for metopic in 10 and unilateral coronal synostosis in 4 infants, one child underwent a combination of both procedures due to a combined sagittal and coronal synostosis. Elevated ICP levels (>15mmHg) were found in 15/20 sagittal synostosis cases (75%, mean ICP 18.6mmHg), in 2/10 metopic cases (20%, mean ICP 13.4mmHg), 2/4 unilateral coronal cases (50%, mean ICP 13.9mmHg). ICP values in sagittal synostosis were significantly higher (p<0.001) than in the other entities. Relative blood velocity improved after decompression (p=0.03), a trend was observed for microperfusion (p=0.06) in all children.

**Conclusion:** These results suggest that elevated ICP and impaired cerebral perfusion exist in single suture synostosis, especially in sagittal synostosis cases, a fact that should be taken in account discussing about indications for surgery. The known influence of the time point of surgery on long-term cognitive development in sagittal synostosis underscores the importance of raised ICP as a possible noxious effector. Larger cohorts need to confirm these first results.

**OP164**

Selective drug delivery through stimuli-responsive recombinant human ferritin nanocarriers as a noninvasive treatment for nonsyndromic craniosynostosis

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**Introduction:** The association between craniosynostosis and Chiari malformation is intriguing and still under investigation. In this study, the role of the lambdoid arch sutures in the development of cerebellar tonsillar herniation is evaluated. The posterior cranial fossa (PCF) changes are assessed in infants with premature synostosis of the major and minor sutures of the lambdoid arch without premature synostosis of the PCF synchondroses.

**Methods:** high-resolution CT studies in 12 infants with multisutural craniosynostosis involving the lambdoid arch and compared with those of 12 age-matched healthy subjects.

**Results:** All patients had hypoplasia of PCF bone structures and normal volumes of the PCF and neural structures. PCF hypoplasia was related to exocciput length in infants with isolated involvement of major sutures, while it was related to posterior skull base hemifossae in infants with isolated involvement of minor lambdoid arch sutures. Foramen magnum AP diameter was reduced in babies with major suture involvement and tonsillar herniation, while foramen magnum AP and LL diameters were reduced in babies with minor suture involvement without tonsillar herniation. Right and left jugular foramen (JF) areas differed in all infants however the area of the smaller JF was significantly reduced only in infants with involvement of minor lambdoid arch sutures.

**Conclusion:** Hypoplasia of PCF bone structures due to sutural synostosis of the lambdoid arch is a required predisposing but not sufficient factor for the development of cerebellar tonsillar herniation through the foramen magnum. Normal PCF volume and foramen magnum anatomy may partly explain the development of cerebellar tonsill herniation in infants with lambdoid arch synostosis.

**OP161**

Lambdoid arch sutures and Chiari malformation in multisutural craniosynostosis

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**OP161**

Non-syndromic Craniosynostosis (NSC) is a rare craniofacial malformation, due to the premature fusion of one or more cranial sutures. Dysregulation of multiple signaling regulating the osteogenic stem cell fate in the fused suture is still partially unknown. The treatment of NSC is exclusively based on surgery; post-surgical relapses occur in about 10% cases and require re-interventions with associated risks for severe adverse effects.
We aimed at characterizing molecular mechanisms underlying the aberrant osteogenic properties of calvarial-derived mesenchymal stromal cells (CMSCs) within fused suture, in order to identify novel endogenous biomolecules to be exploited in the development of nanotechnologies for targeted therapies. Recombinant human ferritin (hFT) was tested as a suitable nanocarrier for targeted intracellular delivery upon binding to the transferrin receptor CD71, which is expressed in CMSCs. Further functionalized hFT-based construct was developed, with the N-terminus of each hFT subunit fused to a sequence, responsive to proteolytic cleavage by metalloproteases (MMPs) followed by an outer shielding polypeptide sequence. In this carrier the interaction between hFT and the receptor is then masked, being favored in the presence of MMP-enriched environment. Our preliminary results show that, upon osteogenic induction, the expression of MMP-9, -13 and 14 results higher in CMSCs isolated from fused suture. Optimization of hFT nanocarrier using a sequence cleaved by MMPs identified represents an innovative strategy to specifically target cells in the pathological skull suture using a stimuli-responsive delivery. Future studies will address the upload of selected compounds able to reprogram the cell fate in the skull suture niche.

**OP191**

The embryological basis of craniopagus twinning: Joining the fusionists and the fissionists

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**Introduction:** Twins occur once in 87 live births, conjoined twins once in 50,000 births, and craniopagi once in 2.5 million births. Due to the rarity and ethical dilemmas involved in performing embryological experiments investigating the etiology of craniopagus twins, several theories have arisen surrounding conjoining events in these twins, namely fusion and fission theories. This report aims to describe the literature regarding these theories and presents a coalescence toward a unified theory of conjoined twinning, with a craniopagus focus.

**Methods:** All relevant literature pertaining to the embryological basis of conjoined twinning was reviewed.

**Results:** The theories of fission and fusion, in their attempts to singularly explain the full spectrum of conjoined twinning, fail to account for key phenomenology supporting one theory over the other in different types of twins. Fusion fails to explain symmetry exhibited by conjoined twins (i.e. situs inversus), and disregards exogenous twinning stimuli (alcohol, mitotic inhibitors) which result in incomplete embryonic separation in animal models. Fissionists disregard reports of rare diamniotic conjoining, insufficient evidence describing why cranial and caudal sites are final locations of failed separation, and joined tissues, as with the brains of craniopagi, which abut and compress each other rather than form a singular, contiguous structure.

**Conclusion:** A dual theory of conjoined twinning is proposed. In cases of omphalopagi, thoracopagi, cephalopagi, and parapagi, large ventral or lateral segments are fused between twins who demonstrate symmetry, may rarely be diamniotic omphalopagi with fused umbilical regions, may share several body parts, and may be the result of incomplete twinning stimuli consistent with a fissionist theory. Rachipagi, ischiopagi, and craniopagi are joined dorsally or along neuropore closure sites, asymmetrically, with any possible rotational component, consistent with a fusion theory. Therefore, to account for all phenomenology, a dual hypothesis may exist for the embryological development of conjoined twins.

**Fission and Fusion Hypotheses**

![Coalescence of Theories](image)

**Flash Presentations**

**ABSTRACT SESSION 1: Neurotrauma/Intensive Care**

**FP82**

A protocol abstract - Long-term prognosis following paediatric traumatic brain injury - A European multicentre study

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**Introduction:** Traumatic brain injury (TBI) is a global burden, and one of the leading causes of death and mortality among children and adolescents. A TBI during childhood can affect the child’s cognitive function and adaptive behaviour (e.g. concentration, communication, socialization and motor skills). Children suffering from a severe TBI are further at risk of postraumatic hydrocephalus, which may impair long-term prognosis. Though the number of paediatric TBI increases, the relationship between intracranial pressure (ICP) and long-term prognosis is still unknown. Further we lack knowledge on ‘normal’ ICP in healthy children, leaving no reference range to guide the treatment of postraumatic hydrocephalus. The aims of this planned observational prospective cohort study in paediatric TBI are to clarify

- If ICP during the acute phase affects long-term functional outcome?
- If ICP during rehabilitation affects long-term functional outcome?
• If reference ICP is related to age, height and postural changes?

Method: Indication for implantation of an ICP monitor follows the Brain Trauma Foundation Guidelines. Instead of a traditional cable-based monitor, a telemetric ICP sensor (Raumedic Neurovent P-tel) is implanted. Vitals (including ICP) will be continuously collected during neuro-intensive care. Follow-up includes six 24-hr ICP measurements and evaluations of physiological and psychological deficits at predetermined intervals.

Study population: Children age 0–17 years, sustaining a moderate or severe TBI, with a clinical need of ICP monitoring. Two subpopulations will be formed at the end of follow-up; 1) healthy children with no or minor physiological or psychological deficits, 2) children with a need of pressure relieving treatment and/or moderate to severe deficits.

Scoring systems: The Abbreviated Injury Scale, the Glasgow Coma Scale, the Kings Outcome Scale for Childhood Head Injury, the Vineland Adaptive Behaviour Scales III.

Perspectives: Inclusion from January 2020. We hereby invite European Trauma Centres to participate. Funded by Rigshospitalets Research Fund

FP178

The legacy of vascular accesses in securing external CSF catheters

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Introduction: Securing the catheter to the skin either with sutures or staples, and to the skull with ‘camino’ still represent the most common options in the management of CSF external drainage. However, these options bear an unavoidable risk of complications. This problem is common to vascular accesses and has been successfully overcome with the introduction of device for subcutaneous anchoring (SecurAcath®), that has rapidly become the standard of care in this field.

Methods: We report our experience with the use of SecurAcath® to secure CSF drainage, either ventricular or spinal.

Results: Since 2015, SecurAcath® was used in 211 cases (mean age 7 years) to secure 195 external ventricular catheters and 16 spinal drainage. Period in place ranged from 1 to 4 weeks. No complication related to the use of the device was observed, in particular there was no case of dislocation or accidental pullout of the catheter. Rate of infection, or superinfection in case of ventricular catheter implanted for CSF infection, was null. A significant reduction of pain medications, compared to historical group (2005-2014, catheters anchored with ‘Roman-sandal technique’) was noticed.

Conclusions: SecurAcath® is a safe and effective device to secure CSF external catheters, with several relevant advantages, including easy placement and maintenance. Moreover, it may stay in place for the whole duration of the catheter and allows a complete antisepsis of the exit site, thus reducing local skin complications. This factor plays a pivotal role on the reduction of infection rate of external CSF catheters.

FP179

Age stratification in pediatric cranial repair: Time has come

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Introduction: Age is emerging as a factor affecting the outcome of cranioplasty. However, the understanding and definition of age-related factors remain faint and still inconsistent.

Methods: We reviewed the current literature and the institutional experience with cranioplasty in children (<18 years old) either with autologous bone and alloplastic materials.

Results: Literature and institutional data show direct relationship of increasing age with lowering complications rate of either autologous-bone assisted alloplastic cranioplasty. This picture is particularly fair until the age of seven, consistently with the physiological growth of skull.

Conclusion: Age under seven years represents a negative prognostic factor and the impact of age further increases in the first year of life, due to the rapid growth of the skull. Age stratification seems essential to personalize the approach to cranial repair in children. Therefore, a proposal for stratification by age would be: i) under 1 year of age, when the skull growth is extremely rapid, ii) in 1–7 years of age, when the skull growth is slower but still significant, iii) over 7 years of age, when the skull could be assimilated to the ‘inert’ adult skull. The impact of age-related factors would be the highest in the first group, with a rate of resorption of almost 100%. This would require different solutions for cranial repair, as the exchange cranioplasty, and eventually different solutions for relieving the intracranial hypertension, as decompressive craniotomy rather than craniectomy. The role of these factors significantly decreases in the third group of patients, thus solutions adopted for cranial repair in adults warrants similar outcome. In the intermediate group, the impact of these factors would be variable and surgical variants would be eventually required for effective cranial repair, as expansion osteotomies in less severe cases and either augmented cranioplasty or contralateral cranial expansion in most severe cases.

FP194

Clinicodemographic profile of paediatric head injury in south East Nigeria - Initial results of a two-centre study

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Introduction: Head injury is associated with significant morbidity and mortality across all age groups worldwide in the developing countries. There is however, paucity of literature on paediatric head injury from our subregion, the sub saharan Africa.

Objective: To evaluate the clinicodemographic profile of pediatric patients with head injury in our subregion.

Method: Initial results of an ongoing two-centre prospective cohort study from January 2017 to October, 2018 in Enugu and Awka. Demographic, clinical, radiological and follow up data were collected and analysed using SPSS version 16. Inferences were judged using 95% level of significance.

Results: One hundred and four(104) patients were enrolled. There was a slight male preponderance, M:F=1.17:1. The mean age was 6.5years. The most common etiology was RTA in 72(69.23%) patients, followed by falls in 24(23.08%). Common symptoms were loss of consciousness 44(42.31%), headache 8 (7.69%), seizure13 (12.50%) and neurological deficit 16 (15.38%). Head injury was mild in 72(69.23%) patients, moderate in 26(25%) and severe in 6 (5.77%) patients. 12 (11.54%) patients had open injury, 90(86.54%) closed injury and penetrating injury 2(1.92%). Associated injuries occurred in 8 patients, four (3.85%) spinal injury, two (1.92%) for both chest and limb injuries respectively. 78(75%) had hemoglobin concentration above 10g/dl and 2(2%) below 10g/dl. 94 patients were managed conservatively. The mean hospital stay was 3.7 days. Outcome at discharge was (GOS)>5 in 85(81.73%) patients, 4 in 16(15.38%) and 3 in 3(2.88%) patients. There was no mortality.

Conclusion: There is a slight male dominance in the occurrence of head injury in children. Road traffic accident is the main cause and anaemia a frequent association.
ABSTRACT SESSION 2: Chiari

FP61

Chronic tonsillar herniation: Pre and postoperative assessment using a semi-quantitative approach: a pilot study

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Introduction: Chronic tonsillar herniation (CTH) is often diagnosed incidentally in pauci-symptomatic patients, making surgical decision an everyday dilemma. Previous findings have suggested that Imaging can overestimate as well as underestimate the significance of foramen magnum crowding. The surgical decision thus rests mostly on clinical findings. However, functional symptoms in children can also be deceptive, both in excess and by default. A reliable evaluation tool could help for decision-making and evaluation of postoperative results.

Material and Methods: We created a semi-quantitative scale in order to evaluate patients with CTH preoperatively and at postoperative control. Clinical items included: sleep, neck pain, reflexes, neurological symptoms, digestion, spine, and cognition; radiological items included descent of tonsils, pointed tonsils, deformed medulla, spinal cord edema, and syrinx. All items were rated as 0 (absent) 1 (compatible or mild) or 2 (characteristic or severe), and summed as clinical and radiological scores. We also rated 0-2 intraoperative findings (tension of the tonsils, arachnoiditis) and overall clinical improvement. Correlations between variables were tested using Pearson’s test and Spearman’s Rho test.

Results: Between July, 2017 and November, 2019, we included prospectively 36 children operated for CTH. M/F ratio was 1.25, mean age was 94.6 months (95%CI 83.7-105.4 months), the mean postoperative interval was 4.5 months. 22 patients (73.3%) had marked clinical improvement, 7 (23.3%) had incomplete improvement; one patient was worse on account of associated craniostenosis requiring cranioplasty. The preoperative clinical score was highly predictive of the postoperative improvement (P=0.001). The radiological score was marginally predictive of intraoperative findings (P = 0.043), and not correlated with postoperative improvement.

Discussion: Semi-quantitative evaluation is a helpful tool for the pre- and postoperative management of CTH. Our study confirms that imaging is unreliable for surgical decision-making in CTH; this suggests that CTH is a dynamic process rather than a static condition.

ABSTRACT SESSION 4: Hydrocephalus I

FP9

Peritoneal insertion of shunts in children: Comparison between trocar and laparoscopically guided insertion

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Introduction: Shunts remain the most common method for treating hydrocephalus of all etiologies and for all age groups. Several methods for shunt placement into the peritoneum are practiced – a mini laparotomy, laparoscopically guided, or percutaneously with a trocar. The goal of this study is to compare 2 minimally invasive techniques in children: trocar and laparoscopy.

Methods: Data was retrospectively collected from 2 centers for children (<18 years old) who underwent a primary CSF shunt to the peritoneum, and had no prior abdominal surgery or significant disease. One center used a trocar, and the other – laparoscopic guidance, for distal shunt insertion to the peritoneum. Demographics, surgical time, and shunt complications were analyzed. Primary endpoint was technique related and non-technique related distal shunt malfunction.

Results: 250 children (220 trocar, 30 laparoscopy) were included. The groups were similar in regards of age at surgery, and hydrocephalus etiology. Length of surgery was nearly double for the laparoscopy group (81 vs 44 min), and more surgeons participated in each case (3.4 vs 2.1). The shunt infection rate was significantly higher in the laparoscopy group (26 vs 7%, p=0.0007). There were no technique related complications in the laparoscopy group, vs 4.1% in the trocar group (non-significant difference). Among infants (<1 year old), there was only 1 distal complication in the trocar group.

Conclusions: In primary shunt surgery, abdominal placement of the catheter using a trocar or laparoscopic guidance is associated with a low distal malfunction rate, with no significant difference in complications between both techniques.
when they are open. It indicates their ability to drain CSF at higher than physiological rate, when the CSF pressure increases above valve's opening pressure. Using siphon-control devices is recommended. ProGav has gravitational only device. Strata has a device sensing difference between atmospheric pressure and negative pressure in a distal drain. Polaris does not have any dedicated siphon control accessory. Certas has a SiphonGuard device sensitive to accelerated CSF flow.

Few valves (Certas, Polaris, ProGAV) do not change their setting in a presence of external magnetic field (up to 3T in MRI magnet). All valves are comfortable in programming. Verification of programmed setting can be done without a necessity of x-ray with exception of HPV.

FP105
Prophylactic use of adjustable gravitational valves for prevention of slit-like ventricle in neonate hydrocephalus

Shunsuke Ichii

FP118
History of gravitational valves (42 different types)

Alfred Aschoff

Alfred Aschoff

1Formerly University Of Heidelberg, Heidelberg, Germany

Object: The slit ventricle syndrome caused by the overdrainage of CSF is one of the last conditions to be avoided in shunted hydrocephalus in neonates. We evaluate the efficacy of the early prophylactic implantation of adjustable gravitational valves (The Miethke proSA®, B.Braun Ltd) for prevention of slit-like ventricle in neonate hydrocephalus. Their successful performance, practical management, and pitfalls are discussed.

Method: Since 2014, combination of the Miethke proGAV® and proSA® have been implanted for eighteen neonate patients with twenty-two VP shunt procedures, including eighteen primary shunt insertions and four revisions. Mean follow-up was 30±18.8 months and mean body weight at primary shunt surgery was 2863±750g for 42.7±4.9 corrected weeks. Initial pressure setting of both proGAV® and proSA® valves were 8.7±2.0 and 20.5±2.1, respectively. Frequency of change of pressure setting during follow-up period were 1.5±1.1 and 0.5±0.7 times, respectively.

Results: Six shunt malfunctions due to mechanical obstruction of CSF flow were experienced including four proSA® obstructions and two peritoneal catheter occlusions. However, the obstruction of ventricular catheter was never experienced by managing pressure setting to avoid slit-like ventricle. Most reasons for proSA® obstructions were in-valve protein depositions. According to compromised conditions for prematurity, four patients experienced shunt infection which resulted in shunt removal.

Conclusions: Data in this study suggest that the ventricular catheter obstruction in neonates shunt surgery who are susceptible to chronic CSF overdrainage due to ventricular noncompliance can be successfully prevented by careful management of pressure setting for not only differential pressure valve proGAV® but gravitational unit proSA®. Therefore, the first choice of both proGAV® and proSA® implantation is considered enough feasible in treatment of hydrocephalus even for neonate population.
designs from 6 companies on the market. Inclusively subtypes, patents, prototypes and concepts we count 42 g-designs, clinically g-valve-papers show massively reduced quotes of overdrainage. The most important problems are implantation-failures (not strictly vertical).

**Conclusions:** Gravitational valves have largely solved the problems of overdrainage. The adaptation on the growth and difficult patients require adjustable g-valves. A vertical position parallel to body axis is the condition sine qua non for a correct function.

**FP150**

**Design & development of a cost effective biodegradable endoscopic third ventriculostomy (ETV) training model**

**Ramesh Teegala**

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**Aim & objectives:** To design Endoscopic Third Ventriculostomy (ETV) training model which is cost effective, biodegradable, easy to prepare and resembling the real ETV surgery.

**Introduction:** Hydrocephalus is a global problem affecting paediatric and adult population due to different pathological conditions. ETV emerged as definitive CSF (Cerebro Spinal Fluid) diversion method. ETV is technically demanding, has steep learning curve and requires off the theatre hands on training. Present model is effective alternative to real ETV surgery with haptic feedback of puncturing the real membrane in the floor of the third ventricle.

**Material and methods:** Different substances used in day to day life are used to create the anatomy mimicking the foramen Monroe, mamillary bodies, anterior third ventricle floor and interpeduncular cisterns with pulsating basilar artery. The assembly is fixed in a green tender coconut to resemble ventricular cavity. The coconut is filled with clear water to mimic the CSF. Through the endoscope, the image resembles the floor of third ventricle and ETV procedure can be performed like a real surgery. One can practice the steps of neuronavigation on this model.

**Results:** Nearly 200 delegates were trained on the model at different places in India. The trainees experience was evaluated on a feedback form with 10 point questionnaire. We observed >90% overall satisfaction among the trainees.

**Conclusion:** This training model prepared mostly from biodegradable materials is environmentally safe, cost effective and has close resemblance to real ETV surgery. Its gives good haptic feedback of membrane puncture and is a very effective tool in acquiring basic neuroendoscopy skills. Keywords: ETV, Neuroendoscopy training, ETV model, Biodegradable, Learning curve
Surgical treatment of arachnoid cyst in children: Retrospective analysis of 140 cases
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Introduction: Single institution retrospective evaluation of surgical treatment of a series of 140 arachnoid cysts in children treated with endoscopic or microsurgical technique or shunt over a 20-year period.

Material & Methods: The clinical data and radiological images of all patients were retrospectively reviewed. Wherever available surgical films were retrospectively re-evaluated. Further surgery was considered as treatment failure.

Results: Anatomical distribution was as follows: Sylvian fissure 41, Interhemispheric 12, CPA 4, Posterior fossa 10, Pineal 1, lateral ventricle 14, third ventricle 12, Quadrigeminal cistern 15, giant hemispheric 11, convexity 9, Suprasellar 9 and choroidal fissure 2.

Ninety-two patients were treated endoscopically, 38 microsurgically and 28 with shunt. The cysts were convexity 9, Suprasellar 9 and choroidal fissure 2.

Conclusions: Results of surgical treatment cannot be compared because of very significant differences in age and anatomical localization of the cysts. Risk factors for failure are evaluated and discussed. Age at the time of surgery is an important predictor of unfavorable outcome (highest risk for <3 months) such as the anatomical position (higher complication rate in interhemispheric cysts, CPA cysts, quadrigeminal cysts and giant hemispheric cysts).

Therapy paradigm with the programmable gravitational valves (proSA) in pediatric hydrocephalic patients
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Objective: The use of a programmable-gravitational-valve (proSA) in shunted hydrocephalic patients does open new perspectives of shunt-treatment. The secondary augmentation of a primary adjustable differential pressure valves with fixed gravitational units became a standard protocol in remaining signs of over-drainage. In order to investigate the clinical course and long-term outcome in those patients a retrospective analysis was undertaken.

Methods: Our hydrocephalus-database was reviewed for programmable-gravitational pressure valves (proSA) as primary or secondary implant from 2013-2019. We retrospectively analyzed age, sex, type of hydrocephalus, intraoperative details, valve settings, ventricular width (FOHR), possible complications and number of re-operations.

Results: 31 patients were augmented with 38 proSA-valves as a primary/secondary implant, while 287 patients remained to have a proGAV during the period of 2013-2019. The age of primary shunt-implantation were 4.4 years in proSA-patients, needing an average of 2.8 re-operations compared to proGAV-alone-patients with age 2.4 years and 1.9 re-operations. The primary gravitational-valve-setting did not differ between the two groups. In the proSA-group the gravitational-valve-setting was significantly (p<0.01) elevated after the proSA-augmentation. The revision rate in proSA-group showed a significant (p<0.01) decrease after proSA-augmentation (76 re-op vs. 10 revisions in total). The proSA valve augmentation did not show any significant difference on FOHR.

Conclusion: The proSA augmented patients seem to represent a cohort being more prone to overdrainage, who are older and experience higher re-operation rate compared to proGAV-alone cohort. Since the proSA augmentation leads to a significant decrease in revision rate while having an increased adjustment level. We conclude that higher resistance in gravitational units in these patients reveals a beneficial effect to decrease shunt complication rate.

Posthaemorrhagic ventricular dilatation in preterm infants: An international survey of management practices
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Introduction: Posthaemorrhagic ventricular dilatation (PHVD) remains a significant complication of intraventricular haemorrhage (IVH) of prematurity despite recent advancements in neonatal care, and is associated with serious long-term neurological morbidity. Previous work has demonstrated significant heterogeneity in the way PHVD is diagnosed and treated (Brouwer, 2012 and Kumar, 2015), in addition to the reporting of research outcomes (Fountain, 2016). Thus, the ideal management strategy with respect to the type and timing of intervention in PHVD remains difficult to elucidate.

Objective: This international survey aims to update our understanding of current practice and how this has evolved in recent years. In addition, we hope to provide an insight into the reasoning behind neurosurgical preferences and decision-making regarding certain aspects of the management of preterm IVH.

Material-methods: An electronic questionnaire was designed and piloted using the online survey platform SurveyMonkey (www.surveymonkey.com). The questionnaire was distributed to paediatric neurosurgeons via the European Society for Paediatric Neurosurgery (ESPN), the British Paediatric Neurosurgical Group, and ListServ. Responses will be collected between October and December 2019. The survey aims to explore overall formal management protocols and recent changes thereof, referral criteria, thresholds for intervention, decision to temporise vs commence definitive treatment, choice of temporising measure, temporising protocol and indications for conversion to definitive treatment.

Results: All responses obtained during the survey period will be analysed, and the results will be presented.

Conclusions: Whilst there is increasing evidence that earlier rather than later intervention in PHVD is beneficial, definitive evidence to support the use of one management strategy over another is not yet available. A consensus regarding diagnostic criteria used, and the standardisation of research outcomes and reporting may allow us to compare different management strategies more effectively, and ultimately improve our understanding of the ideal timing and type of intervention in neonatal IVH.

Management of acute hydrocephalus secondary to posterior fossa tumour in the paediatric population

FP210

Posthaemorrhagic ventricular dilatation in preterm infants: An international survey of management practices
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FP212

Management of acute hydrocephalus secondary to posterior fossa tumour in the paediatric population

FP210
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Introduction: Variations in practice lie in the treatment of hydrocephalus in association with the timing of resective surgery in children with posterior fossa tumours (PFT). A lack of consensus persists regarding optimal management. We reviewed our practice over the last 12 years.

Methods: Retrospective review of children with PFT resected between 2007 and 2019. Timing from diagnosis to resection, extent of resection, radiological evidence of hydrocephalus, presence of papilloedema, and different modalities of treatment: Endoscopic Third Ventriculostomy (ETV), External Ventricular Drain (EVD), Ventriculoperitoneal Shunt (VPS) along with outcomes were recorded.

Results: Full records were available for 67 patients (mean age of 6.3 years). Average time from diagnosis to resection was 1.6 days (median 1 day). Radiological evidence of severe/moderate hydrocephalus was present in 53, papilloedema was confirmed in 22 (documented as absent in 13, not recorded in 33). VPS was inserted post-operatively in 13 (19%) with gross total resection achieved in 10 of those. ETV was performed in 8 (prior to tumour resection in 5) and of those with ETV, 5 subsequently required VPS. 24 patients had an EVD inserted either before, or at the time of resection. EVDs were left clamped post-resection in 4, of whom none required VPS post-operatively (p=0.04). EVDs were left draining post-resection in 14, and of those, 8 developed hydrocephalus requiring VPS (no detailed records were found in 6 patients known to have had EVDs). CSF leak from the wound or clamped EVD site occurred in 5 patients, and all but one of those required VPS.

Conclusion: Early surgery with EVD insertion when clinically indicated, followed by a clamping period post tumour resection to encourage re-establishment of normal CSF reabsorption resulted in a reduced incidence of post-operative hydrocephalus requiring VPS in our cohort. ETV had a high failure rate (63%) in our patient population.

ABSTRACT SESSION 6: Miscellaneous

FP51

QEVO as a new tool for endoscopic-assisted removal of intraventricular tumours in children

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Introduction: QEVO® is a new endoscopic tool, integrated with KINEVO 900 microscope (Carl Zeiss Co.). It allows inspection of the surgical field during the microsurgical procedure, which is especially useful in intraventricular surgery. We evaluated the usefulness and efficacy of QEVO® in the removal of intraventricular tumours in children.

Methods: Ten children have been treated surgically for intraventricular or penetrating to the ventricle tumours using QEVO® since February 2019. The studied group consisted of 4 fourth ventricle, 3 thalamopeduncular, 2 optico-hypothalamic, 1 craniopharyngioma and 1 pineal tumour. Four patients were operated on by suboccipital craniotomy and telovelar approach to the 4th ventricle, one by infratentorial, supracerebellar approach (pineal tumour), another one by pterional craniotomy and lateral subfrontal approach (craniopharyngioma). The interhemispheric, transcaldosal approach was used in the remaining 5 cases. The surgery was performed using endoscopic-assisted microsurgical resection in all cases.

Results: Complete tumour removal was obtained in 7 and subtotal in 4 cases. The extent of resection was adequate to presurgical plan (total or subtotal) in all cases. QEVO® allowed excellent visualisation of intraventricular structures, especially those which were difficult to display by the microscope (a look “around the corner”). No intraoperative complications resulting from the surgical technique occurred. Some limitations of QEVO® as no working channel or possibility to fix the endoscope to the Mayfield frame were also indicated. We presented the operative technique and surgical nuances in the video.

Conclusion: QEVO® appeared to be a useful and efficient tool which allows visualising of hidden morphological structures in the ventricular system. It helps the surgeon to achieve the complete removal of the tumour and avoid intraoperative complications.

FP53

Influence of branching angle on misdirection of regenerating axons

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Introduction: Some patients with obstetric brachial plexus lesion experience persisting suprascapular nerve palsy while more distal targets regain their function. Surgical methods to remedy this condition were established, but the underlying cause of this phenomenon remains unclear. During the exploration of the injured plexus, the angle between the suprascapular nerve and upper trunk frequently is almost 90°. The question arises, whether the relatively large branching angle has any negative impact the nerve regeneration. To test this hypothesis, the bifurcation of the rat sciatic nerve was used as a model.

Methods: After crush injury of the sciatic nerve trunk its main branches, tibial and peroneal nerves, were fixed in two different angles: 90° and 30° for test and control group respectively. The functional recovery was tested using a semi-automated foot-print test. The morphometric features of axons were measured after the regeneration period. Double retrograde tracing of axons was performed to assess the pool of motoneurons in the spinal cord supplying the peroneal nerve before the injury and after the regeneration.

Results: The functional tests revealed statistically significant differences between the studied groups. The number of axons found in regenerating nerves showed no significant difference. The percentage of motoneurons correctly regrowing into the peroneal nerve was significantly lower in the group with nerves fixed at the larger angle.

Conclusion: The large branching angle of the injured nerve may lead to increased misdirection of regenerating axons, which should be considered as one of the factors explaining poor functional recovery despite no abnormalities in axon count within the nerve.

FP54

Expression profiles of cytokines and chemokines in a rat model of myelomeningocele at different prenatal time-points

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Objective: Cellular and molecular mechanisms induced by the presumed ‘second hit’, which presumably underlies progressive functional decline of the myelomeningocele (MMC) placode, are not yet understood. In preceding investigations, we determined key players of post-traumatic lesion cascades in human MMC tissues during post-natal repair. We went back to bench and investigated these mediators in the prenatal course under standardized conditions of an animal model.

Methods: Time-dated Sprague-Dawley rats were gavage-fed with all-trans retinoic acid (60 mg/kg) at day E10. Fetuses were obtained at E16, E18, E22. Spinal cord tissues were screened by real-time RT-PCR for cytokines and chemokines, known to play a role in lesion cascades in the central nervous system. Proinflammatory cytokines which were found on elevated mRNA level like TNFa, Interleukin-1beta (IL-1b), and their receptors were analysed by immunohistochemistry and double-immunofluorescence-labelling (DIF) with neuroepithelial markers. Representing neurorestorative markers Erythropoeitin (Epo) and EpoR were additionally investigated. Normal fetal controls were obtained at the respective time points.

Results: IL-1b showed significant induction at E22, its IL-1-R1 was induced at E16 and E22, in IHC staining was confined to the matrix and marginal layer. Co-staining of IL-1b and Vimentin suggests astroglial cells as a possible source of these mediators, IL-1-R1 co-stained with VIM and Iba1, a marker for microglia. TNFa/-R showed significant induction at E22, DIF confirmed co-staining with Iba. CXCL12 and CXCXR4 showed elevated mRNA levels in controls and mmc, as these cytokines play a crucial role in developmental processes, mRNA levels drop throughout the prenatal time course as expected. Epo is induced significantly at E16, EpoR shows high levels at E22.

Conclusion: Pro-inflammatory cytokines like TNFa/-R, IL-1b/-R1 exhibited a time-dependent prenatal expression in the respective animal model. Epo/-R exhibited different expression patterns compared to controls. These mediators provide potential trial targets in the development of adjuvant therapies.

FP130

Functional outcome after filum sectioning in occult tethered cord syndrome and fatty filum

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Objective: Minor variants of occult spinal dysraphism comprise the tight filum in occult tethered cord syndrome (OTCS) as well as the thickened or fatty filum (FF). The aim of the current study was to highlight clinical scenarios rectifying microsurgical detethering even in almost normal MR images, and to demonstrate postoperative outcome.

Methods: We retrospectively analysed pediatric patients who underwent microsurgical filum sectioning for OTCS or FF under intraoperative electrophysiological monitoring at the Section of Pediatric Neurosurgery, University of Munich and Ulm between 01/2007 and 11/2019.

Results: 33 patients (17 male, 16 female) diagnosed for either OTCS (22 patients) or FF (11 patients) were included in the study. Mean age at surgery was 6.0 years (range 0.6–16.8 years). Presenting symptoms consisted in bladder (26, 78.8%) or bowel dysfunction (7, 21.2%; 3 caudal regression syndromes), motor deficits (19, 57.6%), foot deformities (14, 42.4%) and pain (8, 24.2%; leg, back, perineal). In addition to minimal signs of a tethered cord with tight or fatty filum, MR images showed syrinx in 9 and scoliosis in 4 patients. Postoperatively, bladder dysfunction improved in 16/19 (84.2%), bowel problems in 1/7 (14.3%), motor deficits in 14/19 (73.7%), pain in 4/8 (50%), and foot deformities in 1/14 (7.1%) patients. Apart from one superficial wound infection no complications occurred and none of the patients showed any worsening of their symptoms. Median follow-up was 2.3 years.

Conclusion: The results of the present study demonstrate a surprisingly high chance for improvement of bladder and motor deficits as well as pain in patients with either a tight or a fatty filum after sectioning of the filum. The complication rate is low. Thus, the indication for filum sectioning should always be considered in patients with typical symptoms even when MR images show only minimal or no clear signs for tethered cord.

FP171

High reality simulation scenario for intraoperative MRI setting

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Introduction: Intraoperative magnetic resonance imaging is a very useful tool for the treatment of multiple neurosurgical pathologies. Application in a pediatric setting is a challenge due to security reasons including patient and surgical team, complexity of the workflow during the procedure and the need to properly coordinate a multidisciplinary team. We have performed a highly realistic simulation of the whole procedure before starting the technique in our center.

Material and methods: We simulate two different types of patients using modified pediatric simulation dummies (for realistic weight and heads compatible with the head holders). Two different types of heads were tested, different surgical positions and different padding options for the surgical field. The transfer of the patient from the operating room to the MRI suite with the multidisciplinary team was tested and a medical emergency situation of the patient was also simulated during the MRI. The transfer protocol was also validated. All the steps of the process, participants and equipment were the same as for a real surgery.

Results: No critical errors were found in the design of the process that prevented it from being carried out with the appropriate security measures. Proposals were made regarding the placement of the patient and the use of specific material. The safety protocol was validated and elements that could improve patient safety were identified.

Conclusion: Simulation has been a very useful tool before starting intraoperative MRI. Professionals had the opportunity to express their opinion and modify existing protocols, based on real experiences. It has also contributed significantly to improve the workflow of the multidisciplinary team responsible for the patient and to increase the safety of the processes.

FP214

Efficacy of transcutaneous electrical nerve stimulation on urodynamic parameters and urinary tract associated symptoms of children with myelomeningocele

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Introduction: The use of anticholinergic drugs and clean intermittent catheterization (CIC) are the treatment options for patients with neurogenic bladder (NB) due to myelomeningocele (MMC). However, compliance to treatment has been a problem in children. Transcutaneous electrical nerve stimulation (TENS) is a noninvasive treatment modality with good response in non-NB and might be a possible option for bladder...
rehabilitation in children with NB. The aim of this study is to evaluate the efficacy of TENS on urodynamic parameters (UD) and urinary tract (UT) associated symptoms of children with NB due to MMC.

**Material and Methods:** Presacral (S2-4) TENS was applied to 12 patients (7 boys, 5 girls; median age 8 years) who were resistant to the use of medication and CIC for bladder rehabilitation. Each session lasted 20 minutes, with a frequency of 10 Hz and a generated pulse of 350 μs. The child’s sensitivity threshold determined intensity. Urodynamic studies were evaluated for each patient and a questionnaire evaluated UT symptoms before and in the 6th month of the treatment. The urodynamic parameters (Wilcoxon Test) and UT related symptoms (McNemar test) were compared for significant changes that might be associated with TENS.

**Results:** Of UD variables, MaxPdet decreased significantly from 46 ± 15.3 cmH2O to 35 ± 11.3 cmH2O after treatment (p=0.002). TENS had a significant effect on reducing the detrusor overactivity (83% vs 50%, p=0.46). Additionally, urinary tract infection episodes and constipation reduced after the treatment (58% vs 5% p=0.002, 50% vs 16% p=0.008).

**Conclusion:** Transcutaneous electrical nerve stimulation had a positive effect on reducing the maximum bladder pressure and overactive detrusor contractions during the urodynamic studies and also reduced the UTI episodes and constipation in a limited number of pediatric MMC patients with NB.

**FP223**

**Cervical Cord Compression: Outcomes in the Pediatric Patient**

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**Purpose:** To review motor outcomes in pediatric patients with cervical cord compression.

**Methods:** We conducted a retrospective chart analysis of 20 patients under the age of 2, with cervical cord compression followed at our institution between 2014 and 2019. Medical records reviewed included physical exams, imaging modalities and surgical interventions.

**Results:** Patients reviewed presented with a diagnosis of Achondroplasia, Ehler Danlos syndrome, Dpygge-Melchior-Clausen syndrome, Skeletal dysplasia and Russel Silver syndrome. All of the patients had confirmed cord compression on MRI, 19/20 of those patients required surgery. Median age for surgical intervention was three months. 17/20 went on to meet all of their motor milestones. Patients reviewed showed improvement on the Peabody Developmental Motor Scales-2 (PDMS-2) post-operatively.

**Conclusion:** Cervical cord compression is an uncommon occurrence in the pediatric population. The literature states when cervical cord compression does present in this population it can result in significant deficits with a significant impact on motor function. In our series several patients who we have intervened on have had good long-term outcomes.

**ABSTRACT SESSION 7: SDR II**

**FP100**

**Fluctuations of motor functions in postoperative course in children treated for lower limbs spasticity by selective dorsal rhizotomy**

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**Introduction:** Selective dorsal rhizotomy (SDR) is one of the neurosurgical methods of reducing spasticity of lower limbs. While the reduction of spasticity can be seen immediately after surgery, it is not equivalent to the improvement of motor capabilities. This study aims to analyze changes of motor functions in postoperative period.

**Methods:** Children undergoing SDR were assessed using gross motor function measure (GMFM-88) preoperatively, at 3-6 weeks after the surgery and during subsequent follow-up visits. 82 patients aged 2 - 17 years were operated since 2012. Available GMFM data from 28 patients in short postoperative period and 22 patients with observation period of at least 12 months after the surgery were analyzed. Scores in five GMFM domains as well as total GMFM score were analyzed separately using the paired t test.

**Results:** The mean total GMFM-88 score in short postoperative assessment was 0.8 percentage points (p.p.) lower than preoperatively, with characteristic improvement in some domains accompanied by deterioration in others. Long term observations revealed regular improvements in most of the patients leading to the increase of mean total score of 8.9 p.p., with only two patients (10%) remaining slightly below the initial level (less than 1 p.p.).

**Conclusion:** Reduction of spasticity by SDR gives a chance of improving function to the children struggling with motor impairment.

**FP120**

**Neurosurgical management in spasticity**

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**Introduction:** Surgical management of spasticity vary. Authors present the five year experience with the management of patients with spasticity due to mostly Cerebral palsy and other diseases.

**Method:** First step is Baclofen test. In our conditions it is done by surgeon. Physical examination before the test is the first step and also with video documentation. Under general anesthesia the patient is examined again and intrathecal lumbar catheter is placed. When the patient is completely recover, the same or next morning we give 50-75ug of Baclofen intrathecally and catheter is removed. After 4 hours we examine the patient for the third time and the third video is done again. Last exam is next day morning. After that, we can perform selective dorsal rhizotomy or Baclofen pump implantation, depends on patients conditions. After three months period we perform surgery. Modified Ashworth scale (MAS) we use as criteria.

**Results:** We performed 52 tests. After that, in 21 patients Baclofen pump (BP) implantations was done. The dose vary from 100ug-624ug/24, mean 245ug/24. MAS is better from 1-3, mean 1,75. Complications - 1 infection and pump explantation. 2 catheters replacements and one fluid collection around the pump appeared. The mean patient age at the time of BP implant is 9,7 years. Selective dorsal rhizotomy was performed in 12 children. One level laminectomy with IOM. 11 bilateral, one only left side. Follow up vary from 1-5 years. There were no complications or need of other surgery. In 19 patients we did not perform any surgery. Parents or caretakers were afraid of new technique. Or they were approaching much more from the procedure.

**Conclusion:** Baclofen test looks fine method before surgery. The results are encouraging. Improvement of quality of life is the main goal in our patients.
Intrathecal delivery of baclofen in children: A ten year retrospective review from a single centre

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Introduction: Gamma-amino butyric acid agonist baclofen is used to treat spasticity. In its oral form, its effect can be variable and its dose is limited by adverse effects, including excessive sedation. Intrathecal baclofen can produce higher local concentrations in cerebrospinal fluid at a fraction of the equivalent oral dose. We review our experience of delivering this medication intrathecally in a single centre over the past eleven years.

Methods: We performed a retrospective analysis reviewing the outcome data for consecutive children who underwent procedures involving intrathecal baclofen delivery at a single institution between January 2010 and December 2019. Data was collected on patient demographics, the type of pump insertion, and the complications that occurred.

Results: In total, 80 patients underwent baclofen-related procedures (including test doses and/or pump insertions and/or revisions) with 71 test dose procedures being completed and 48 primary intrathecal Baclofen pumps being inserted. In total 160 procedures were completed on these patients (including surgeries to treat subsequent surgical complications). In the patients undergoing primary baclofen pump insertion, the mean patient age was 10 years (median age 9.4 years, range 3.9 to 16.7 years). The male : female ratio for pump insertion was 32 males : 16 females. Of the primary pump insertion cohort, 6 patients (12.5%) experienced post-operative infections requiring surgical intervention, 9 patients (18.8%) experienced leak of cerebrospinal fluid at the catheter insertion site requiring further surgery and within the remaining cohort 3 patients (6.3%) required pump/catheter revision within six months of primary surgery.

Conclusion: We have evaluated the experience of a single centre in performing procedures relating to intrathecal Baclofen delivery. We discuss the most frequent complications within this subset of patients and ways in which we have minimised these adverse events to optimise the patient care pathway.

FP152

Initial experience of surgical treatment in patients with cerebral palsy in the Republic of Kazakhstan

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Introduction: Surgical treatment of Cerebral Palsy is one of the effective methods in case of spasticity in children. In current report, we share our initial experience of surgical treatment in patients with cerebral palsy (CP) in the Republic of Kazakhstan (RK).

Methods: The frequency of CP in RK is 2.0-5.9 per 1000 births. 10,000 cases from 44,000 registered children with disabilities were diagnosed with CP. We present our retrospective study, which include 20 cases of CP treated surgically from January 2018 to November 2019.

Results: The total number of treated children was 20 cases, 9 female and 11 male with 12 diplegias, and 8 quadriplegias. The age was ranged between 4 and 15 years old (average 8.5 years). The pre-op GMFCS level amounted to the following percentages 10%(II), 10%(III), 60%(IV) and 20%(V). Post-op results indicated GMFCS by one level improvement. Modified Ashworth scales showed spasticity level in 6 patients are 2, the largest group have 3, and the other 3 children have 4 points. All children were mentally preserved. Presenting symptoms were spasticity, hyperreflexia with extended zones, delay in the development of motor functions, poor coordination and gait disturbances. Given the presence of spastic diplegia in patients, the ineffectiveness of the previous therapy, we decided to perform SDR with several approaches (Peacock’s, Park’s, KIDr). In the early postoperative period, we observed a decrease of muscle tone, gait improvement, a significant increase in the volume of passive and active movements. The postoperative rehabilitation contributed to a significant improvement of the life quality. One-year follow-up demonstrated no recurrence of preoperative spasticity.

Conclusion: These cases show that despite the poor nature of the surgical treatment, postoperative effect is significant, which contributed to the improvement of the quality of the children’s life and makes it much easier to take care for them.

ABSTRACT SESSION 8: Vascular

FP90

Surgical treatment of pediatric aneurysms – a single center experience

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Introduction: Intracranial aneurysms are pathological conditions characterized by abnormal dilatation of blood vessels. They affect both arteries and veins, and can be saccular and fusiform.

Methods: We present a retrospective review of eight children with intracranial cerebral aneurysms who were surgically treated in our Department from January 2011 to December 2017. Surgical treatment involved preoperative placement of external lumbar drainage, or external ventricular drainage in patients with ruptured intracranial aneurysms, followed by supraorbital or frontotemporal osteoplastic craniotomy. The exclusion of an aneurysm from the circulation is based on placement of a clip on the neck of the aneurysm. However, often aneurysm trapping and bypass surgery are necessary.

Results: Eight patients with intracranial aneurysms were surgically treated in our Department in a period of seven years. The average patient age was eight years and nine months. 62.5% of the patients were male. In all patients the aneurysm was located in the anterior cerebral circulation, and in 50% of them the location was the middle cerebral artery. In 50% of the patients the aneurysm was located in the anterior cerebral circulation, and in 50% of them the location was the middle cerebral artery. In 50% of the patients the aneurysms had ruptured. Preoperative diagnosis in most patients involved MRI angiography and cerebral DSA. In the patients with a ruptured aneurysm, diagnosis was based on MSCT angiography and cerebral DSA. 37.5% of the patients had fusiform aneurysms. Regardless of whether the aneurysm had ruptured or not, the leading symptom in all patients was headache. Five of the eight patients postoperatively presented with a normal neurological status. Postoperative follow up lasted from a minimum of two up to eight years. Only one patient presented with a new-onset neurological deficit. In all other patients, the last follow up revealed unchanged neurological status or complete recovery. Only one patient developed postoperative hydrocephalus.

Conclusion: Intracranial aneurysms rarely occur in children. Surgical treatment is always complex and often involves trapping and bypass surgery.

FP91

Single institution experience in the treatment of cerebral cavernous hemangioma in the pediatric population
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Introduction: Cerebral cavernous hemangiomas (CCHs) are slow-flow venous malformations. Most commonly these are single lesions that occur in the elderly population. CCHs are usually asymptomatic, and clinically manifest only when ruptured. They present with epileptic seizures and focal neurological symptoms. The gold standard in the diagnosis of CCH is brain magnetic resonance imaging (MRI). Surgical treatment is indicated in ruptured and symptomatic CCHs.

Methods: Pediatric patients with a diagnosis of CCH who underwent resection at our institution were examined retrospectively from January 2013 to December 2017. Surgical resection of a CCH was indicated in symptomatic patients and patients with a ruptured CCH. Upon osteoplastic craniotomy, the exact location of the CCH was verified by intraoperative MRI neuronavigation. Using different approaches, mostly the transcortical route, the cerebral cavernous hemangiomas were removed, thus eliminating the risk of intracerebral bleeding.

Results: During a five-year period, ten pediatric patients with cerebral cavernous hemangiomas were surgically treated in our Department. The average age of the operated patients was ten years and two months. Six of the patients were male. In eight patients the CCH was located in the cerebrum, one patient had a cerebellar cavernoma, and one patient a cavernoma in the brainstem. The frontal lobe was the most common location. Intraoperative signs of hemosiderin deposits were verified in 70% of the patients. 50% of the patients presented with seizures. Other dominant symptoms were focal neurological deficits and signs of elevated ICP. Surgical treatment was based on osteoplastic craniotomy and ablation of the CCH. In 70% of the surgical procedures neuronavigation was used (MRI and intraoperative ultrasound). Average follow-up length was 52.8 months and in 80% of the patients the postoperative course showed improvement.

Conclusion: This retrospective study suggests that surgical ablation of symptomatic CCHs improves the patients’ neurological status and quality of life.

ABSTRACT SESSION 12: Hydrocephalus II

FP52

Optimizing the evaluation of shunt malfunction with 3D venous phase contrast angiography MRI

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Objective: In the situation of suspected shunt malfunction MRI is widely accepted as a primary evaluation tool. Symptoms can be specific, and the presence or absence of ventricular enlargement does not reliably predict raised intracranial pressure (ICP) in these patients. We aimed to investigate 3D venous phase contrast angiography (PCA) in the situation of shunt failure and suspected raised intracranial pressure.

Methods: We analysed MRI studies of shunted children presenting with symptoms of elevated ICP and therefore receiving surgery due to shunt malfunction. Patients were included when pre- and postoperative MRI included an axial T2-weighted image and 3D venous PCA. We assessed Evans’ index on T2 weighted images for assessment of ventricular enlargement and venous PCA for compression of superior sagittal, left/right transverse sinus. Sinus compression was defined as reduction in diameter and/or reduced/missing signal. Elevated ICP was defined as compression of at least two sinuses.

Results: We included 19 (11 male) shunted patients with symptoms of raised ICP, receiving surgery for shunt malfunction, on whom pre- and postoperative MRI was performed. All three sinuses were compressed in 12 patients, of which 11 showed normalization after shunt revision. Only two sinuses were compressed in 6 children. 3D venous PCA showed normalization after shunt revision in all cases. Of 18 patients with compression of 2 or 3 sinuses 15 showed no significant change in Evans’ Index. The only patient who did not show any sinus compression showed significant change in Evans’ Index.

Conclusion: Our results show that ventricular morphology is no reliable marker for elevated ICP in shunt malfunction. Sinus compression might serve as a predictor for raised ICP. To confirm indication for surgery, addition of 3D venous PCA is a helpful tool, especially useful to identify paediatric patients with elevated ICP in which assessment of clinical symptoms can be challenging.

FP74

Biophysics of ICP in pediatric slit ventricles syndrome

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Introduction: It is well recognized that in slit ventricle syndrome ICP can be high, which is usually associated with the ventricular drain blockage. However, the initial cause of syndrome is shunt overdrainage. Infusion test allows to diagnose the problem and support clinical decisions about patient’s management. Easiest way to measure ICP is through the shunt prechamber, but this may be disturbed by a nature of the syndrome.

Material & methods: We examined clinical material including infusion tests and overnight ICP monitoring in 8 pediatric cases with radiological and clinical diagnosis of slit ventricles. Patients were younger than 15 years of age, all of them were shunted shortly after birth, with a previous history of shunt revisions. All of them presented with persistent headaches and/or visual deterioration. In 7 cases pressure in shunt chamber (CP) was measured during the infusion test. In two cases intraparenchymal ICP was monitored overnight.

Results: In all pre-chamber infusion tests, baseline CP was low (below 15 mm Hg) without pulse waveform. After start of infusion pressure abruptly increased to above shunt opening level, still without visible pulse waveform. In shunt with siphon-control device, distal occlusion was performed during infusion. In all cases recorded CP increased to very high values (>50 mm Hg). In three cases it spontaneously decreased after initial surge to level 20-30 mm Hg, with pulse waveform clearly appearing in recording. In 2 cases with parenchymal overnight monitoring ICP showed increased overnight dynamics, and was pulsatile.

Conclusion: In slit ventricles syndrome intraparenchymal ICP is often elevated with increased dynamics. Non-pulsatile pressure measured in shunt prechamber is not always equivalent to ICP. During pre-chamber infusion test, in shunts with distal occluder (like siphon-control device), occlusion may re-expand collapsed ventricles. Adjustment of the drainage system to eliminate overdrainage can be recommended.

ABSTRACT SESSION 14: Neuro-Oncology III
FP22
Characteristics of the skull base surgery by craniotomy in pediatrics
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Introduction: Pediatric skull base surgery is a rare approach, but both craniotomy and trans sphenoidal approach are essential procedures. In this study, we investigated the merits and characteristics of pediatric skull base craniotomy compared with adult cases.

Methods: We studied 23 cases of 20 cases of skull base surgery (only craniotomy; 3-19 years old, since 2010). The approaches were 4 cases of anterior transpetrosal approach (ATP), 4 cases of lateral suboccipital approach, 2 cases of transcondylar approach, 1 case of subtemporal epistemopericranial approach, 1 case of infratemporal fossa approach, 9 cases of basal interhemispheric approach, and 2 other cases. The strategies were the same as for adult cases.

Results: The softness of bone, dura mater, the amount of muscles and ease of retracting exceeded those of adults, and the basic operation and surgical field deployment were easier than adults. There were no major intraoperative troubles or postoperative cerebrospinal fluid leakage. Postoperative cranial nerve palsy appeared and worsened in 6 cases, 3 of which improved after 6 months. In ATP cases, a safe approach was possible without placing a spinal drain and drilling of the petrous apex was easier than in adults. The reason for this was that in addition to bone softness, the air content at the petrous apex was undeveloped in children. Preoperative evaluation of superficial middle cerebral vein (SMCV) drainage patterns was also useful in preventing venous damage that could cause major bleeding and brain swelling.

Conclusion: In the case of pediatric skull base surgery, it was considered possible to perform safe surgery as in adults by preoperative image evaluation of venous running for each case and combined use of several monitors.

FP47
Desmoplastic infantile astrocytoma and ganglioglioma: A series of 11 patients treated at a single institution
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Introduction: Desmoplastic infantile astrocytomas and gangliogliomas (DIA/DIG) are rare neuroepithelial tumors, usually occurring in the first two years of life. Despite radiological and histological appearance than can lead to a misdiagnosis of malignant tumors, biological behavior is usually benign: they are classified as grade I tumors.

Methods: The medical records, imaging studies, and operative and pathology reports obtained for pediatric patients who were treated for DIA/DIG at the authors’ department were reviewed. Neuronavigation was used to plan the surgical approach: preoperative contrast-enhanced MRI with MR angiography helped to identify big vessels’ involvement and prevent major bleedings. Postoperatively, an MRI study performed within 24 hours was used to assess the extent of tumor resection.

Results: Since 2008, 11 patients (6 females, 5 males) underwent resection of their desmoplastic infantile tumors at the authors’ department. Median age at surgery was 4.2 months (range: 3.3-13.4 months). Mean follow up was 74 months. Resection was complete in 3 patients, subtotal in 5 patients, partial in 2; one patient received a biopsy. All but 1 patient presented a big tumoral cyst; four of them (40%) required emergency treatment for the management of intracranial hypertension. Four patients (36.3%) presented radiological progression of the known tumoral residual that required reoperation. Two of them developed secondary leptomeningeal dissemination and were referred to chemotherapy. One patient developed drug-resistant epilepsy that was cured with temporal lobectomy.

Conclusions: Complete surgical resection is the treatment of choice. However, it may not always be feasible: adhesions to major vessels, large size of cysts and bleedings are some surgical challenges to be considered, along with the young age of patients. In case of recurrence or progression of residual, surgical resection is still the treatment of choice, when feasible. Chemotherapy should be reserved in case where no further surgery can be performed.

FP48
Paediatric brain tumour spread: A post-mortem 3D-microscopic study
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Background: Paediatric brain tumours are a leading cause of death in children. We understand little of the factors that make the advanced stage of such brain tumours become untreatable. We hypothesised that a characteristic of late-stage disease is extensive tumour migration. To explore this, we used developed techniques to investigate the pattern of infiltration in three-dimensions (3D) in advanced disease by using post-mortem tissue.

Methods: Slices from the brains and spinal cords of children who had died of glioma and who had undergone autopsy were selected, including regions containing the tumour and remote regions of the central nervous system (CNS). They were scanned with a microfocus computed tomodogram (MCT) and analysed in three dimensions. The tissue was then processed for histology to compare the patterns of infiltration.

Results: We obtained 19 samples of brain, brainstem, cerebellum or spinal cord from 5 children (2 pontine gliomas, 1 bi-thalamic diffuse midline glioma, 1 pontine pilocytic astrocytoma, 1 parieto-occipital glioblastoma). At autopsy, all cases showed microscopic evidence of more extensive infiltration of the tumour since the last pre-mortem MRI. All samples obtained from post mortem, were invaded by tumour except one (a medullary sample from the GBM case). The three spinal cords studied showed massive leptomeningeal dissemination with a bulging mass; two invaded also the parenchyma. Tumour seemed to invade locally through white matter and remotely through leptomeninges.

Conclusion: This is the first post-mortem study of the whole CNS of children who died from glioma at a three-dimensional microscopic scale. Using a combination of both 3D MCT and 2D histological methods, we have shown that at death, most of these tumours extend widely throughout the CNS. No imaging technique alone is, for now, powerful enough to depict these patterns and this suggests that imaging in life is likely to underestimate the extent of disease.

FP55
Neuroendoscopic intraventricular surgery in children with small ventricles using frameless navigation system
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Introduction: Purely endoscopic surgery for intraventricular tumors in patients with small ventricles is a challenging procedure because of the risk of morbidity during the intraventricular approach. The size of the
endoscope sheath (6 mm) relative to a small-sized ventricle together with the proximity of the choroid plexus, the internal cerebral veins, and the hypothalamus seem to present increased risk. The use of the VarioGuide frameless system (Brainlab AG, Feldkirchen, Germany) can minimize the risk of damaging nearby structures in patients with intraventricular lesions and small ventricular size.

**Patients and methods:** We present a retrospective study with surgical videos of 9 pediatric patients with intraventricular lesions treated between 2014 and 2018. There were 6 girls and 3 boys with a median age of 12 years old. Six patients had lesions in the lateral ventricles and three in the anterior part of the third ventricle. The small ventricular size was defined by a frontal occipital horn ratio of 0.37.

**Results:** The diagnosis was germinoma in 3 patients, hamartoma in 2 patients, SEGA in 2, and choroid plexus papilloma in 2 patients. The germinoma patients were treated with radiotherapy according to the standard protocol and the other patients were only treated with radical surgical resection. There were no procedure-related complications. There was just 1 case of cerebrospinal fluid leak after the endoscope per patient to insert the peel-away sheath and to cannulate the ventricle.

**Conclusion:** The use of the VarioGuide frameless system for intraventricular endoscopic surgery is highly recommendable for pediatric patients with small ventricle size. This technique may help minimize the risk of unnecessary brain damage during the entrance to small ventricles.

**FP104**

Endoscopic supracerebellar infratentorial approach for pediatric pineal lesions

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**Introduction:** The supracerebellar infratentorial (SCIT) approach is frequently used for the treatment of lesions in the pineal region and can be performed in a sitting or prone position. We describe our experience with the endoscopic SCIT approach, using a prone position, with mild neck extension and rotation.

**Methods:** We analysed all pediatric and adults patients operated with the endoscope-assisted SCIT approach between July 2013 and January 2018.

**Results:** Seven pediatric patients have been included in the series. The mean follow-up was 24 months (range 6-64 months). The median dimensions of the lesions were 19x19x19 mm. Five patients presented with headache, two with diplopia, one with Parinaud syndrome and acute hydrocephalus. The excision was total in all cases, except for a germinoma, which was subtotally resected after histologic intraoperative verification. No residual tumor was seen on the control MRI scans. Postoperatively one patient developed a new, transitory Parinaud syndrome, which resolved spontaneously within a few months. A CSF subcutaneous fistula occurred in three cases.

**Conclusions:** The endoscopic SCIT approach is effective and safe for the removal of pineal lesions, even of large dimensions. The endoscope guarantees a detailed, close view and illumination of the deep seated structures and the tumor resection can be performed with bimanual use of micro-surgical instruments.

**FP1122**

Central nervous system tumours (CNS) in children under the age of two years: A thirteen year retrospective review

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**Introduction:** CNS tumours in children under the age of two years are a rare commodity. We have reviewed the different types of tumour pathologies, locations and outcomes for this subgroup of patients who have received treatment at a single centre.

**Methods:** We performed a retrospective analysis reviewing the outcome data for consecutive children under the age of two years with CNS tumours treated at a single institution between August 2006 and December 2019. Data was collected on demographics, tumour location, histopathology, treatment received and outcome.

**Results:** 69 patients were treated with a mean age of 12.8 months (median: 15.4 months) with a range from the first day of life to 24 months of age. The male : female ratio was: 35 : 34, 22 patients (31.9%) had posterior fossa tumours, 39 patients (56.5%) had supratentorial tumours (of which 10 were dermoid-related), 8 patients (11.6%) had spinal tumours. Within the cranial cohort of 61 patients, 16 patients (26.2%) developed hydrocephalus requiring surgical intervention. Of the patients with posterior fossa tumours, 2 underwent biopsy of brainstem lesions and the remaining cohort (n=20) underwent tumour resection. 13 patients (21.3%) required re-operation for further tumour resection at a later stage, 2 patients (3.3%) developed post-operative infections and 1 patient (1.6%) developed a subdural haematoma requiring surgical evacuation. In the spinal cohort, 3 patients had extradural tumours, 1 had an intradural extramedullary tumour and 3 had intramedullary tumours. 4 patients underwent tumour resection through laminotomy, 4 underwent laminoplasty. 1 patient developed hydrocephalus requiring surgical intervention, 2 patients required further tumour resection at a later stage and no patients developed post-operative infections.

**Conclusion:** Our series demonstrates the varied tumour locations, diagnoses and surgical treatment options and the associated challenges of surgical interventions for tumours in children under the age of two years.

**FP160**

Proteomics of pediatric ependymomas

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**Introduction:** Ependymomas respond almost selectively to surgery, with a relative resistance to radiotherapy and a confirmed resistance to common chemotherapeutic agents. Surgery may be particularly complicated by the tendency of the molecularly called Group A posterior fossa ependymomas to affect small children and extend to the cerebello-pontine angle embracing cranial nerves. A proteomic characterization could therefore help in finding possible prognostic differential factors among tumors of different grades and localization.

**Methods:** The intact and digested proteome of 12 pediatric ependymomas of different grade and localization have been analyzed by the top-down and the shotgun proteomic approaches after tissue homogenization of the acid-soluble and the acid-insoluble fractions resulting from centrifugation (HPLC-Orbitrap Elite MS).

**Results:** Together with profiling a common signature of ependymoma tumor tissues, the obtained data evidenced interesting differentiations between WHO II and III tumor grades following both proteomic approaches. Particularly, top-down proteomics distinguished the grade III tissue specimens for the down-expression of proteins involved in oxidative metabolism while shotgun data evidenced the exclusive classification of pathways involved. Gene ontology classification of the proteins identified with confidence by the shotgun strategy evidenced the pathways connected to de novo
pyrimidine deoxyribonucleotide biosynthesis and ribonucleotides salvage, response to oxidative stress and hypoxia, blood coagulation and cell cycle as distinguishing WHO grade III tissues.

**Conclusions:** This is a first, preliminary step toward the knowledge of the proteomic behavior of pediatric ependymomas. Further considerations based on the diverse tumor localization (group A and B subventricular ependymomas) and supratentorial ependymomas are under preliminary evaluation.

**FP189**

Use of Gamma Knife stereotactic radiosurgery as adjuvant therapy after subtotal removal of clival chordoma

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**Introduction:** Chordomas are locally destructive tumors with high rates of recurrence and therapeutic strategies remain controversial. Gross total removal is often not achievable due to the particular location.

**Methods:** We report two cases, one male and one female with extensive clival chordomas that were partially resected. The 12-year-old boy presented in 2012 with progressive left hemiparesis. He underwent twice surgical excisions and the remnant was treated with γ-knife stereotactic radiosurgery to the residual tumour (25 Gy in 5 doses). The 15-year-old girl presented in 2014 with right hemiparesis and underwent once surgical excision and the remnant was treated with γ-knife stereotactic radiosurgery to the residual tumour (25 Gy in 5 doses). The 15-year-old girl presented in 2014 with right hemiparesis and underwent once surgical excision and the remnant was treated with γ-knife stereotactic radiosurgery to the residual tumour (25 Gy in 5 doses).

**Results:** Both cases recovered completely neurologically and live normal life. After 5 and 7 years follow-up respectively both cases haven’t developed recurrence and are stable radiologically.

**Conclusions:** γ-knife stereotactic radiosurgery is a useful tool for the treatment of clival chordomas both as adjuvant therapy, offering a satisfactory long-term control of disease.

**FP220**

Birth seasonality of childhood central nervous system tumors

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**Introduction:** Season of birth, a surrogate of seasonal variations of exposure to environmental factors during the perinatal period, has been associated with increased risk of several cancers. We leveraged unpublished primary data contributed by 16 population-based childhood cancer registries operating in 14 Southern and Eastern European (SEE) countries aiming to explore the potential association of season of birth with childhood (0-14 years) central nervous system (CNS) tumors.

**Methods:** Primary incidence CNS tumor cases (n=6014) were retrieved from 16 SEE registries (1983-2015). Poisson regression and meta-analyses on season of birth were performed in nine countries with available live birth data (n=4987). Analyses by birth month and sub-analyses by age, gender and principal histology were also run.
Results: Children born during winter were at a slightly increased risk of developing a CNS tumor overall [incidence rate ratio (IRR): 1.06, 95% confidence intervals (CI): 0.99-1.14], and of embryonal histology specifically (IRR: 1.13, 95% CI: 1.01-1.27). The winter peak of embryonal tumors was higher among boys (IRR: 1.24, 95% CI: 1.05-1.46), especially in the course of the first four years (IRR: 1.33, 95% CI: 1.03-1.71). By contrast, boys <5 years born during summer seemed to be at a lower risk of embryonal tumors (IRR: 0.73, 95% CI: 0.54-0.99). A clustering of astrocytomas was found among girls (0-14 years) born during spring (IRR: 1.23, 95% CI: 1.03-1.46).

Discussion: The present study provides some evidence for age-, gender- and principal histology-related seasonal variations of childhood CNS tumors. These differentials may be biologically plausible possibly attributed to seasonally variant perinatal factors, such as epigenetic modifications and early-life environmental exposures. Expansion and improvement of cancer registration and linkage with pathology, surgical and cytogenetic reports could refine if birth seasonality is causally associated with CNS tumor risk and assist in elucidating the causal pathways of this lethal childhood disease.

ABSTRACT SESSION 15: Epilepsy

FP155

Retrospective analysis of resective epilepsy surgery for pediatric patients with nonneoplastic lesions: A series of 32 patients

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Resective epilepsy surgery is an effective treatment modality for patients with intractable epilepsy. Its benefits are proven in adults and promising results are also achieved in children. We evaluated clinical and radiological features and postoperative results of 32 patients, that underwent resective epilepsy surgery with a mean follow up period of 30 months. Patients with neoplastic lesions are excluded from the study. Among 32 patients, 10 were female and 22 were male. Mean age was 8 (1-17). Majority of the lesions were in the temporal lobe (50%) followed by frontal (41%), parietal (6%) and occipital (3%) lobes. Ten patients were found to have mesial temporal sclerosis. 18 patients were diagnosed with cortical dysplasia, further classified with Blumcke Classification. There were four type IA, one IC, two IIA, three IIB, three IIIC and one IID. Four patients couldn’t be attributed to any type due to lack of specimen. Remaining patients were diagnosed with Landau Kleffner syndrome, Rasmussen encephalitis, electrical status epilepticus during slow sleep (ESSE) and glialosis. There were no major complications except transient worsening of existing motor deficits in four patients, which resolved shortly. Seizure outcome was determined in seven patients (22%) Engel I and in nine patients (28%) Engel II. Three patient died due to other comorbidities. Resective surgery is an efficacious option for selected patients suffering from intractable epilepsy. With benefits of invasive monitoring, cortical mapping and neuronavigation technologies, it is a safe and effective treatment modality.

ABSTRACT SESSION 16: Craniofacial

FP29

Outcome improvement after ropivacaine scalp nerve block for craniosynostosis surgery

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Introduction: Craniosynostosis surgery is considered a painful procedure due to extended scalp and periosteal detachment, and is associated with prolonged postoperative analgesies and their side effects. In this prospective case series study, we investigated intraoperative hemodynamic parameters, postoperative analgesic consumption and the early postoperative complications in children undergoing craniosynostosis repair under general anesthesia when scalp nerve block with ropivacaine was involved.

Methods: After standard anesthesia induction, scalp nerve block with ropivacaine 0.2% plus epinephrine 1:800,000 (max-dose 2 mg/kg) was performed. Hemodynamic parameters and analgesic consumption (phenylalan 2-5μg/kg) were noted. Patients were further monitored in the recovery room. Requirements of additional analgesia (paracetamol 10mg/kg every 6hours and morphine 0,01mg/kg), indicated by the Children’s Hospital of Eastern Ontario Pain Scale (CHEOPS) pain score of >9, and incidence of side effects (sedation, nausea, and vomiting) were recorded during the first 24 hours. The targets for scalp nerve block were: the major and lesser occipital, major auricular, auriculo-temporal, supraorbital and supratrochlear nerves.

Results: A total of 40 patients were recruited in this study; 95% of them presented important diminution of analgesic consumption in the recovery room along with the reduction of postoperative symptoms compared with the usual anesthetic procedure. There was also a relative intraoperative hemodynamic stability.

Conclusion: Scalp nerve block can be proposed as a complement to the routine craniosynostosis anesthetic protocol, because it is easy to perform, provides intraoperative hemodynamic stability and it seems to reduce the need for supplementary analgesics during the perioperative period.

FP45

Posterior fossa pentagon: A useful screening tool for detecting skull base anomalies

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Introduction: The mid-line sagittal posterior fossa pentagon has been highlighted as a useful tool in assessing the proportional integrity of the bony posterior fossa in relation to Chiari 1 deformity (Poretti et al., 2016). Normally the posterior fossa pentagon is symmetrical. Asymmetric pentagon geometry is a result of skull base and cranio cervical junction anomalies (Raybaud and Jallo, 2018). We propose that the pentagon can be applied as an imaging screening tool for detecting skull base anomalies.

Methods: The pentagon is formed by five lines: 1.Cilival - basion to dorsum sellae, 2.Incisural - dorsum sellae to vein of Galen/straight sinus junction,
We mapped the posterior fossa pentagon on the midline sagittal MR image for patients with variable skull base abnormalities.

**Results:** We illustrate disproportional posterior fossa geometry with altered pentagon lines and angles compared to a normal control, for example:
1. Shortened foraminal, clival lines and elongated incisural, supraoccipital lines with rhomboid pentagon configuration in achondroplasia.
2. Flattened pentagon base with near horizontally oriented supraoccipital line in Pierre Robin sequence.

**Conclusion:** The sagittal midline posterior fossa pentagon is a useful screening tool for detecting skull base anomalies which may have impact on surgical management.

**Complications, morphological and functional results after surgery for metopic synostosis**

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**Introduction:** Few studies have evaluated the complication rate and long-term morphological and functional results after surgery for metopic synostosis (MS).

**Material and methods:** We reviewed patients operated for MS in our institution between 1999 and 2019. The regular management is cranioplasty with fronto-orbital bandeau, starting around 9 months of age; in older children, we perform cranioplasty without bandeau, and surface drilling in teenagers.

**Results:** We reviewed 188 patients, M/F ratio was 3.2, mean age at surgery was 12.5 months; 57 cases (31.0%) were syndromic. We performed a cranioplasty with bandeau in 179, without bandeau in 4, and surface drilling in teenagers. The mean duration of follow-up was 65 months.

Two patients died, because of postoperative bleeding; a third patient had postoperative hemorrhagic shock, which could be salvaged successfully. 3 patients (1.6%) had operative site infection, which was managed conservatively, while 13 others (7%) had urinary infection postoperatively; secondarily, 8 (4.4%) developed superficial complications related to steel wires. Morphological results were good (Whitaker 1) in 148 (80.1%), and suboptimal (Whitaker 2) in 35 (19.1%). Three of these underwent lipofilling for temporal hollowing. None required reoperation for cranioplasty or lacuna. The most prominent factor predicting suboptimal morphological result was the late age of surgery. Forty-four patients (23.9%) had developmental delay; among 112 school-age children, 87 (72.5%) followed a normal curriculum. The only independent predictive factor for developmental delay was the existence of a syndromic context.

**Conclusions:** The majority of children operated for MS using cranioplasty with bandeau achieve favorable morphological and developmental outcomes; however, bleeding is a major concern in surgery for MS. A syndromic context is a major confusing factor for the evaluation of developmental outcome. The morphological evaluation and comparison between series using different techniques is hampered by the lack of a consensual quantitative evaluation scale.

**FP63**

Partial hybrid cranial vault remodeling in late correction of scaphocephaly and revision surgery. A monocentric retrospective study of nine consecutive cases

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There is currently no consensus on the surgical attitude to be adopted for late management of sagittal synostosis or for revision scaphocephaly surgeries without prolapse of the cerebellar tonsils. We present here a monocentric retrospective study of nine patients operated consecutively by a fixed expansion method of the cranial vault which may be associated with a fronto-orbital remodeling. The procedure consists in the realization of multiple parietal tongue-in-groove osteotomies fixed by resorbable plates. Simultaneous fronto-orbital remodeling have been performed when needed. No intraoperative complication was noted. The average operating time was 141 min. Six patients (66.7%) had a blood transfusion during the perioperative period. The average hospital stay was 4.8 days. With a mean follow-up of 26.7 months, no surgical revision was noted. In all patients with clinical or ophthalmologic signs of intracranial hypertension, we highlighted a disappearance of signs within 4 months. No protective helmet has been used. The craniofacial remodeling was judged very good by the family and the surgical team. Multiple tongue-in-groove tenons remodeling cranioplasty associated or not with a fronto-orbital advancement is a safe technique. It seems to us to be a good alternative to floating or fixed bi-parietal or bi-parieto-frontal cranial flaps because of the very large increase in endocranial volume and the possibility of physiologically and aesthetically remodeling the parietal and fronto-orbital regions.
Results: The procedure proved to be safe. There was no morbidity or mortality. Correction of the skull was immediate. It was maintained throughout the 1-4 years follow up period. The Cranial Index improved from an average of 60-64 to 78-82. Blood transfusion was needed in small amounts in every case.

Conclusion: The “Internal Helmet” can successfully substitute for the external molding helmet. This will save time, cost, and inconvenience to the child and his family.

FP88

The “No Bandeau” technique for correction of anterior skull deformities

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Introduction: Correction of the frontal skull deformities (Plagiocephaly, trigonocephaly, etc) entailed creating a bandeau and a bifrontal bone flap. Both pieces are then refashioned and reapplied. In this paper, we used a single piece of bone to substitute for both the bandeau and the forehead.

Methods: Twelve patients have been operated. Their age ranged: 3-12 months age. A bifrontal craniotomy including the Supra orbital rims was extracted. This was turned anteroposteriorly and used as a new Supra orbital margin and forehead.

Results: The procedure proved to be safe with no morbidity or mortality. Correction of the deformity was immediate and satisfactory. Being a single piece of bone, the forehead was smooth and symmetrical. No plates were used.

Conclusion: The “No Bandeau” technique is simpler and faster than the currently used techniques. The new forehead is smoother and more symmetrical.

FP128

Cranioplasty for residual bone defects after craniosynostosis surgery. A study of case series over 17 years

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Introduction: Surgical treatment of craniosynostosis in children can be responsible for late defects of the cranial vault by an incomplete ossification process. The incidence of cranial defects after craniosynostosis surgery (CDCS) is poorly reported in the literature with a variable incidence of 0.5% to 18.2%. To better understand the impact and management of this situation, we selected and reviewed al cranioplasties that met this criterion between 2002 and 2019.

Patients and method: We found 41 patients (28 M and 13 F) operated between January 2002 to January 2019 who underwent cranioplasty for CDCS’s in the infancy. All patient were at least 5 years old (range 5 to 17 years, median 11). The indication was aesthetic in 28 patients and for headaches, learning difficulties or changes in the cerebral blood flow in 13 patients.

The material used in cranioplasty was the poly-methyl-methacrylate (PMMA) in 40 patients and customized porous hydroxyapatite in 1 patient.

Results: The mean follow-up period after cranioplasty was of 37 months (range 2 to 125 months, median of 27 months). In the postoperative period there were no mortality nor neurological complications. There were 3 cases (7%) of superficial local postoperative wound infection but with no evidence of long-term infection. The long-term CT scan follow-up showed no material migration, dislocation or fractures.

Conclusion: Considering the characteristics of the cranial vault after craniosynostosis surgery the treatment by cranioplasty with heterologous materials appears to be feasible thus avoiding donor site morbidity. For selected cases with small defects, our experience shows that the use of PMMA may be a safe alternative for the cranial vault repair in children older than 5 years.

FP169

Physical activity and complex craniosynostosis

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Complex craniosynostosis may be associated to other anomalies like syndactyly, cervical vertebral fusion, hearing loss or visual impairment that might affect the ability of the patient to practice a physical activity. Aim of this study is to investigate if and how children with a complex craniosynostosis are hindered from practicing physical activity.

Materials and methods: We created a questionnaire for children with a complex craniosynostosis that we submitted electronically to determine what type of physical activity the children practice (in school or in a sports club or association or with family). To get the most participation possible, we transferred the questionnaire to a patient’s association.

Results: 30 families responded to the questionnaire. 56,7% of our sample is composed of children with Crouzon syndrome (mean age 10,5 years old, boys: 14).

16 children indicated they had limitations to practice physical activity. 11 had some medical contraindications (contact/combat sports and all kinds of practice in which there is a risk of head trauma). They concerned all types of complex craniosynostosis except Muenke syndrome; 12 children reported that they cannot participate to all the activities proposed in school by the Physical Education Teacher. 4 children do no participate to any sport activity at school, in one case even in the absence of medical contraindication due to a lack of adaptations to her physical limitations. However, they are still able to have some physical activity regularly with their family which takes into account their limitations.

Discussion and conclusions: Caregivers and school teachers should take into account the specificity of every child with a complex synostosis to find what activity can be the most adapted to the child’s disease, and also his/her needs, capacities and wishes.

FP182

Emissary veins and pericerebral cerebrospinal fluid in trigonocephaly. Do they define specific subtypes?

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Introduction: Trigonocephaly may be associated with the presence of emissary veins (EV) and abnormal intracranial cerebrospinal fluid (CSF) dynamics resulting in pericerebral effusion (PE). However, the incidence of such findings is not fully elucidated. The aims of this study are to study the presence of the metopic EV and the PE in attempt to identify distinct forms of presentation from computed tomography (CT) scans of patients with trigonocephaly.

Method: We retrospectively review the preoperative brain CT scans of 74 children (52 boys, 22 girls) with trigonocephaly. The PE was compared to the estimated value corrected for age. Correlations among these
values and indices and with the morphology of the synostotic metopic suture were analyzed.

**Results:** Preoperatively, an endocranial metopic notch was seen in 70% (52 patients with a “Ω” or “V” ridge). Emissary veins were identified in 34 of 74 patients (45%), at a mean distance of 2.04 cm (1.18-2.94 cm) from the nasofrontal suture (nasion). The presence of EV was significantly correlated to the presence of an “Ω” type of ridge (p<0.05). Among 50 infants who underwent the CT scan before 50 weeks of age, 17 (34%) had larger PE than expected. The presence of PE significantly correlated with the presence of EV (p<0.05) and with the “Ω” type of ridge (p<0.05). The presence of PE was also significantly associated with interfetal angles under 134° (p<0.005).

**Conclusions:** We can hypothesize an association between EV, PE and the “Ω” notch: 1) The presence of emissary veins as the consequence for local venous hypertension due to the sagittal sinus constriction; and 2) the presence of CSF disturbances due to malabsorption and venous blockage. The long-term results of distinguishing between normal and pathological PE are still to be determined.

**FP185**

**Modified pi-plasty for treatment of sagittal craniosynostosis: a 12-year experience**

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**Introduction:** We intend to present our 12-year experience treating isolated, non-syndromic scaphocephaly by using a dynamic cranioplasty, called modified pi-plasty, in order to evaluate the efficacy and safety of the procedure.

**Methods:** A retrospective review of all patients’ charts submitted to modified pi-plasty between 2007 and 2018 at Hospital de Santa Maria (Centro Hospitalar Universitário Lisboa Norte Lisbon, Portugal) was performed. Demographic data, pre- and post-operative craniometric data, perioperative estimated blood loss, length of stay in the Paediatric Intensive Care Unit (PICU), total length of stay in the hospital and surgical morbidity were analysed.

**Results:** Fifty-four patients were operated according to the modified pi-plasty technique, with a male: female ratio of 5:4:1 and a mean age of 9.04 months old. There was an average improvement of the Cephalic Index (CI) from 68.79 preoperatively to 75.15 at 3 years of post-operative follow-up. Most patients (94.44%) required intraoperative blood transfusion; the average length of PICU stay was 1.94 days and the mean total in-hospital stay was 4.52 days. One child was re-operated 2 years later for optimization of the cranial shape. There was no mortality and the overall morbidity was negligible (1 reoperation for non-optimal head shape).

**Conclusion:** The modified pi-plasty provided satisfactory and long-lasting cranioeccentric results and was shown to be a safe surgical technique for the correction of isolated non-syndromic scaphocephaly. It should be considered a surgical option when evaluating a patient older than 6 months-old or presenting with a severe deformity.

**FP217**

**Minimal invasive cranioplasty in syndromic multisuture craniosynostosis**

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**Object:** Early minimal invasive stripcraniectomies have become a standard procedure in single suture craniostenoses, e.g. in sagittal synostosis. In order to prevent extreme deformities and complications related to increased ICP this technique can also be beneficial in syndromic multisuture craniosynostosis.

**Methods:** This is a retrospective study of a consecutive single unit series of patients who underwent minimal invasive stripcraniotomies in patients with syndromic multisuture craniosynostosis. Demographic and clinical data as well as surgical and follow up information have been investigated. The standard surgical procedure was excision of all cranial sutures (except the metopic suture) in all cases. The cosmetic results have been evaluated.

**Results:** Eight patients have been operated so far. All of them were operated between week 4 and 12. The following syndromes have been treated: Apert (2), Muenke, Baere-Stevenson-cutis-gyrata, familiar TBCID32-variant, Saethre-Chotzen, Mercedes-Benz- and Kleeblattschaedel-deformity of unknown genetic background (1 each). In all but one (Mercedes-Benz-deformity) patients, between 1 and 3 additional cranioplasties became necessary after 6 months of age. No surgical complications occurred. The child with Baere-Stevenson-cutis-gyrata-syndrome died at 2 years of age. He had tracheostoma due to choanal atresia since birth and vp-shunt. All others have no further complications, e.g. good eye status and no sleep apnea and are clinically stable (follow up 7 – 75 months). The cosmetic results are good or very good after initial minimal invasive procedures.

**Conclusion:** Early minimal invasive stripcraniectomies are able to prevent extreme craniofacial deformities and complications related to increased ICP in syndromic multisuture craniosynostosis. The technique is safe, even in very young and compromised children and does not interfere with secondary surgical procedures.

**Poster Presentations**

**POSTER TRACK 1.1: Miscellaneous**

**PP58**

**Epi-subdural abscess induced by paranasal sinusitis in infant with post living-donor liver transplantation**

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**Introduction:** The fatality rate of subdural abscess has been found to have improved compared to the past. However, the risk is still high in children with immunodeficiency and timely diagnosis and treatment are necessary. We report a case of epi-subdural abscess induced by paranasal sinusitis with post living-donor liver transplantation.

**Methods:** A 10-year-old boy with biliary atresia has a history of partial liver transplantation ten months after birth. He was hospitalized for vomiting, fever, and left eyelid swelling. Although the source of infection was unknown at first, swelling of the left eyelid gradually became apparent, and CT revealed a mucosal thickening of the left sinus and a left frontal epi-subdural abscess. Endoscopic drainage was performed, and Streptococcus intermedius was detected in the cultured specimen. The bacteria were also detected from blood culture and considered to be the causative organism. Antibacterial treatment was performed, and all symptoms disappeared within a few days. On the 15th postoperative day, a ring enhanced mass sized 2 cm on the left frontal lobe was found on head MRI. On the 22nd postoperative day, the abscess and the surrounding brain edema expanded. Decompressive surgical treatment was also considered, but it would not be a radical treatment. Eventually, treatment with reduced immunosuppressants and increased antibiotics were selected. The abscess disappeared on the 34th postoperative day. Antibiotics were used for 62 days. The
patient was discharged after confirming that epi-subdural abscess did not relapse.

Results/Conclusion: In pediatric liver transplantation cases, long-term immunosuppressive therapy is required, so the risk of sinusitis spreading to subdural abscess is high. The management for epi-subdural abscess requires a multimodal approach, such as antibiotics, surgical treatment, and reduction of immunosuppressants. Appropriate treatment combinations are essential for children with immunodeficiency.

Decompressive craniectomy in PICU

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Introduction: Decompressive craniectomy (DC) remains still a controversial, though life-saving procedure, performed to reduce increased intracranial pressure (ICP). Morbidity and mortality following DC are depended to the indications of the procedure. In this study we report the incidence, indications, morbidity, mortality and neurological outcome of DC in PICU patients.

Methods: The medical records of all patients who underwent DC in PICU from 2015 to 2019, were retrospectively reviewed. Clinical data collected were age, days of mechanical ventilation, days of treatment in PICU, indications for DC, timing, ICP values before and after DC and Glasgow Outcome Scale (GOS) on discharge from PICU and at 6 months.

Results: From a total of 495 admissions, 17 craniectomies were performed. Mean age was 6.3 years (range 40days to 15.5 years), mean days of treatment in PICU was 26.82 (range 7 to 78 days), mean days of ventilator support was 19.94 (range 5 to 47). Indications for DC were: severe traumatic brain injury (TBI) with subdural hematoma in 10 cases, intracerebral hemorrhage (hemorrhagic stroke) in 4 cases and global ischemia after cardiac arrest in 3 cases. Mortality after DC performed in TBI cases was zero but there were 5 deaths following DC for intracerebral hemorrhage and global ischemia. GOS on discharge from PICU was worse after DC for hemorrhagic stroke (1 to 3) and global ischemia (1 to 2) than after severe TBI (3 to 5). All cases that had a favorable neurological outcome (GOS 4 and 5) presented with a reduction in ICP below 20mmHg after DC. Most frequent complications were hygroma and hydrocephalus.

Conclusions: In our series morbidity and mortality after rescue DC performed for other reasons than TBI, remain very high. In the opposite DC after severe TBI is a life-saving procedure with a satisfactory neurological outcome and low mortality.

Chiari malformation in children: A single center experience

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Introduction: Chiari malformation defines a herniation of the rhombencephalic structures beyond the foramen magnum for at least 5 mm. It can be related to several different conditions and it can cause hydrocephalus and/or syringomyelia.

Methods: All pediatric cases of Chiari malformation treated in our Department between 2016 and 2019 have been reviewed.

Results: A total of 47 children have been included in the study. 43 were Chiari 1 and 4 were Chiari 2 malformation. A total of 9 cases have been treated surgically.

Conclusions: Chiari malformations can be caused by different pathogenetical processes, which must be correctly recognized to select the most appropriate surgical treatment for each single case. Craniocervical decompression is a safe and effective procedure, but still carries some risks of surgical complications.

Is “minimally invasive” a legitim scientific term or an incorrect anticipation of unproven results?

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Objective: In 1966 the term “minimally invasive” (MI) was coined for carcinomas in situ (Barter). For 18 years MI was used in this precise original meaning 0-4 times per year only. Later on the term spreaded arbitrarily in the overall medicine into 81,107 papers (11/2019). Unfortunately the term “minimally invasive” has a threefold semantic: 1. local malignomas, 2. a normative meaning closed to the ultimative aim of every medicine (“nil nocere”), 3. as inaccurat substitute of precise terms such as endoscopic, endovascular, etc. procedures, which are not finally proved. The term oscillates uncontrollably between 2 and 3.

Methods: MI/ MIN (minimally invasive neurosurgery) were systematically screened in Lit.

Results: MI was created in 1966, remained a rarity over 15 years and increased slowly in the 80ties. Between 1990 and 2019 MI-articles exploded from 53 to 7806 titles per year and reached now 81,107. - In neurosurgery MIN was created in 1985 (Blacklock) followed by Ascher (1991) and Hellwig/Bauer (Minimally invasive neurosurgery...). From 1991 to 2018 the MIN-papers increased from 2 to 544/per year; now to 5025. - Old, but precise terms such as stereotaxy (Goodlee 1885), endoscopy (Desormeaux 1865), endovascular were substituted by the diffuse euphemistical term MIN, which suggest, but not confirm less sideeffects, dangers and pain. Paradoxical effects are common: The ETV has a lethality of 0.28% (8/2985; Bouras 2011; 0.4% Tefre 2018), but is “minimally invasive”, shunts with a peri-operative mortality of 0.1% are “invasive” (diRocco 94).

Conclusion: Scientific language requires precision, unambiguity and a crystal-clear distinction between descriptive and normative terms. The apropri-declaration of a treatment as MI anticipates any empiric evaluation and should be avoided. MI belongs in the world of advertising, not of science.

Massive bilateral subgaleal hematoma in an adolescent after minor trauma

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Introduction: Subgaleal haematoma is a rare condition usually observed at the neonatal age and related to ventouse assisted delivery. It is very rare after this age and usually related to significant head trauma and coagulation disorders.
Methods: A 10-year-old boy presented with massive bilateral scalp swelling extending down to the zygomatic arches and periorbital area. He had a recent history of a minor hit with a small bruise at the right frontotemporal side 2 weeks prior after hitting on a doorpost. He was also using very tight swimming cap at the pool. At presentation, he had low hemoglobin and had to be transfused. An MR scan showed extensive bilateral subgaleal haemorrhagic collections of varying ages.

Results: Initially conservative treatment was adopted with observation and blood transfusion. After ten days, as the collections persisted, he underwent surgical evacuation through two small frontal incisions. 800 ml of old blood collection were removed together with small calcified clots and an elastic head bandage was put. He had to be transfused a second time postoperatively. The collections were completely resolved eventually.

Conclusions: Subgaleal hematomas after minor trauma in the adolescent age group are very rare. After literature search, only 8 other such cases were found. A possible mechanism in our case could be a small cephaloheumatoma, which gradually extended due to hair pulling because of the tight swimming cap. Conservative management may not be sufficient if the collections do not absorb within reasonable time.

Method: Cerebrovascular autoregulation monitoring based on pressure reactivity index after severe traumatic brain injury in neonates and children: First case series in Italy

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Introduction: Cerebrovascular autoregulation (CA) is a physiologic mechanism aimed to preserve cerebral blood flow. CA can be continuously monitored processing commonly available signals and its impairment after brain injury is associated with poor outcome in adult and pediatric patients. Pressure Reactivity index (PRx) expresses the correlation between arterial blood pressure (ABP) and intracranial pressure (ICP) allowing to calculate optimal cerebral perfusion pressure (CPPopt).

Methods: We prospectively collected data using the ICM+ Software (Cambridge University, UK) in three consecutive patients admitted in pediatric intensive care unit after severe TBI. PRx was real-time displayed and recorded on an observational basis. CPPopt, where available, was calculated plotting PRx against CPP within 4 hours as previously described. Three different clinical scenarios are reported. Case #1 is a 6 years-old child with a left temporal contusion who developed intracranial hypertension despite maximized therapy and underwent decompressive craniectomy. Case #2 is a 4 years-old child with bilateral frontal contusions where ICP and CPP were adequately controlled with second-tier medical treatments. Case #3 is a newborn monitored after evacuation of a post-traumatic epidural hematoma with associated acute brain swelling.

Results: ABP and ICP signals were acquired and processed for a total of 285 hours, reporting just one technical failure with significant data loss due to an unexpected hardware crash. Raw data were recorded with one-minute resolution and stored according with privacy policy. Calculated variables included PRx, CPPopt and time spent in critical region (TICR) for set threshold. All three patients were treated following current clinical guidelines and presented good neurological outcome at hospital discharge (GOS:1-2).

Conclusions: PRx monitoring seems to be feasible, allowing CPPopt calculation. We hypothesize that it may be a valuable tool in the context of multi-modal monitoring after TBI in children. Further research is ongoing to define its role in clinical practice.
Pre-operative and post-operative modified Ashworth grade and GMFCS level was measured.

**Results:** Eight patients (6 males, 2 females) of spastic cerebral palsy with age range 6 to 18 years (mean age: 12.9 years) were operated by a single surgeon over the study period. Seven patients had spastic diplegia and one had spastic hemiplegia. The preoperative Ashworth grade in all patients was 3 or 4 in various involved muscle groups. Six patients with spastic diplegia underwent microsurgical DREZotomy at L3-S1 level bilaterally, one patient with spastic diplegia and bladder complaints underwent microsurgical DREZotomy at L3-S4 level bilaterally whereas one patient with spastic hemiplegia on the right side underwent microsurgical DREZotomy at C5-T1 level and L3-S1 level on the right side. The post-operative Ashworth grade in all patients improved to 0 or 1. The caregivers of all patients reported increased ease in doing physiotherapy.

**Conclusions:** Microsurgical DREZotomy is a cost-effective tool in decreasing limb spasticity in patients of spastic cerebral palsy. Neuromonitoring should be used as an adjunct to avoid complications.

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**PP24**

**Dorsal Rhizotomy in a non-cerebral palsy Adolescent with Familiar Spastic Paraplegia type 4 (SPG4)**

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**Introduction:** Dorsal rhizotomy, under appropriate indications, is an effective surgical treatment for spastic diplegic children suffering from cerebral palsy. We present a case of non-cerebral palsy adolescent with familiar spastic paraplegia type 4 (SPG4) treated by Keyhole Interlaminar Dorsal Rhizotomy (KIDr).

**Methods:** A 15 y/o boy with familiar spastic paraplegia (mutation c.1496G>A(p.R499H) for SPG4 gene. He was non-ambulatory on functional status GMF-CS III unable to walk without assistive devices and caregivers support. The Ashworth scale for lower limbs was 4 with inexhaustible clonus. In standing position he was in hyperlordotic painful lumbosacral contracture, scissor-like adduction and equino-varus. KIDr was performed with two interlaminar spaces, preselected according to planning. At L1-L2 (for L2/L3 roots) and L5-S1 (for S1/S2 roots) were enlarged, respecting the spinous processes and interspinous ligaments. Ventral root stimulation identified the radicular level. Dorsal root stimulation evaluated its implication in the hyperactive segmental circuits, helping quantify the percentage of rootlets to be cut. The amount of root sectioning bilaterally was: L2 75%, L3 50% and S1 75%.

**Results:** The excess of spasticity was immediately reduced. The Ashworth score decreased to 0, with no clonus, abnormal painful postures. In six-month follow-up the patient is on GMF-CS II, able to walk independently without assistive devices.

**Conclusion:** The efficiency and safety of dorsal rhizotomy depends on the accuracy of radicular identification together with selectivity of root sectioning. We report, for the first time, the case of a non-CP adolescent who underwent dorsal rhizotomy for the management of spasticity secondary to SPG4.

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**PP106**

**Selective dorsal rhizotomy - goniometry is a useful method for outcome measuring**

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**Introduction:** Selective dorsal rhizotomy is a well known and effective treatment of lower limb spasticity. The aim of our study was to assess the reliability of goniometry as a method for evaluation of the SDR outcome and to assess the relation between the percentage of the sectioned rootlets and the postoperative goniometric changes of the lower limbs.

**Methods:** All children treated with SDR between 2018 and 2019 have been included in the study.

**Results:** The goniometric changes and improvements of the lower limbs after surgery revealed to be a reliable tool for measuring the success of the SDR. We report the goniometric changes in the lower limbs after SDR. In all children we sectioned a variable amount of rootlets between 50 and 80%. No statistically significant difference have been found between the amount of sectioned rootless and the goniometric changes in the lower limbs after SDR.

**Conclusions:** Goniometry is a reliable tool for measuring the successful outcome after SDR. There was no correlation between the amount of sectioned rootlets and the postoperative goniometric changes.

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**PP110**

**The expanding role of selective dorsal rhizotomy: A review of outcomes for spasticity of genetic etiology**

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**Introduction:** Selective dorsal rhizotomy (SDR) is most commonly performed for children with the spastic diplegic variant of cerebral palsy to improve ambulation. Its role in the treatment of spasticity in other conditions is not well-established. We aimed to review outcomes following SDR for the treatment of functionally limiting spasticity of a genetic etiology.

**Methods:** A systematic literature review was performed based on the PRISMA guidelines, by searching the Medline, Embase, Cochrane and PubMed databases. Articles were included if they described the application of SDR for spasticity of genetic etiology. Data pertaining to the pre- and postoperative clinical condition of the patients, operative technique employed, complications and reported outcomes in relation to spasticity and gross motor function are collectively summarized.

**Results:** Five articles reporting on 15 patients (9 males, 6 females) met the inclusion criteria, of which three articles reported on SDR for hereditary spastic paraplegia (HSP) in ten patients, one article reported a case of Leigh syndrome and another article reported one additional case of HSP, two cases of Pelizaeus-Merzbacher disease and a single case of Sjogren-Larsson syndrome. Follow-up ranged 18-252 months. Two patients with confirmation of the ALS2 mutation underwent treatment. The mean age at the time point of surgery was 15 years (median 11 years, range 3-37 years). Although all patients experienced a reduction in spasticity, the long-term gross motor functional outcomes objectively assessed at last follow-up were heterogeneous.

**Conclusion:** The early experience of utilizing SDR in the context of genetic disorders causing spasticity suggests a possible role in static conditions. Further evidence is required prior to the widespread adoption of SDR for such disorders as, based on the collective observations of this review, although spasticity is consistently reduced, the long-term effect on gross motor function remains unclear.
Comparing the surgical approaches and techniques in selective dorsal rhizotomy. Single center experience

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Introduction: During past 30 years, surgical treatment of spasticity in Cerebral Palsy (CP) patients underwent development with good short and long term results.

Methods: Since 2018 selective dorsal rhizotomy for 20 patients was performed. We present single center experience with three modern methods.

Results: Well known all over the World method is extended Peacock’s approach, which is done via laminotomy of L1-L5 levels. The aim of this method is to differentiate dorsal roots from motor by using intraoperative neuromonitoring (ION). After sensitive roots L2-S1 are already selected, they are separated from 2 to 6 rootless and each of them are stimulated. According to the ION respond roots are cut. Surgery using described approach was done in 7 cases. GMFCS was 3 to 5. Three-month follow-up shows improving for 1 point in all cases. Keyhole interlaminar dorsal rhizotomy (KIDr) suggested by Sindou is aimed to avoid spinal instability after surgery. The skin incision is similar to the previous one. During the procedure L1-L2, L3-L4, L5-S1 interlaminar spaces are opened and one can identify the roots of L2-L3, L4-L5, S1-S2 entering in to the foramina intervertebralis. After differentiation of dorsal roots, stimulation I started and depending to the ION response and clinical behavior of the spasticity preoperatively roots are cut, from 30 to 75%. The range of GMFCS at 7 patients was 3 to 5 and follow-up shows the same results. The single-level approach developed by Park was performed in 6 patients GMFCS ranged between 5 to 2. The surgery targeted to open the conus medullaris on the L1 level and take all sensitive roots close to conus left from L1 to S1. Postoperative follow-up demonstrated improvement for 1 point.

Conclusion: according to our short term experience, we did not find any differences in outcomes between mentioned three different methods.

Role of intraoperative neurophysiology during rhizotomy for spasticity: How it is utilized in rhizotomy surgery

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Introduction: We have recently conducted a minor survey about rhizotomy for spasticity. Several questions were asked for 7 pediatric neurosurgeons dealing with rhizotomy. Apart from surgical procedures, there seemed wide difference about the role of intraoperative neurophysiology (ION). ION was used for the following purposes:

1. Judging abnormality of the posterior root/rootlet
2. Differentiating a posterior root from anterior one
3. Identifying a spinal level of a root
4. Confirming muscle innervation of a root
5. Mapping pudendal nerves

Results: ION had been applied by all with variety of combination of the above purposes. None seemed to share the same combination. Some surgeons were skeptical about reliability of purpose 1 and not so enthusiastic for ION. Those who performed rhizotomy through the one-level laminotomy applied purposes 2 & 3. Purpose 4 seemed to be applied when more functional approach was preferred. The survey revealed different standard for the posterior root/rootlet cutting. Majority of surgeons cut the root/rootlet based on the predetermined cutting rate. Other cut it based on the ION during surgery. In the former case, a surgeon cut roots/rootlets up to predetermined rate (50-70%) based on neurophysiological abnormality at each root level. The latter, roots/rootlets were cut independent of level. A third way was to cut a posterior root to predetermined rate (50 or 75%) based on the muscle innervation of the anterior root.

Conclusion: The survey disclosed current diversity regarding rhizotomy. In order to differentiate from “non-selective” rhizotomy, it would be recommended to integrate the use of ION so that “selective” rhizotomy could be more “functional”.

POSTER TRACK 1.3: Hydrocephalus I

PP7

Prospective monocentric study of ventriculoperitoneal adjustable differential pressure valve measurements in infants with hydrocephalus under 6 months old

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Objective: Ventriculoperitoneal Shunt (VPS) with adjustable differential pressure valves are commonly used to treat infants with hydrocephalus avoiding shunt related under- or overdrainage. The aim of this study was to analyse the influence of VPS with adjustable differential pressure valve on the head circumference (HC) and ventricular size (VS) stabilization in infants under six months old with post intraventricular haemorrhage, acquired and congenital hydrocephalus.

Method: Forty three hydrocephalic infants under the age 6 months were prospectively included between 2014 and 2018. All patients were treated using a VPS with adjustable differential pressure valve and a fixed gravitational unit. Head circumferences and transfontanelle ultrasonographic VS measurements were regularly performed. Higher or lower pressure valve modifications were done when HC measurement was lower than the 10th percentile or when it exceeded the 90th percentile, respectively. The patients were divided into two groups: infants with hydrocephalus due to an intraventricular haemorrhage (IVH-H; n = 20), and infants with hydrocephalus due to other aetiologies (OAE-H; n = 23) and analysed separately.

Results: Overall 84% of 43 children needed pressure valve adjustments, 28% of them up-regulation, 28% down-regulation. The mean of pressure valve modification was 3.7 (±1.42 CI95) per patient in the IVH-H group, versus 2.95 (±1.41 CI95) in the OAE-H group. The median of last pressure valve was lower at 9 cm H2O (mean 8.1 ±1.62 CI95) in the IVH-H group comparing to 5 cm H2O (mean 5.56 ±1.29 CI95) in the OAE-H group. The median of last pressure valve was lower at 9 cm H2O (mean 8.1 ±1.62 CI95) in the IVH-H group comparing to 5 cm H2O (mean 5.56 ±1.29 CI95) in the OAE-H group. The median of last pressure valve was lower at 9 cm H2O (mean 8.1 ±1.62 CI95) in the IVH-H group comparing to 5 cm H2O (mean 5.56 ±1.29 CI95) in the OAE-H group. The median of last pressure valve was lower at 9 cm H2O (mean 8.1 ±1.62 CI95) in the IVH-H group comparing to 5 cm H2O (mean 5.56 ±1.29 CI95) in the OAE-H group.

Conclusion: Optimal VPS pressure valve values in infants can barely be predicted to gain normalisation of the HC and VS. However, after long term follow up and several pressure valve modifications, this normalisation is possible and seems that infants with IVH-H need a higher pressure valve comparing to infants with OAE-H.

PP41

Lateral fissure arachnoid cysts treated by microsurgical cystocephostomistenctomys-results of treatment

Marek Mandera1
Introduction: Controversies concerning indications for surgery and the optimal technique of arachnoid cysts treatment still exist. Most surgeons use the endoscopic technique; however, some prefer a microsurgical approach. The objective of the study is the presentation of our method and analysis of the results for children treated for lateral fissure cysts at our department.

Methods: We reviewed retrospectively 72 children treated microsurgically for lateral fissure arachnoid cyst between 2006 and 2018 at our institution. The most of patients were boys (82%). The mean age at the time of surgery was 6.3 years (ranged from 6 weeks to 18 years). There were 12 (16%) infants in the studied group. Forty-six cysts (64%) were on the left side. Twenty-one (29%) cases were classified as grade II and 51 (71%) as grade III cyst. 47 (65%) patients were symptomatic, and in 25 (35%) cases, the cyst was revealed incidentally. The mean follow-up was 4.3 years (ranged 9 months-11.5 years).

Results: The outcome was estimated using clinical and radiological criteria. We found the treatment as successful if the symptoms released and/or the cyst and compression of neural structures decreased in MR, performed not earlier than 3 months after surgery. We also estimated if the flow void in the stomy was seen in T2 scans. We obtained the release of the symptoms or significant clinical improvement in 40 (85%) patients. The cyst reduction was observed in 37 (69%) cases. In the next 9 patients (12%) significant reduction of mass effect despite the stable cyst volume was found.

Conclusions: Microsurgical cytocystocysternostomy made by microcraniotomy is an effective and safe method of treatment for lateral fissure cysts.

PP115

Codman caserta: Collaps of accuracy, loss of 8 of 18 pressure ranges, safety risks

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Introduction: In 2011 the Codman-Certas was launched, in 2013 recalled and in 2015 relaunched. We found in PubMed with Certas 8 und CertasPlus 3 papers only.

Methods: Since 1988 we tested in vitro 195 adjustable valves (34 new). 118 adjustable Medos, 12 Codman MicroValve (2 with SG), 41 Miehtke ProGAV, 2 ProSA, 13 Sophysa SU 843, 3 Polaris. Our clinical experience base on 1388 adjustable valves in 1127 patients. We analyzed Certas spezimen, 5 Certas-patents, company-data and related literature.

Results: In contrast to the excellent precision of the adjustable Medos (+10 mmH2O) Certas offers fifefold poorer tolerances (+20 to +50 mmH2O). Eklund (2012) measured in range 400 mmH2O even deviations of 51-156 mmH2O. - The 18-stepped Medos allows a subtile fine regulation. Certas has only 7 steps, 3 of those in the seldom used high pressure (145-215 mm). - Safety: During chamber puncture the tip of a needle can penetrate the valve mechanism. - With stronger magnets it is possible to elevate the rotor and to adjust in every position. - Interferences with Smartphones, Tablets and even switch-off (Ozturk 2017) are described in 4 papers.

Conclusions: CertasPlus has solved the Medos-problems of X-rays after adjustments. The price is a deterioration of precision, loss of fine tuning options and safety deficits (missing needle guard; disturbance by electromagnetic apparat). In iNPH-patients the risk of cSDHs counted with Certas 16.7% (Sundström 2017)

PP116

The adjustable Kuffer-Strub-valve in Bern 1969

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Objective: The two earliest designs and clinical trials of adjustable valves are seldom citated and unknown in neurosurgery. The first was a magnetic hold ball-valve, constructed by Vannevar Bush (MIT) in cooperation with Donald Matson, which was implanted in Boston from the early fifties up to 1957 in 18 patients. The second valve was built, implanted in 3 children and patented by Francois Kuffer and D.Strub in Bern 1969.

Material and Methods: The valve-related literature (577), patent-lists (>50) and catalogues of 28 shunt-manufacturers were evaluated exhaustive for historical valves, prototypes and designs. Personal communications of Pudenz, Schulte, Holter, S.Hakim, Portnoy, Scott, Kuffer and others supplemented the rechere. We received one new and one Kuffer-valve explanted after 6 years.

Results: The Kuffer-Strub-valve is a cone-in-cone valve in a slim cylindric polyphenylenoxid body. A screw allowed an individual adjustment of the tension of the spring pre implantation or during a revision. In addition the valve contains 2 conic screw-connectors, to avoid the problematic ligations (Schweiz. Pat Nr.496445,1969; US-patent 3.674,050,1972). After 3 successful implantations the valve was offered the Extracorporeal company in USA, who “feel that we are not justified in spending monies […for this device…” (1.Nov.1972). The exact same concept of open adjustment with a screwdriver was published in 1973 by S Hakim, who patented 4 design variants (US-patents 4,551,128; fig 2-5; 1985). The variant 6 shows a rotating magnet and is a direct precursor of the Sophy-and Hakim-Medos-patents 1983-84. Portnoy and Schulte inaugurated the palpatoric switchable On-Off-valve in 1973, Harris and Cordis a palpatoric two-way valve in 1976 (US-Patent 3,985,140).

Conclusions: In 2019 at least 10 different adjustable valves (18 variants) are available on the market. Including 5 historical models and 20 prototypes we count at least 35 valves

PP133

Surgical options and functional outcome in symptomatic temporal arachnoid cysts

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Objective: Arachnoid cysts (ACs) are rare and typically located in the middle cranial fossa. ACs become symptomatic with signs of increased intracranial pressure, but the clinical spectrum is diverse. So far there is no clear recommendation of whether and how (microsurgical or endoscopic fenestration, cyst shunts) symptomatic ACs should be treated.

Methods: 33 children (29 boys, 4 girls; mean age 8.3 years) operated for a symptomatic temporal AC between 1995 and 2019 were retrospectively analysed. Chart review and postoperative quality of life assessment (SF-36, KINDL®, GBI, GCBI) was performed. Cyst volume was measured with HorosTM software. Clinical outcome was graded into four subgroups (free of symptoms, improved, unchanged, worse). Written consent from the caregivers as well as an ethical approval was obtained.

Results: There were 4 Galassi type I, 4 type II and 25 type III cysts; 13 on the right, 18 on the left and 2 on both sides. Mean follow-up time was 44.5 months. 8/33 became symptomatic with posttraumatic cyst rupture
and bleeding. 20/33 complained of headaches, 13/33 had non-specific symptoms, 5/33 had epilepsy. Cyst volume varied from 10 to 325.8 cm³ pre- and from 2.4 to 201.1 cm³ postoperatively. Microsurgical fenestration was performed in 25/33, endoscopy in 7/33 and shunt insertion in 1/33. 24/33 (72.7%) patients were symptom-free at >6 months follow-up, 4/33 were clearly improved (12.1%), 5/33 (15.2%) were unchanged. Four patients required repeat surgery for insufficient cyst drainage, one after microsurgical fenestration, 2 after endoscopy and one after an internal shunt. Two subdural hygroma/hematoma required surgical intervention. Subdural effusions resolved completely without intervention in 14/33.

Conclusion: It can be challenging to select the right surgical candidate in temporal ACs. The long-term outcome is favourable in more than 80% of the patients. Microsurgical fenestration seems to be more effective in cyst drainage than other surgical options.

PP196

A single center experience of using fixed pressure gravitational shunts in the treatment of pediatric hydrocephalus

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Introduction: We describe an observation study with a single centre experience of fixed pressure gravitational shunts in the treatment of pediatric hydrocephalus.

Material: During August 2008 - December 2019, 116 gravitational ventriculo-peritoneal shunts were implanted (112 Pedi-GAV and 4 GAV valves, Christophe Mietheke GMBH and Co KG, Potsdam, Germany) in 90 hydrocephalic children (41 males). New shunts were 69 of the 116 operations, 24 in the first year of life. Mean age at implantation was 53 months (range: 1.7-213). Mean follow-up was 41.2 months (range: 1-92). Cause of hydrocephalus was IVH in 24, tumour in 38, infection in 7, Dandy Walker syndrome in 2, vascular (AVM, vein of Galen) in 3, congenital pathologies and aqueduct stenosis in 7, spina bifida in 2, and Chiari I in 2, anachondyst cyst in 3.

Results: Among the 116 implanted valve systems there were 35 obstructions (30.1%), 5 infections (4.3%), 7 underdrainage (previous CSF infection, the opening pressure of 4 cm H20 was too high to be tolerated) and 5 case of overdrainage (slit ventricles, history of differential pressure as the first valve in the neonatal period). Of the 35 obstructions 14 (12%) were due to ventricular catheter malposition (replaced in the first few days after surgery). Hence, the true valve system obstruction rate was 18.1%.

Discussion: The midterm result of the use of gravitational valves in pediatric hydrocephalus is satisfactory, with a low early complication rate and no significant late side effects.

POSTER TRACK 1.4: Hydrocephalus II

PP4

Transient obstructive hydrocephalus of an infant following mild head injury: Case report

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Introduction: Head injuries in infants are usually asymptomatic. We describe a case of an 11-month-old patient with transient acute obstructive hydrocephalus following mild head injury.

Case Report: We report the case of an eleven month-old girl who suffered repeated episodes of vomiting caused by mild head trauma. At the admission, she was neurologically intact but one hour later she became deteriorated and drowsy, presenting with the “setting sun sign”. The brain CT scan revealed acute obstructive hydrocephalus at the level of aqueduct and the child urgently underwent an external ventriculostomy placement in order to control the intracranial hypertension. The neurological signs and symptoms, as well as the imaging, rapidly improved after surgery. Two-year follow-up revealed an absolutely normal psychomotor development of the child.

Discussion-Conclusion: Transient acute obstructive hydrocephalus in children is a very rare entity and its pathogenesis remains unclear. However mild head trauma could offer a viable pathogenetic mechanism for such a rare pathology.

PP16

The cerebral surfactant system - An overview presentation

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I like to give a overview-presentation on the current work published on the cerebral surfactant system and its relation to hydrocephalus:

14. Schob S, Lobisien D, Friedrich B, Bernhard MK, Gebauer C, Dieckow J, Gawlitza M, Pirlich M, Saur D, Bechmann I, Braeuer L, Hoffmann KT, Nestler U, Preuss M. “The Cerebral Surfactant System and it’s alteration in hydrocephalic conditions” PLOS One 2016 Sep 22; 11(9): e0160680 (IF 3.074).

15. Schob S, Dieckow J, Fechenbach M, Peukert N, Weiss A, Kluth D, Thome U, Quäschling U, Lacher M, Preuß M. “Occurrence and colocalization of surfactant proteins A, B, C and D in the developing human CNS” Frontiers Aging Neurosci 2017 Jan 4; 8: 324. (IF 4.348).

17. Krause M, Peukert N, Härtig W, Emmer A, Mahr CV, Richter C, Dieckow J, Puchta J, Pirlich M, Hoffmann KT, Nestler U, Schob S, Lobsien D, Friedrich B, Bernhard MK, Gebauer C, Pirlich M, Voigt P, Sunov A, Hoffmann KT, Quäschling U, Preuß M «Correlations of Ventricular Enlargement with Rheologically Active Surfactant Proteins in Cerebrospinal Fluid» Mol Neurobiol. 2017 Dec 27. doi: 10.1007/s12035-017-0835-5 (IF 5.076).

27. Schob S, Wöß A, Dieckow J, Richter C, Pirlich M, Voigt P, Sunov A, Hoffmann KT, Quäschling U, Preuß M »Correlations of Ventricular Enlargement with Rheologically Active Surfactant Proteins in Cerebrospinal Fluid in Cranial Magnetic Resonance Imaging. Mol Neurobiol. 2017 Dec 27. doi: 10.1007/s12035-017-0835-5 (IF 6.19).
examine the changes of surfactant protein concentrations in CSF of preterm babies suffering from intraventricular hemorrhage.

**Patients and Methods:** Consecutive CSF samples of 21 preterm infants with intraventricular hemorrhages (IVH) and posthemorrhagic hydrocephalus (PHHC) were collected at primary intervention, after 5-10 days and at time of shunt insertion approx. fifty days after hemorrhage. Samples were analyzed for surfactant proteins A, B, C and G by ELISA assays and the results were compared to 35 hydrocephalus patients (HC) without hemorrhage and 60 control patients.

**Results and Discussion:** Premature patients with IVH showed a significant elevation of surfactant proteins SP-A, C and G compared to HC and control groups: mean values for the respective groups were SP-A 4.19 vs. 1.08 vs. 0.38 ng/ml. Mean SP-C 3.63 vs. 1.47 vs. 0.48 ng/ml. Mean SP-G 3.86 vs. 0.17 vs. 0.2 ng/ml. SP-A and G concentrations were slowly falling over time without reaching normal values. SP-C levels declined faster following neurosurgical interventions and reached levels comparable to those of hydrocephalus patients without hemorrhage.

**Conclusion:** Intraventricular hemorrhages of premature infants cause posthemorrhagic CSF flow disturbance and are associated with highly significant elevations of surfactant proteins A, C and G independent of total CSF protein concentrations.

**PP121**

Bilateral optic neuropathy and loss of vision in a 11 year old girl with a 4th ventricle choroid plexus papilloma: A case report

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**Introduction:** Optic atrophy is a term used to describe the end-point of the optic nerve degeneration. This damage of the nerve fibres can occur along any section of their course from the retina to the lateral geniculate body. Hydrocephalus resulting from CSF overproduction or flow obstruction, as in a choroid plexus papilloma, can lead to elevated intracranial pressure and subsequently prolonged papilledema and optic atrophy.

**Methods:** A 11 year old girl was submitted to our clinic with reported visual defects (strabismus and astigmatism). Opthalmic examination had revealed papilledema and MRI had showed a 4th ventricle tumor causing hydrocephalus and shifting brainstem and cerebellum. An external ventricular catheter had already been urgently placed in another hospital. After admission, a middle suboccipital craniotomy and removal of the tumor was performed.

**Results:** Following the operation, there was a longterm ICU hospitalisation because of various complications (pulmonary infection, fever, epileptic seizures and difficulty in airway maintenance). Despite removal of the tumor, hydrocephalus remained so a Ventriculoperitoneal shunt was finally inserted. However, visual acuity tested postoperatively was found disturbed. Ophthalmic exam demonstrated total amaurosis and bilateral optic disc pallor.

**Conclusion:** Hydrocephalus management in a young patient with established visual defects considered not so major, such as strabismus, may not always prevent optic neuropathy and its negative consequences in the sense of vision. Early evaluation of symptoms from the ophthalmologist and tumor resection are crucial.

**PP154**

Brain herniation into the subdural space: Rare iatrogenic complication following treatment of a giant calcified subdural hematoma

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**Introduction:** Chronic subdural hematoma (CSDH) with dural calcifications (“armoured brain”) in previously shunted patients is a rare condition, especially in pediatric population. Following surgical treatment, opening of the cortical membrane can lead to progressive brain herniation into the subdural space due to brain re-expansion. Only few cases are reported in literature.

**Methods:** We describe presenting symptoms, radiological findings, surgical treatment and outcome of a case treated in Department of Pediatric Neurosurgery of Santobono Children’s Hospital.

**Results:** A 15 yo boy previously shunted for congenital hydrocephalus, presented with a 9-month history of severe headache. At presentation he had severe macrocrania (67cm) and neurological examination showed drowsiness, speech delay, bilateral Babinski. CT showed a giant right hemispheric CSDH (13x7 cm) with 5cm midline shift. He underwent in emergency drainage of the CSDH through a right frontal craniotomy, allowing drainage of a large amount of pultaceous material and drainage placement. CT scan showed only partial evacuation of collection. One day later he underwent replacement of the existing valve with an externally adjustable valve set at high pressure, followed by enlargement of craniotherapy with evacuation of the residual CSDH. The cortical membrane was partially opened following extensive dissection and removal of the calcified shell. However, serial radiological exams showed fluid reaccumulation in the subdural space and cortical herniation of the parietal lobe through an opening of the internal calcified membrane, accompanied by upper limb weakness and vomiting. Therefore, the patient underwent a rightsubduro-peritoneal shunt, Y connector with previous VP Shunt, redo of hematoma associated with further peeling of visceral calcified membrane. The patient experienced a gradually clinical improvement consistent with a substantially decrease of CSDH.

**Conclusions:** This case illustrates a rare complication of treatment of CSDH. The extensive peeling of the calcified neomembrane is mandatory in order to prevent brain strangulation and neurological complications.

**PP165**

Low or negative pressure hydrocephalus in complex paediatric posterior fossa tumour patients

**Springer**
**PP42**

**Endovascular treatment of deep-seated AVM coexisting with DVA sharing the same outflow in 7-year-old boy**

Kirsten Van Baarsen, Tymon Skadorwa, Kristoffer Kędziołka, Mikolaj Eibi, Marcin Roszkowski

**Introduction:** The co-existence of an arterio-venous malformation (AVM) with developmental venous anomaly (DVA) is a very rare phenomenon in pediatric population. A combination of deep-seated AVM and DVA sharing the same venous outflow promotes endovascular treatment but raises technical problems regarding the possibility of complete exclusion of AVM from circulation without the occlusion of DVA venous drainage.

**Methods:** We present a case of a 7-year-old boy with a ruptured AVM of the right medial temporal lobe, treated endovascularly with retrograde venous access embolization. Diagnostic imaging revealed in the AVM area the presence of DVA with a single AVM-DVA common outflow to the vein of Galen. During the procedure a balloon was placed in the M1 segment of the right middle cerebral artery (R-MCA) in front of the lenticulostriate perforators. From the venous side via left internal jugular vein, the vein of Galen was reached and two microcatheters were placed in the AVM nidus.

**Results:** The AVM venous outflow was closed with coils in order to protect the DVA from occlusion of the main venous trunk. Subsequently, using a second microcatheter, the AVM nidus was filled with liquid Onyx 18 embolization material from the venous side thus closing the venous outflow, the nidus and arterial anastomoses. During retrograde AVM nidus embolization, a balloon in R-MCA was opened to reduce the arterial inflow, to improve polymer penetration in the nidus from the venous side, and to control the filling of arterial feeders. Control arteriography confirmed the complete occlusion of AVM with preserved DVA drainage.

**Conclusion:** The combination of vascular malformations (AVM+DVA) in children may be successfully treated by means of endovascular embolization. A retrograde venous access provides an adequate and safe approach in unusual combination of deep-seated temporal AVM and DVA.

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**PP43**

A rare case of hemorrhagic stroke following cerebral venous sinus thrombosis in 13-year-old girl with ulcerative colitis

Tymon Skadorwa, Krzysztof B. Kędziołka

**Introduction:** Venous hemorrhagic stroke is a rare complication of cerebral venous sinus thrombosis (CVST) in children. In turn, CVST is an...
unusual presentation of a systemic inflammatory disease such as ulcerative colitis (UC). The coexistence of these two conditions produces diagnostic confusion regarding the origin of intracranial bleeding.

**Methods:** We present a case of 13-year-old girl with UC diagnosed for a spontaneous intracranial hemorrhage to the right occipital lobe. She complained about headaches and nausea but was neurologically intact. Her UC status was stable, with no flares in last 6 months. Differential diagnosis included the bleeding from a vascular pathology (arteriovenous malformation, cavernous malformation) or an underlying tumor.

**Results:** MR spectroscopy excluded brain tumor and CT angiography did not show any vascular pathology. The girl was treated conservatively and on the day 14 a complete resolution of a clot was noted. A sudden L>R anisocoria provoked a fundoscopic exam, which showed bilateral papilledema. In MR venography a CVST was diagnosed. The patient was treated with therapeutic doses of heparin with good neurologic and radiologic outcome.

**Conclusion:** CVST is a rare finding in UC patients. It may manifest as a spontaneous intracerebral bleeding of venous origin and therefore should be considered in children with systemic inflammatory diseases.

**PP93**

Surgical treatment of arteriovenous malformations in the pediatric population

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**Introduction:** An arteriovenous malformation (AVM) is a pathological condition characterized by the direct connection of arteries and veins. AVMs are high-flow formations.

**Methods:** We present a retrospective review of six pediatric patients who underwent surgical treatment of cerebral AVMs at our Department from January 2011 to December 2014. Following craniotomy, an arcutate durotomy was performed and the blood vessel malformation was verified. Upon identification of the cerebral arteries feeding the AVM, a temporal clip was placed on the branch of the supplying artery. The feeder was then coagulated and cut. Lastly, the draining vein was reconstructed and coagulated. The malformation nidus was completely removed en bloc and submitted for histopathological analysis.

**Results:** During a four-year period, six pediatric patients with a diagnosis of cerebral AVM were treated at our Department. Five patients (83%) were female. The average age was fourteen years and eight months. The leading symptoms were headache and impaired avidity. The most common location (in 50% of the patients) of the AVM was in the supratentorial region of the frontal lobe. An AVM rupture was verified in three out of six patients. Preoperative diagnosis involves endocranial MSCT, endocranial MRI and cerebral DSA. Osteoplastic craniotomy and AVM ablation were done in five of the six patients. The early postoperative course was uneventful in 50% of the patients. Late follow-up showed normal neurological status in five of the six patients. Only in one patient an assessment of neurological efficacy in the early and late postoperative course showed a persistent hemiparesis. Follow-up neuroangiography included brain MRI and MR angiography. In all patients, follow-up endocranial MRI and MR angiography showed a satisfactory postoperative status.

**Conclusion:** Surgery, one of the options for treating AVMs in the pediatric population, shows excellent results, especially in the treatment of patients with a ruptured AVM.

**PP97**

Intracranial complex aneurysm clipping in a 8 months old boy

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**Introduction:** Intracranial aneurysms are extremely uncommon in the pediatric population, even more so in infants. They tend to have irregular morphology and an increased risk of bleeding than in adulthood.

**Methods:** An 8 months infant was admitted to the Emergency department presenting vomiting and drowsiness. On examination a right hemiparesis was found. This hemiparesis was recovered one week later. CT scan revealed a massive left sylvian haematoma with subarachnoid hemorrhage. Angiography showed a complex left M2 saccular aneurysm with 2 small and 1 one large artery emerging from the sac.

**Results:** The patient did not undergo endovascular therapy because of the high risk of efferent arteries occlusion. The 3D angiographic study showed distal anastomosis of the 2 small efferent arteries with branches from the M2-M3 segment. One month after the onset of the stroke the infant was operated. A microsurgical dissection, guided by electromagnetic navigator, was performed through the intact brain tissue to reach the aneurysm. The 2 small efferent arteries were coagulated and finally a curved clip was implanted keeping the distal blood flow. The patient recovered perfectly after the surgery with no new neurological deficit and was discharged home 1 week later.

**Conclusions:** Preoperative analysis of the 3D angiography is essential to plan accurate surgical approach. Neuronavigation system is useful in cases where the anatomy is distorted by a previous hemorrhage. Bypass surgery in infants is very difficult because of the size and the fragility of the vessels.

**PP162**

Spontaneous deep intracerebral hemorrhage without any profound underlying structural abnormalities. Was AVM the offending pathology?

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**Introduction:** Brain AVMs are abnormal connections of venous and arterial systems without intervening capillary network. They occur in less than 1,5% of the population and the most common clinical presentation is intracranial hemorrhage, followed by seizure, headache and focal neurologic deficits. Spontaneous angiographic regression has been seen in less than 1,5%.

**Methods/Results:** We report the case of a 3.5 years old toddler who was admitted due to an episode of generalized tonic-clonic seizures with concomitant right-sided hemiparesis, expressive aphasia. The CT scan revealed acute intraparenchymal bleeding located in the frontoparietal brain region, near the ventricular system, moderate degree of subfalcine herniation, perilesional edema and subarachnoid hemorrhage in the interhemispheric fissure. Due to refractory ICP the patient underwent a decompressive craniectomy, along with US-guided intraparenchymal blood clot evacuation. Postoperative MRI-MRA-MRV was unable to verify a vascular or other types of abnormality. A complete workup revealed no underlying bleeding disorders. During follow-up, her postoperative neurological status improved significantly. The DSA visualized
only an early draining vein in the vicinity of the hemorrhage which was nourished from a small diameter branch of the left pericallosal artery and was draining to the superior sagittal sinus. three months after the ictus, a repeat MRI–MRA–MRV revealed no pathology. Based on that evidence, the most common diagnosis was considered to be an unrecognized AVM which was thrombosed at the same time as its rupture.

**Conclusion:** Given the significant potential morbidity of any of the relevant available treatment modalities, spontaneous thrombosis should be regarded as a fortuitous event that may represent the most elegant resolution to a dangerous pathology. Additionally, although the diagnosis of a ruptured occult AVM should remain a diagnosis of occlusion, we should bear it in mind in cases of unknown etiology intracerebral hemorrhage, in which a comprehensive diagnostic work-up failed to distinguish any underlying disorder.

**POSTER TRACK 2.1: Dysraphism**

**PP35**

**Congenital pterional dermal sinus: Report of two cases**

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**Introduction:** Dermal sinus tract (DST) is an uncommon form of cranial or spinal dysraphism found along the midline of the neuraxis, from the nasion down to the sacral region. A lateral cranial origin is exceedingly rare, with very few cases previously published in the English literature. Herein, we describe two cases of pterional DST.

**Methods:** We present two patients affected of pterional DST and we describe our management based on a literature review through Pubmed Medline.

**Results:** Case 1: The patient is a 6-month-old girl with a “dimple” over a right temporal mass discovered shortly after birth. Magnetic resonance imaging (MRI) showed a high T2 signal tract in the right temporalis region, which appeared to extend from the skin surface to the middle cranial fossa. An elliptical incision was made around the skin dimple. A DST associated to a dermoid cyst, attached to the dura of the middle cranial fossa, was identified and excised.

Case 2: The second patient is a 16-month-old girl with a right temporal mass with signs of local infection. Spontaneous purulent drainage through a dimple located over the skin surface was noticed. MRI demonstrated a DST coupled with a dermoid cyst. The lesion was excised through a curvilinear skin incision centered on the tissue mass.

**Conclusion:** To date, seven cases of laterally positioned cranial DST have been reported in the literature. The embryogenesis of these lesions has not been adequately characterized but various hypotheses have been proposed. The presence of a cutaneous dimple on the forehead indicates the potential for an underlying DST. If a DST is suspected, a surgical microdissection and excision of the entire tract should be considered to prevent the risk of local soft tissue infection or meningitis.

**PP147**

**Giant anterior sacrococcygeal meningocele**

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**Introduction:** Meningoceles are rare neural tube defects usually herniating dorsally from the lumbosacral spine, although they rarely herniate ventrally. Their course is usually occult and diagnosis may be done in an advanced age in relation to other types of spina bifida, nevertheless without significant clinical consequences. The aim of this work is the presentation of a case with a giant anterior sacrococygeal meningocele, its treatment and its outcome.

**Methods:** The female patient, 16 years old, had been complaining for urine incontinence for the previous three months. On clinical examination, no neurologic deficit, bone deformity or cutaneous stigma indicative of meningocele was observed. A sizeable meningocele herniating anteriorly from the sacrococcygeal spine was depicted in the MRI of the lower spine, extending into the pelvis and pushing the pelvic viscera forward and downwards. The meningocele sac was free of nerve roots.

**Results:** Under continuous neurophysiological monitoring of the lower limbs we performed a laminectomy at the level of the sacrum. The dura was opened and the neck of the meningocele was identified. The cerebrospinal fluid was evacuated from the meningocele sac and the defect was closed in a watertight fashion using sealant matrix coated with fibrinogen and thrombin as well as fibrin sealant. Postoperatively, the symptoms improved markedly.

**Conclusion:** In the treatment of patients with an anterior meningocele, the identification of the defect and the watertight closure of the spinal canal are important. Continuous neurophysiological monitoring is necessary during the operation. Full recovery represents a feasible goal.

**PP163**

**Dermal sinus tract associated with dermoid cyst and intramedullary abscess of the conus medullaris to an 11-month infant**

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**Introduction:** The incidence of intramedullary tumors of the spinal cord is 2–4% of all central nervous system tumors. Intraspinal dermoid cysts are less than 1% in incidence, commonly seen in extradural location in lumbar area. They are usually associated either with lumbar spinal dysraphism or a dermal sinus tract.

**Methods-Results:** We present the case of an eleven-month-old boy who was operated because of an open dermal sinus tract with associated dermal hemangioma in the lumbosacral area. The patient’s MRI revealed syringomyelia throughout the conus medullaris and an edematous cystic type lesion within, extending from L3-S2 vertebrae approximately of 11mmx49mmx10mm, with ring enhancement after the administration of paramagnetic substance. The patient was operated, and the dermal sinus tract was totally removed. It is noteworthy that after the myelotomy, pus along with hair and sebum were discharged, resembling a dermoid cyst. The 48-hour post-operative MRI revealed the complete evacuation of the abscess, along with the elements composing the intramedullary dermoid cyst. After a four-week post-operative course of intravenous antibiotics, his neurological and medical status was improved. The follow-up MRI after three months was unremarked.

**Conclusion:** Dermal sinus is an epithelium-lined track, which extends inward from the skin surface for varying distances and often connects the body surface with the central nervous system or its coverings. The patients become symptomatic due to infection or because of compression of adjacent neural structures. Spontaneous rupture of the dermoid cyst can
result in ventriculitis and meningitis. Dermoid is most frequently seen in dorsolumbar area (75%) out of which 63% have intradural extramedullary location and 38% intramedullary location. Intramedullary dermoid cyst usually presents late in 2nd or 3rd decade of life with significant neurological compromise. In the presence of a dermal sinus, presentation becomes early due to sinus discharge and infection, as it occurred in our patient.

**PP172**

*Treatment with negative pressure in mielomeningocele cutaneous flap*

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Introduction: We present the case of an infant with lumbosacral myelomeningocele and infection of the cutaneous flap with *P. aeruginosa*, successfully treated by topical cures with a single-use negative pressure system PICO (Smith & Nephew).

Material and methods: We present the case of an infant with a history of polyomalformative syndrome (large lumbosacral myelomeningocele L2-S3, congenital hypothyroidism, unafiliated lymphopoeenia, nephrotic syndrome, right aberrant subclavian and vascular ring due to ductal closure). Surgery of myelomeningocele at 48 hours of life, covering the defect with rotational bilobar cutaneous flap. A ventricular-peritoneal shunt was placed on the fourth day of life. Daily wound cures were performed. There was evidence of superficial infection of the wound at 10 days after the intervention (border dehiscence and necrosis in the lower part). Positive wound cultures for *P. aeruginosa*, so antibiotic treatment was started first with piperaizilina-tazobactam and then with ciprofloxacin. After performing occlusive cures with epithelializer agents without good results, the wound team of our center was contacted and it was decided by consensus to apply a single-use negative pressure occlusive dressing (Smith & Nephew). With this system cures are performed every 72 hours for 3 weeks, accelerating the epithelialization of the wound by second intention and resolving the skin infection.

Discussion: In superficial wound infections, with a low risk of CSF fistula, dressings with a negative pressure system may be a valid alternative to conventional cures in selected patients. With these systems the process of epithelialization of wounds is accelerated and the risk of bacterial contamination of them is reduced.

Conclusions: Negative pressure systems can be a good alternative to conventional cures in Neurosurgery in patients with wounds in which healing by second intention has occurred and in which the probability of CSF fistula is low.

**PP174**

*Anterior sacral meningocele: Posterior approach with wall plication*

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Introduction: Anterior sacral meningocele is a rare lesion. It is the result of a defective formation of the caudal cell mass, so it is frequently associated with other urogenital or anorectal malfor-mations. In the absence of any other syndrome, the symptoms of the anterior sacral meningocele are very subtle: low back pain, headache in relation to postural changes or recurrent meningitis. Usually, patients have symptoms related to the mass effect: constipation, urinary retention, abdominal pain, dysmenorrhea and other gynecological problems. Motor and sen-sory alterations in lower limbs occur rarely.

Material and methods: A 15-year-old patient with Currarino syndrome, who underwent rectoperitoneal fistula-type malformation surgery at 8 months of age, without subsequent complications. Referred to our center because during the study of dysmenorrhea, a large pelvic mass of 18x13 centimeters was detected by ultrasound. Lumbar spine MRI showed a large anterior sacral meningocele, with no neural content, no other spinal cord abnormalities and no pelvic teratoma. The pa-tient did not present any other symptoms. A trans sacral approach was performed, with evacuation of the meningocele content and plication of its walls to close the communication between the dural sac and the meningocele, given the impossibility of dissecting the neck of the malformation for ligation.

Discussion: The gold standard diagnostic test of the anterior sacral meningocele is MRI which can also reveal other associated anomalies (lipoma, dermoid cyst, pelvic teratoma, tethered cord or other) and detail its content.

Conclusions: In the posterior approach a laminectomy is performed and the communication area between the proximal dural sac and the meningocele is closed. Anterior approach or mixed approaches have also been described for large meningoceles with a slightly higher risk of complica-tions. We present a case in which a posterior approach was designed, with plication of the walls and complete exclusion of the lesion.
surgery but also hemivertebra resection and deformity correction at the same time.

**POSTER TRACK 2.2: Neuro-oncology I**

**PP5**

Endoscopic assisted transcallosal approach for SEGA vs everolimus: a case report

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**Introduction**: Subependymal Giant Cell Astrocytoma is the most common central nervous system tumor in patients with tuberous sclerosis complex. Surgical resection is the standard treatment for SEGA. However, not all tumors are amenable to safe and complete resection. Newer mTOR therapy has demonstrated promising results.

**Methods**: A female of 9 years old with controlled epilepsy, mild neurodevelopment disorder, and normal clinical evaluation has been followed up with MRI every two years. Last control showed a tumor increased in size, located at the left foramen of monro. There was no signs of ventricular enlargement or invasion of white matter structures. Surgical resection by an endoscopic assisted transcallosal approach was indicated.

The procedure consisted on performing a small craniotomy (4 x 4 cm) using a transverse skin incision. After dural opening, the surgery was performed using a rigid high definition endoscope and other standard endoscopic instruments.

**Results**: There was not any neurological impairment associated with the procedure. The patient was discharged five days after the surgery. At 6 month follow up, MRI showed complete tumor removal.

**Conclusions**: Newer mTOR therapy has demonstrated promising results in recent clinical trials. However, some of the disadvantages includes tumor recurrence after drug discontinuation. This can determine lifelong treatment to be required for some patients. Long term side effects are little known when chronically administered for decades or more. We reserve everolimus for multiple lesions, when showing invasion of internal capsule, caudate nucleus or thalamus, or history of prior resections with anatomical distortion on scanning. The endoscopic assisted inter hemispheric approach provides a cistern to ventricle route instead of parenchyma to ventricle in transfrontal approach. Minimized retraction, minimal dissection of the interhemispheric fissure, improved illumination and field of view were important issues to prevent cortical damage and subsequent neurological deficits.

**PP21**

Advantages and indications for the use of transsphenoidal endoscopic access to tumors of the skull base in children

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**Introduction**: Tumor of the chiasmal-sellar region is a frequent phenomenon in pediatric neurosurgical practice. Despite its benign structure, the tumor is aggressive, prone to recurrence, high risk of endocrinological and ophthalmological disorders, as well as leading to a violation of the flow of mental processes in the child. The main goal of surgical treatment of this pathology is the maximum total removal of the tumor with the preservation of vital vascular and nerve structures. Increasingly, transsphenoidal endoscopic access is used as an alternative to transcranial microsurgery.

**Discussion**: The incidence of epidermoid tumors is between 1% and 2% of all intracranial tumors. The usual locations of epidermoid tumor are the parasellar region and cerebellopontine angle, and it is less commonly located in suprasellar region. Epidermoid cysts located in the brain stem are rare.

**Methods**: The first patient, a 25-y/o woman admitted with symptoms of intracranial hypertension and the MRI showed a large suprasellar-intraventricular epidermoid cyst compressing the third ventricle and brainstem. Endoscopic intraventricular aspiration, partial capsular removal and additional ventriculo-cisternostomy was performed. The second patient, a 20-y/o woman with lumbar pain admitted and the MRI showed a tethered cord to L5 level. Further brain MRI showed an intrinsic anterior brainstem epidermoid cyst. Aspiration of the cyst and partial capsular removal was realized by transsphenoidal endoscopic approach through partial resection of clivus.

**Results**: The incidence of epidermoid tumors is between 1% and 2% of all intracranial tumors. The usual locations of epidermoid tumor are the parasellar region and cerebellopontine angle, and it is less commonly located in suprasellar region. Epidermoid cysts located in the brain stem are rare.

**Conclusion**: In General terms, we came to the conclusion that safe, maximal-ly sparing the hypothalamus resection provides very good tumor control while minimizing severe deficits. The air spaces of the nasal cavity and the sphenoid sinus form a convenient corridor for the approach to the neoplasm of the skull base using transsphenoidal access. The safety of this access depends on the sphenoid sinus and the anatomy of the base of the patient’s skull. There are individual differences in the degree and nature of pneumatization of the sphenoid sinus. Endoscopic technique minimally traumatizes cerebral structures, which is especially important in the neuropsychological prognosis of the child and his adaptation to the educational environment.

**Conclusions**: Thus, we recommend treatment of this pathology in centers with extensive experience of these operations and emphasize the importance of long-term follow-up, especially given the high frequency of relapses and complications in benign disease that affects a young group of patients.

**PP25**

Endoscopic approach for suprasellar and brainstem epidermoid cyst – Video presentation

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**Introduction**: The incidence of epidermoid tumors is between 1% and 2% of all intracranial tumors. The usual locations of epidermoid tumor are the parasellar region and cerebellopontine angle, and it is less commonly located in suprasellar region. Epidermoid cysts located in the brain stem are rare.

**Methods**: The first patient, a 25-y/o woman admitted with symptoms of intracranial hypertension and the MRI showed a large suprasellar-intraventricular epidermoid cyst compressing the third ventricle and brainstem. Endoscopic intraventricular aspiration, partial capsular removal and additional ventriculo-cisternostomy was performed. The second patient, a 20-y/o woman with lumbar pain admitted and the MRI showed a tethered cord to L5 level. Further brain MRI showed an intrinsic anterior brainstem epidermoid cyst. Aspiration of the cyst and partial capsular removal was realized by transsphenoidal endoscopic approach through partial resection of clivus.

**Results**: The incidence of epidermoid tumors is between 1% and 2% of all intracranial tumors. The usual locations of epidermoid tumor are the parasellar region and cerebellopontine angle, and it is less commonly located in suprasellar region. Epidermoid cysts located in the brain stem are rare.

**Conclusion**: The endoscope-controlled technique enables a safe tumor removal without retracting vital neurovascular structures of brainstem.
Introduction: Transcranial access in the treatment of tumors of the chiasmal-sellar region implies extensive combined defects, which can subsequently lead to the development of life-incompatible complications. According to some authors, the use of transsphenoidal endoscopic access in children is not advisable, has a number of features and disadvantages.

Materials: 20 patients with tumors of the chiasmal-sellar region. Age from 5 to 17 years (med 12.5). Two groups were identified: using endoscopic transsphenoidal access (6 patients), transcranial access (14).

Results: Cranioraphyngiomas prevailed (60%). In the preoperative period, the clinical picture was presented: hypertension-hydrocephalus syndrome (10 (50%)), chiasmal syndrome (1 (5%)), paroxysmal syncope (2 (10%)), neuroendocrinological syndrome (5 (25%)), delayed sexual development (3 (15%)), visual impairment (20 (100%)).

Removal of tumor from pterional access in 4 (23%) patients, subfrontal (7 (40%)), transcallular (3 (17%)). Total tumor removal in the first group - 4 (67%), in the second-6 (42%).

In the postoperative period in group 1, regression of hypertension-hydrocephalus syndrome was observed, improvement of visual functions in 15 patients (67%), in the second-6 (42%). The duration of anesthesia and surgery, a large volume of skull defect, the predominance of intraoperative blood loss were observed in the second group.

Conclusion: The most favorable rehabilitation prognosis in children is the use of endoscopic transsphenoidal access in the treatment of chiasmal-sellar tumors. Minimal discomfort for patients after this surgery is associated with a reduction in hospital bed days after surgery. Endoscopic transsphenoidal access provides better opportunities for total tumor removal and improvement of visual and endocrine functions.
Object: Cervico-thoracic dissociation of the spine is a rare congenital condition while having major impacts on stability and neurological function. Surgical treatment includes potential decompression as well as instrumented spinal fusion. Only few cases of cervico-thoracic dissociation have been reported in children. This report intends to demonstrate the complexity of this condition and its surgical management options based on two cases.

Methods: Children with cervico-thoracic dissociation underwent instrumented occipito-thoracic fusion. Timing and options of surgical management are discussed including an overview of the literature.

Results: Two patients, aged 9 and 12 were treated. The first patient presented with asymmetric chronic weakness of the upper extremity and unstable neurogenic bladder. Imaging showed a cervico-thoracic dissociation with severe distortion of the posterior facets and a dysplastic spinal cord. The second patient presented with cervico-thoracic dissociation presented with mild spasticity and unilateral weakness of the upper extremity, being an independent walker with full bowel and bladder control. A low energy trauma (fall from his height) resulted in tetraplegia by increasing the amount of antero-posterior displacement. In this patient slow progressive Halo traction under close clinical control obtained a better sagittal alignment, followed by improvement of the neurological status. A Halo vest was then applied. Posterior decompression and an instrumented occipito-thoracic fusion were performed with abundant corticocancellous bone graft (iliac crest). The first patient underwent the same treatment sequence, without pre-operative Halo traction. The last follow up confirmed solid fusion and minor residual neurological impairment in both patients at 5 and 6 years post surgery.

Conclusion: Cervico-thoracic dissociation is a rare condition, which can be successfully managed by instrumented occipito-thoracic fusion. A sudden displacement with neurological deterioration may respond to careful progressive pre-operative Halo traction. Timing of occipito-thoracic fusion surgery remains a debate with respect to actual instability.

PP84

Spontaneous spinal epidural hematoma in an infant: A challenging diagnosis

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Introduction: Spontaneous spinal epidural hematoma (SSEH) is rare in children, specially in infants. The early recognition and treatment are crucial for reducing the severity of neurological deficits. In infants, the non-specific presentation of symptoms may delay the diagnosis and the decision-making process.

Methods: We report here a case of SSEH in a 5-month-old girl who initially presented with irritability, facial asymmetry and right hemiparesis. After a normal CT-Scan and CSF studies, a hypothesis of acute disseminated encephalomyelitis was done. After 07 days a Cervical magnetic resonance disclosed a large posterior epidural hematoma extending from C1-C5. There was no history of trauma and no evidence of coagulopathy.

Results: A emergency decompressive laminotomy was done at the same day of cervical MRI. Neurologic examination has showed a tetraparesis with maximum power of 2/5 at left arm. At surgery, upon laminotomy, an epidural hematoma was observed with no vascular abnormality. After evacuation the dural pulsation returned and hemostasis was completed with Surgicel. Laminotomy was closed with absorbable sutures. The patient had gradual improvement of her neurological status. 02 months later she had no neurological deficits.

Conclusion: The majority of SSEH occurs in the posterior aspect of spinal canal. The disproportion of the weight of the head to the body in infants with no head control may rupture the valveless epidural vein system at cervical spine (Lee et al). The occurrence of mild transient facial palsy in our case mislead the initial diagnosis and challenging the right approach. Early surgical decompression is the treatment of choice and laminotomy is a good option in children (Caldarelli et al).

PP101

Outcome of dermabondTM prineoTM for wound closure after intradural spine surgery in children – preliminary results of eight consecutive patients

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Purpose: Tissue adhesive glue is well established for the closure of wound lacerations and short surgical incisions in children. In adults DermaBondTM PrineoTM skin closure system (DPSCS), which consists of both tissue adhesive glue and a self-adhesive mesh, for closure of medium-length surgical incisions has been reported to enhance patient comfort and leads to good cosmetic outcomes. We aimed to investigate the outcome of DPSCS for spinal wound closure in children.

Methods: We prospectively collected data of all patients undergoing surgical repair of intradural spinal procedures, at our institution. Patients with revision surgeries or non-intrudural procedures were excluded. Patients’ demographic and surgical data were collected. Wound healing during hospitalization, at two weeks and three months follow-up were evaluated.

Results: We included 12 consecutive patients in this study. Two patients showed a minimal cutaneous dehiscence at one end of surgical incision, which was managed conservatively and healed with time. DPSCS was removed after an average of 13.9 days (IQR 12.5 – 14.3) by the surgeon (11/12 cases) or paediatrician (1/8 cases). In one case, an additional dressing was mistakenly placed on top of DPSCS, which led to an accidental removal of the DPSCS on the 10th postoperative day, however this did not affect wound healing. In another case, a cutaneous haemangioma adjacent to the surgical site was macerated due to the DPSCS requiring additional local care, while the surgical incision remained unaffected. There was no CSF leak or infection. All patients had satisfactory cosmetic outcome after three months. Two patients did not reach the 3-month follow-up yet.

Conclusion: Our preliminary results show that DPSCS seems to be safe and leads to satisfactory cosmetic outcome for spinal wound closure in children. Its simple application facilitated professional and parental care. Nevertheless, in cases of skin malformations, traditional skin closure might be more suitable.

PP108

Is it possible to use composite peek / carbon fiber implant for spinal bone tumors in pediatric population? A case report and literature review
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Background: Today treatment of spine bone tumors includes combination of surgery and radiotherapy more frequently: in metastatic disease, it has been accepted since long time and based on clinical evidence, in primary tumors, combination of surgery and radiotherapy can be considered in all the cases in which a satisfactory oncological margin cannot be achieved. However, metal implants are an obstacle in the collaboration between surgeons and radiation oncologists. Carbon-fiber-reinforced polyethylene–ether–ether–ketone (CFR-PEEK) composite implants can make the radiant treatment easier and more effective. In the literature, there are currently no works that evaluate the reproducibility of this system in a pediatric environment.

Case description: We present the case of a 13-year-old boy with metastatic Ewing sarcoma and secondary D11 somatic fracture with need for decompression and stabilization. We have decided a posterior approach and we have performed D11 laminectomy and D9-L1 stabilization with pedicles screws. We have used PEEK/CFR implant in order to make easier and more effective the post-operative radiotherapy. We had no complications, the patient was walking with bust in the second day after surgery, he had good pain control and he was discharged five days later. After a month, he needed radiotherapy treatment without planning problems.

Conclusions: The treatment of spinal bone tumors includes surgery and radiotherapy. CFR/PEEK implants facilitate radiant treatment, with possibility of a better outcome. Our case shows that it is possible to use these systems also in pediatric population, with a better synergy between treatments.

PP218

Cervical spine injuries in young athletes

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Introduction: Cervical spine injuries during sports activity are emergency situations and they need accurate resolution and treatment.

Aim: In this study an accurate presentation is made about records of such injuries and the indications of treatment. Then an analysis of various demographic features is performed.

Material-Method: This study included 40 cases of lumbar and thoracic spine injuries in amateur sportsmen (<30 years old), who were treated in General Hospital in a 4 years period, range of age was from 10 to 30 years and median age 23.5 years.

Results: The most common injuries occurred during team sports, sport-sea activity, motorsports and bicycle amateur sports accidents. Well organized and efficient health care appears to be essential during sport events.

Key words: trauma – spinal column – injuries – accidents – first health aid care – neurosurgery – spine surgery – traumatology – emergency medicine – sports

POSTER TRACK 2.4: Hydrocephalus III

PP15

Topical instillation of vancomycin lowers the rate of CSF shunt infections in children

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Introduction: Shunt surgery in pediatric patients still bears a significant risk of infection, in addition to mechanical complications of the shunt system. Antibiotic-impregnated periperaoperative and perioperative antibiotics have been extensively studied for their potential to reduce shunt infections. We examined the effectiveness of intrawound application of vancomycin powder during shunt surgery.

Patients and Methods: Patient records of 78 primary shunt implantations at a mean age of 40 months were reviewed. 52 patients (mean age 50 months) had been treated according to standard surgical and perioperative procedures (Std), whereas 26 patients (mean age 20 months) additionally had received topical application of vancomycin powder before wound closure (Vmc). Overall infection rate was 3.8%, in Std patients 5.8% and in Vmc patients 0%. The rates of CSF fistula and revision surgery were similar in both groups (5.8% vs 8% and 23.1% vs. 30%, respectively).

Conclusion: To the best of our knowledge, this is the first report on topical vancomycin instillation, indicating its efficacy for the prevention of shunt infection in pediatric patients. Further studies with a higher number of patients are needed to verify this finding.

PP33

Idiopathic spinal cord herniation associated to Chiari I malformation and hemihypertrophy

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Introduction: Idiopathic spinal cord herniation (ISCH) represents an uncommon diagnostic entity, mostly diagnosed in middle-aged and elderly females. We describe an extremely rare case of a thoracic ISCH associated to hemihypertrophy and Chiari I malformation (CIM) in a child.

Methods: We present an adolescent patient affected of an ISCH and we describe our management based on a literature review through Pubmed Medline.
Results: A 13-year-old girl of Caucasian origin was referred to our clinic for left hemihypertrophy and scoliosis. Spine MRI showed a thoracic spinal cord herniation and a CIM. Neurological examination revealed no pathological findings. Therefore, we adopted a conservative management and the patient remains asymptomatic 3 years after diagnosis.

Conclusion: Herniation of the spinal cord through a dural defect may occur spontaneously (idiopathic) or secondary to trauma and surgical procedures. Patients with ISCH may develop progressive thoracic myelopathy, presenting as either a Brown-Sequard syndrome or spastic paraparesis. MRI usually demonstrates a ventral or lateral displacement of the thoracic spinal cord. Management of this condition should be individualized for each patient.

The indication of surgery is strong in patients with progressive myelopathy, but asymptomatic patients can be followed closely.

Hernia, we present the first case of a pediatric patient affected of an ISCH in association with CIM and hemihypertrophy. Very few cases of CIM associated to hemihypertrophy have been previously published. The authors postulate that these two entities could share a common dysembryology of mesoderm. The etiology of the ISCH is not established but some studies have demonstrated that a congenital duplication of the dura can allow the herniation of the spinal cord through the inner dura. Therefore, we want to emphasize the importance of complete brain and spine imaging at diagnosis in all pediatric patients with hemihypertrophy, in order to detect additional congenital malformations.

PP39

Does a leaking external ventricular drain lead to an infected external ventricular drain?

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Objective: The insertion of an external ventricular drain (EVD) is one of the mainstays of temporary management of hydrocephalus; acquired infection of the drain is a significant cause of morbidity, often prolonging treatment of the condition.

We sought to determine whether there is an association between a drain leaking and it subsequently becoming infected in paediatric neurosurgical patients.

Materials and Methods: Prospective surveillance of all EVDs inserted by our unit from 1 January 2014 to 14th November 2019, in patients aged < 16yrs at the time of operation. All drains were inserted using a standard procedure, including peri-operative antibiotic prophylaxis and all patients were admitted to the regional neurosurgical unit for subsequent management.

For each procedure, data was collected on patient age, gender and whether the CSF was sterile at the time of insertion, if a CSF leak occurred and it subsequently became infected in paediatric neurosurgical patients.

Results: A total of 48 EVDs (22.9%) experienced a CSF leak; 19 EVDs (9.0%) developed an infection. There was no association between subsequent EVD infection and patient gender, age at time of insertion or whether there was a proven or suspected CSF infection at the time of insertion. 8 EVDs which experienced a CSF leak became infected, (16.6%); 11 EVDs which did not leak, developed an infection, (6.8%), p<0.05.

The relative risk of infection, following CSF leak from an EVD was 2.45, 95% confidence interval (1.05, 5.75).

Conclusion: Patients with external ventricular drains who experience a CSF leak are at increased risk of subsequent infection of their CSF compared to those who do not.

PP70

Hydrocephalus following posterior fossa tumour resection: unexplained development of shunt independence in three paediatric patients

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Introduction: Hydrocephalus is a common complication following posterior fossa tumour resection and many children go on to require definitive management in the form of a ventriculoperitoneal shunt. The pathophysiology of hydrocephalus in this setting is not fully understood and dependence on a shunt can be difficult to assess. We describe three children with post-operative hydrocephalus who went on to develop shunt independence.

Methods: A single-centre retrospective case series analysis was conducted on three paediatric patients (aged 1, 3 and 16 years respectively) who developed hydrocephalus following posterior fossa tumour resection.

Results: Two patients underwent resection of a posterior fossa pilocytic astrocytoma and one patient underwent resection of a medulloblastoma. At the time of initial resection, one patient underwent external ventricular drain (EVD) insertion and one underwent endoscopic third ventriculostomy. All three patients went on to require a ventriculoperitoneal shunt within a month of surgery due to post-operative hydrocephalus, associated with a pseudomeningocele in two cases. All three patients latterly required shunt removal and EVD insertion (in one case 2 months post-operatively due to radiotherapy-associated wound breakdown, and in two cases 5 years post-operatively for intra-abdominal infection). One of these patients underwent ICP monitoring which demonstrated shunt dependence, and again required a period of external ventricular drainage 6 months later due to wound infection. In all three cases, the EVDs were challenged by drainage elevation and the patients were found to be shunt-independent, remaining so at last follow-up.

Conclusion: These cases serve to emphasise that children managed with ventriculoperitoneal shunts following tumour resection may go on to develop shunt independence. This was discovered by challenging these patients’ EVDs prior to considering shunt re-insertion, and we therefore advocate this practice.

PP102

Complications in the treatment of pediatric hydrocephalus: A single center experience

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Introduction: Hydrocephalus occurs when there is a retain of CSF in the ventricles. A correct treatment is based on the insertion of a ventriculoperitoneal shunt (VPS) or on the use of endoscopic third ventriculostomy (ETV).

Methods: We reviewed all children treated at the Unit of Pediatric neurosurgery of the University Medical Centre Ljubljana from January 2016 to September 2019 for a newly established diagnosis of hydrocephalus.

Results: A total of 56 children have been treated. 9 have been successfully treated with ETV and 41 had a VPS insertion. We present the etiologies, the types of temporary drainage devices used, the additional
endoscopic procedures that have been performed beyond ETV, and the rate of shunt revision and infection.

**Conclusion:** VPS and ETV are both effective treatment of hydrocephalus. Every possible strategy must be adopted to reduce shunt related complications, particularly shunt insertion. Using ETV reduces the rate of shunt insertion, but its successfulness depends largely on the correct preoperative patients selection in well selected patients.

**PP203**

**CSF infections in children with hydrocephalus and ventricular shunts and drains**

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**Introduction:** CSF infections still represent a common complication of ventricular shunts and drains placement. **Methods:** A pediatric retrospective cohort study was performed to analyze the incidence of infections of CSF devices placed to treat hydrocephalus by neurosurgical team of Bambino Gesù Children Hospital (Rome, Italy) from January 2018 to August 2019. We included CSF shunts, ventricular catheters with closed subcutaneous reservoirs (not-connected VCSR), EVDs as tunneled ventriculostomies and VCSR connected to an external drainage system. We excluded community-acquired meningitis and encephalitis. Periprocedural prophylaxis was performed with Cefazolin.

**Results:** We observed 23 cases of CSF infection among 162 devices (14.2%). The incidence rate of CSF infection for 1000 device-days was 5.45 for overall EVDs (95%CI 5.32-5.59), 1.02 for not-connected VCSR (95%CI 1.0-1.05), and 0.59 for shunts (95%CI 0.58-0.60). Cumulative hazard of CSF infection at 30 days after device placement was 0.46 for EVDs (95%CI 0.19-1.08), 0.14 for not-connected VCSR (95%CI 0.06-0.31), 0.05 for shunts (95%CI 0.02-0.13) (log-rank test p=0.01). Median time of CSF infection onset was 13 days after device placement. The most common clinical features of infection were fever (52.1%) and local signs (34.7%) as CSF leak and hyperemia of catheter insertion site. Tests performed in the first 24 hours from the onset of CSF infection showed normal blood count, median C-reactive protein of 5 mg/dl, CSF median cell count of 133 cells/µl, glucose of 37 mg/dl and proteins of 82 mg/dl. The most common microorganisms isolated on CSF cultures were Staphilococcus Epidermidis (32%) and Pseudomonas Aeruginosa (20%). In cases of failure of systemic antibiotic therapy, we administered intrathecal antibiotic therapy in 7 of 25 cases (30.4%).

**Conclusion:** We recorded a lower incidence rate of EVDs infections compared to other studies, probably due to our extensive use of VCSR (as Rickham) connected to an external drainage system. Further research is needed to confirm this data.

**PP13**

An institutional pilot study on evaluating concerns and needs of parents’ caring for children with shunt-treated hydrocephalus

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**Objective:** Pediatric hydrocephalus often results in serious concerns and stress of involved parents and caregivers. Understanding their concerns and needs regarding communication, information, and support potentially improves treatment success and outcome of shunt-treated children and lessen the psycho-social burden of these families. To address this question, we performed an institutional pilot-study to evaluate parents’ concerns and Needs in our outpatient neurosurgical service.

**Methods:** Different questionnaires addressing various aspects of patients/parents/physician communication, need of support, psychological aspects etc. Were sent to parents whose child was currently flowed-up in our out-patients service (9/2012-9/2013 n = 72). Questionnaires included among others the Hydrocephalus Concerns Questionnaire (HCQ), the Distress Thermometer (DT), the GAD-7 and the PHQ-9. Twenty parents agreed to additionally participate in a comprehensive assessment including the assessment of communication preferences (adapted version of the Measure of Patients’ Preferences MPP), of need-for-information (self-developed structured questionnaire), and of supportive care needs (adapted version of the Supportive Care Needs Survey, SCNS-34). Data on parents’ sociodemographic background was collected. Medical history of affected children was evaluated retrospectively.

**Results:** 47% of parents returned completed forms that were valid for evaluation. 21% returned incomplete or blank forms. Children’s age of included parents was 3-21 years. 57% of parents described high psychosocial distress (scored ≥ 5 in the DT). All parents described a variety of concerns regarding the medical and psychosocial well-being of their child. In this neurosurgical setting, parents’ main concerns were focused on medical treatment (e.g., re-operation, shunt complications). Parents’ needs for information and
emotional support were high and independent of objective data. However, more distressed parents expressed higher communication, information and support needs.

**Conclusion:** Parents of shunt-treated children have specific fears, concerns and needs. Physicians should be aware of this aspect and offer professional support if needed.

**PP67**

**Hospitalized children and the role of spirituality before and after surgery: A review of the literature**

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**Introduction:** In the modern era examining the role of emotional and spiritual support to hospitalized children (of different faith traditions and various spiritual backgrounds) and their families is still a little investigated topic. The objective of this review is to present relevant research findings regarding children and the influence of spirituality in their well-being and the well-being of their family members—caregivers, while being hospitalized before or after surgery.

**Methods:** A literature search of the electronic databases PubMed-MEDLINE, EMBASE and Google Scholar was performed to identify studies published before December 2019. Although no published research focused on neurosurgery and children, several original studies presented raw clinical data on children undergoing other forms of surgery.

**Results:** All of the studies indicated that spirituality as a broad concept improved the reported quality of life of the children and their families as examined with self-reports. This finding could be incorporated in clinical practice.

**Conclusions:** Although further analysis and data collection in different cultural settings is required, these results support a beneficial influence of incorporating spirituality in the hospital care. Future research should further investigate if the cognitive and neuropsychological impairments of hospitalized children can also be influenced by exposure to spiritual-centered interventions.

**PP89**

**The effectiveness of calvarial vault operation in cranioserebral disproportion cases**

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More complications are seen as more hydrocephalus cases are treated currently. There can be chronic, severe, intermittent headache in patients with ventriculoperitoneal shunt. This symptom can decrease the quality of life and sometimes can be associated with cranioserebral disproportion. In cranioserebral disproportion cases cerebral volume exceeds the calvarial volume. In this situation calvarium cannot adapt to the growing cerebrum and normal physiologic increases in intracranial structures.

We have evaluated the clinic and radiologic findings of 10 ventriculoperitoneal shunted pediatric patients on whom calvarial vault operation was performed because of cranioserebral disproportion between September 2016 and September 2019 in Ege University Hospital Department of Neurosurgery.

The common property of all these 10 patients are to be operated in the radiologic examinations of all cases. Cranioserebral disproportion was thought with the clinic and radiologic findings and calvarial vault operation was performed for all the cases. Frontal decompression and split craniotomies till temporal basis were chosen as surgical technic. Preoperative complaints were regressed in all cases postoperatively. It was also seen that slit ventricles can enlarge after calvarial vault operation. Cranioserebral disproportion is a rare and difficultly diagnosed entity and the correct surgical technic fort his situation must be calvarial vault operation.

**PP123**

**Communicating hydrocephalus: Difficulty with the diagnosis**

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**Introduction:** While obstructive hydrocephalus is mostly associated with ventriculomegaly as well as other radiological and clinical clues, communicating hydrocephalus is usually mysterious lacking such clues. This makes the diagnosis difficult and delayed.

**Methods:** In this work, we are presenting 6 cases of communicating hydrocephalus. The diagnosis was difficult and delayed. The course of the disease was very acute in three of them leading to loss of vision.

**Results:** Measuring the ICP is oftentimes the only way to diagnose communicating hydrocephalus. Otherwise, the diagnosis may be totally missed or delayed. Pseudotumor cerebri is in itself a communicating hydrocephalus associated with brain congestion. Differentiation of both entities is needed.

**Conclusion:** We need to increase the awareness with communicating hydrocephalus. A high index of suspicion is needed in order not to miss such cases.

**POSTER TRACK 3.1: Craniofacial I**

**PP18**

**MRI-based CAD-planning for craniosynostosis corrective surgery**

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We present our protocol for CAD-based craniosynostosis surgery in children for frontoorbital and posterior advancement using MRI-based planning and template design based on 4 individual cases illustrating the novel technique.

**PP98**

**Turner syndrome and craniosynostosis: common pathophysiological spectrum in the same patient**

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**Introduction:** Turner syndrome (TS) is one of the most frequent chromosomal aberrations, caused by the partial or complete loss of the X chromosome. Skeletal anomalies are a characteristic phenotypic finding, although the presence of associated craniosynostosis constitutes an unusual pathology with very few references in the literature. We describe a case of Turner syndrome associated with an early closure of the sagittal suture.
**Method:** This is a 5-year-old patient who presented with failure to thrive, psychomotor retardation and cranial deformities including scaphocephaly. MRI revealed no compromise of CSF flow at the level of the occipitocervical junction; funduscopy was consistent with papillary paleness and the VEP showed a delay through the optic pathways. Genetic analysis showed an Xq isocromosome.

**Results:** Different genes have been identified in the pathogenesis of TS. SHOX gene (Xp22), and its interaction with other growth regulator genes, are responsible for different bone anomalies in TS as well as in other skeletal dysplasias. In TS, the haploinsufficiency of the SHOX gene, located on the short arm of the X chromosome, is justified by the presence of isocromosomes of the long arms of the X chromosome. Classic cephalometric studies demonstrated marked alterations in the skull base in patients with TS. The association of abnormal cranial morphology together with the craniosynostosis could cause a decrease of the volume in the posterior fossa. In this patient, the dynamic study of CSF in flow MRI was normal, so clinical, radiological and ophthalmological follow-up was prescribed.

**Conclusions:** Craniosynostosis in a rare entity in TS. Its presence must lead to a high degree of suspicion to rule out other craniocervical malformations.

**PP109**

3-D model for surgical planning sphenoid dysplasia repair

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**Introduction:** Sphenoid dysplasia is a distinctive diagnostic feature of Neurofibromatosis type-1, that occurs in 3-11% of patients with this autosomal dominant disorder. It is characterized by a unilateral malformation of the sphenoid bone in which the intracranial content of the middle fossa herniates through the enlarged superior orbital fissure, causing a pulsating exophthalmos and in the long term the loss of visual function.

**Methods:** We present a case report of a sphenoid dysplasia, in which a preoperative 3-D model of the skull was used to plan the operative procedure and to design the best shape of the titanium mesh.

**Results:** The 3-D model allows an exact planning of the surgical procedure. In particular, it allows to determine which part of the bone compresses the eye globe and has to be drilled. Finally, it allows to design the exact shape of titanium mesh, that will be sterilized and implanted in the skull defect.

**Conclusions:** The use of a 3-D skull model is easy and effective in planning the surgical procedure in sphenoid dysplasia.

**PP183**

Reduction cranioplasty using a 3D preoperative virtual model for treatment of extreme macrocephaly

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**Introduction:** Reduction cranioplasty is an off-standard and complex surgery with few indications and challenging risks. Our objective is to describe an innovative operative technique to perform a reduction cranioplasty, using a pre-operative 3D printed model to simulate the surgery.

**Methods/Results:** An 11 month-old male was transferred from Cape Verde to our centre with untreated congenital hydrocephalus and polydactyly. On admission, he was drowsy, with a bulging anterior fontanel, widely opened cranial sutures and a giant head measuring 64 cm. The brain computed tomography (CT) scan showed massive hydrocephalus and a non-functioning shunt. The hydrocephalus was promptly addressed and a programmable valve was placed in order to allow a progressive decrease of the ventricles’ size over time. The patient’s clinical condition improved to the point where he developed a social smile and anti-gravity power on the 4 limbs and, despite his cranial sutures were maximally override, his head circumference was still 61 cm and he had no head control. A reduction cranioplasty was then thought to work as a way to improve his motor skills. A helicoidal brain CT scan was used to render and segment the skull volume and it was printed on a 3D model. This printed model was then used to perform the intended osteotomies, simulating the intra-operative time. We then scanned the simulated “operated 3D printed skull” and merged it with the original CT scan to verify the accuracy of the model. The plan was finally transferred from the 3D model to the patient’s skull. There was no perioperative morbidity. On follow up year one, the child’s head circumference was 56 cm, he was able to hold his head and seat unassisted.

**Conclusion:** An operative simulation using a 3D printed model may optimize the surgical results of such an unusual surgical procedure as a reduction cranioplasty.

**PP188**

Different neurosurgical implications in familial inherited sclerosteosis

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**Introduction:** Sclerosteosis is a sclerosing bone dysplasia secondary to an alteration in the SOST gene that has a pattern of recessive inheritance. It is an uncommon pathology with few cases reported in the literature. Progressive skeletal overgrowth, more pronounced in the skull and jaw, is a characteristic phenotypic finding, which can lead to increased intracranial pressure.

We describe two sibling patients diagnosed with sclerosteosis.

**Method:** Both patients had similar phenotypes characterized by skeletal overgrowth, brachydactyly, nail alterations, bilateral facial paralysis and mixed hearing loss. Both were diagnosed with a Chiari malformation secondary to cranial bone hyperostosis and associated signs of endocranial hypertension. In one sibling MRI revealed a new syringomyelia and in the other, the ophthalmological control detected a papilledema, refractory to medical treatment with acetazolamide.

Due to these findings and given the natural history of the disease, surgical treatment consisting of extradural decompression of the posterior fossa was proposed.

**Results:** In the sibling with papilledema, a suboccipital craniectomy was performed with wide release of the foramen magnum. In-line drilling of the entire suboccipital squama was necessary due to a bone thickness of 2 to 3 cm in an extension of 6 x 5 cm. Currently, the funduscopy controls reveal the resolution of papilledema, while acetazolamide was discontinued. The other patient is scheduled for the same surgical procedure.

**Conclusions:** Cranial hyperostosis in severe cases of sclerosteosis can cause an increase in intracranial pressure, even at early ages. The lack of targeted medical therapies turns surgical decompression in a fundamental option for the management of this pathology.

**POSTER TRACK 3.2: Craniofacial II**

**PP20**

Intracranial pressure, brain morphology and cognitive outcome in children with sagittal craniosynostosis
Background: Patients with sagittal craniosynostosis are at increased risk of developing raised intracranial pressure (ICP) and neurocognitive deficiencies such as reduced attention, planning, speech, behavioural and learning disabilities.

Aim: To determine if the existing literature supports a correlation between elevated ICP and cognitive outcome in patients with sagittal craniosynostosis. Secondly, to investigate if the risk of developing neurocognitive deficiencies can be explained by changes in brain morphology in this patient category.

Methods: Systematic literature review in PubMed.

Results: A total of 190 publications were reviewed to determine a possible correlation between raised ICP and cognitive outcome, of which four were included in the study. No significant association was found. 44 publications on brain morphology in sagittal craniosynostosis were identified, of which 11 were included in the review. Clear evidence of morphologic changes in multiple areas of the brains of sagittal craniosynostosis patients was found in the literature.

Conclusion: The existing literature does not support an association between increased ICP and negative cognitive outcome in patients with sagittal craniosynostosis. Brain morphology is altered in areas related to neurocognition and language in the same patient group. These changes might play a role in the development of neurocognitive deficiencies, though no definitive link is yet established, and further investigation is warranted.

PP81

The value of resorbable osteosynthesis in reconstructive surgery of craniosynostosis: a comparative study between absorbable sutures and a resorbable plating system

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Introduction: Resorbable osteosynthesis is widespread used in the fixation of bone fragments during the surgical correction of craniosynostosis. The purpose of the current study is to compare and evaluate the effectiveness of absorbable sutures and a resorbable plating system as a fixation method in the treatment of craniosynostosis without modification of the osteotomy design.

Methods: 100 children with age up to 24 months were investigated. Children were divided into two groups (50 patients each), according to the type of fixation material used: in the first group Vicryl sutures (Ethicon Slovakia) were used for osteosynthesis, and in the second group the RapidSorb plating system (Synthes CMF Slovakia) was applied.

Results: The mean surgical time was 184.5 and 189.3 minutes among the two groups. The mean age at the time of surgery was 8.5 and 8.7 months respectively in the two groups. The average follow-up period was 36.8 months in the first group and 36.9 months in the second group. In the first group one child presented with minimal dislocation of a bone fragment, while in the second group one patient developed a wound infection, and another one displayed signs of inflammatory skin reaction.

Conclusion: Based on our findings, resorbable osteosynthesis with the exclusive application of Vicryl sutures or RapidSorb plating system shows favorable results in the surgical management of children with craniosynostosis.

PP103

Total cranial vault remodelling reduces the frontal bossing in children with scaphocephaly

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Introduction: Scaphocephaly is characterized by a biparietal narrowing and a frontal and occipital bossing. Many surgical techniques have been described, many of them being addressed only to the correction of the biparietal hollowing. The aim of our study was to assess the postoperative changes of the frontal bossing among children who have undergone a biparietal expansion compared to those who have undergone a total cranial vault remodelling.

Methods: We compared 30 children being treated with a biparietal expansion, with 10 children that had a total cranial vault remodelling. We measured the cephalic index and compared the curvature frontal bossing between the two groups.

Results: Children who have undergone total cranial vault remodelling presented a better esthetic outcome and a better curvature of the frontal bone, compared to those who had just a biparietal expansion.

Conclusions: The postoperative results showed a better esthetic outcome of children who underwent a total cranial vault remodelling.

PP181

Proteus syndrome with craniofacial involvement: how to beat the elephant man

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**Introduction:** Proteus syndrome is a rare and complex disorder caused by an activating AKT1 mutation, characterized by malformations and overgrowth of multiple tissues. We describe the case of a 16 year old boy, who developed a cranial asymmetry by the age of one and was later diagnosed with Proteus syndrome. At six years old, he underwent a partial resection of an abnormal skull overgrowth, but due to progression of the cranial hyperostosis down to the forehead several years later, a more complete resection and reconstruction with a patient-specific implant was performed to correct the severe disfiguration.

**Methods:** Prior to surgery, a digital 3D model of the skull was constructed, based on CT images. On the model, we defined the resection margins. A cutting guide was 3D printed to accurately perform the craniotomy exactly as planned during the virtual resection. A special challenge was the ballooning of the frontal sinus. The sinus had to be removed and the ostium occluded. Next, a patient-specific implant was put in place to reconstruct the shape of the skull. To facilitate placement and allow a small gap for the pericranium flap occluding the frontal sinus, the implant was made in two parts. The lower part was placed first. After verification of correct positioning, the upper half was placed and connected with screws.

**Results:** The postoperative esthetic result was very satisfying apart from a minor asymmetry of the left eyebrow and medial canthus, that was later corrected by the ophthalmologist.

**Conclusion:** We described a case of Proteus syndrome with severe craniofacial overgrowth, for which resection and reconstruction of the skull with a patient specific implant was performed. The cosmetic result after surgery was very satisfying.

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**PP195**

Sagittal cranial stenosis in twins rapport of cases

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Craniosynostosis is a premature fusion of cranial sutures, the origin of this premature fusion is attributed to a complex interaction among genetic.

We report a rare case of sagittal cranial stenosis in dizygotic (fraternal) twins. A dichorionic twins were the product of a vitro fertilization in a non-consanguineous mariage , delivered at 28 weeks of gestation. Admitted in neonatology, an excellent evolution is observed but cranial evolution showed a sagittal cranialasynostosis. Images showed a posterior fusion for the boy and median fusion for the girl. Genetic analysis and surgical treatment will be organise. We report a rare case of sagittal craniosenosis in fraternal twins.
POSTER TRACK 3.3: Epilepsy

PP19

Real-time MRI scan protocol for babies and children <6 years avoiding sedation

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We present our real-time cranial MRI protocol for non-contrast scans in patients <6 years. The MRI protocol is able to obtain sufficient brain MRI scans in all 3 spatial directions within 8 seconds. We will present data of the first 25 patients, analysis of the usability of the scans, need for repeat scans with sedation and interrupted/incomplete scans. The real-time cranial MRI protocol enables us to provide follow-up non-contrast MRI scans in pediatric neurosurgical patients after fontanel closure up to 6 years without hospitalisation, need for anaesthesia and psychological trauma to the small patients.

PP37

Can we use resting-state fMRI instead of task fMRI to map language networks preoperatively in pediatric neurosurgery?

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Background: Epilepsy affect neural processing and often cause the reorganization of functional networks and eloquent brain areas. Pediatric patients are often poor candidates for conventional brain mapping techniques (i.e. awake surgery, task functional magnetic resonance imaging, t-fMRI) as it is harder to get them to comply to the task. Resting-state fMRI (rs-fMRI) is an emerging presurgical brain mapping based on the intrinsic neural activity of the brain at rest. Since it is “task-free” it has the potential to overcome the limitations of conventional techniques. In addition, the children can be watching a video during the MRI which increases the chances of getting motion free images.

Purpose: Compare language networks obtained from rs-fMRI with those from t-fMRI (i.e. verb generation, naming) in pediatric patients with brain tumors or epilepsy.

Methods: Language networks were identified from 1) task-fMRI data, 2) rs-fMRI using independent component analysis (ICA) with 20, 40 target components and automatic dimensionality estimation. Rs-vs-task fMRI concordance was determined via spatial cross-correlations >.204, significant.

Results: Language networks derived from rs-fMRI showed significant spatial correlation with task-based ones. Rs-fMRI maps obtained with target components >40 showed higher overlap with task-fMRI than those obtained with 20 components. Overall, the rs-fMRI derived maps were larger.

Conclusion: Our preliminary experience using rs-fMRI mapping in pediatric cases suggests this technique can be used to identify language networks.

PP50

VNS. Surgical revision and replacement Techniques, tips and tricks: Meyer children hospital experience in 20 patients

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Introduction: VNS is currently approved for therapeutic use in patients aged >12 years with drug-resistant epilepsy and depression. Despite the implantation has become a straightforward procedure in experienced and dedicated units, the surgical revision and replacement can be challenging, especially when performed many years after the implantation.

Methods: We reviewed our series of 63 patients who had VNS implantation for treatment of drug resistant epilepsy. Median follow up was 11 years. In our cohort, 20 patients received VNS revision.

Results: 11 pt had complete hardware removal and 9 pt had hardware substitution. In 5 pt the hardware was removed because no positive effect was recorded after the implantation. 5 patients had hardware complications including high impedance, breakage of the electrode and disconnection of the electrode pin. After surgery, 3 patients reported wound problems related to the battery implant wound. Vocal cord palsy, coughing and phrenic nerve dysfunction was transiently experienced by 1 patient respectively. The control of seizures improved after VNS replacement and revision in all patients.

Conclusion: VNS implant surgery is a safe procedure with minimal side effects reported. In case of revision of the device, the surgical procedure can be challenging, and hardware failure should always be considered when patients do not report clinical benefit and reduction of seizure activity.

PP97

Magnetic resonance-guided laser interstitial thermal therapy: Preliminary experience in children

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Introduction: Magnetic resonance-guided laser interstitial thermal therapy (MRgLITT) is a minimally invasive procedure that can be used to treat intracranial tumors, epilepsy, and chronic pain syndromes. We report our preliminary experience with two pediatric patients.

Methods: Two patients with Pediatric brain tumors were treated with MRgLITT since July 2019. At the time of preparing the abstract another 4 patients are scheduled for surgery. The Visualase thermal laser system (Medtronic) was used. Laser catheter was placed with a frameless stereotactic approach (Medtronic stealth station).

Results: The first patient was a 9-year old baby girl affected by onco-predisposing syndrome, who developed a recurrence of glioblastoma (GBM) in the right peritrigonal region. The second patient was a 9-year old girl, affected by NF1, who presented a contrast enhanced right frontal lesion during the follow up. Both patients underwent frameless stereotactic biopsy during the same procedure, that confirmed glioblastoma (in the first case) and revealed a low-grade glial tumor (in the second case). The procedures were uneventful. GBM patient developed seizures in the first post-operative days that required medications and prolongation of the hospital stay. The second patient was discharged from the hospital 48 hours following the procedure. On post-operative MRI both tumors presented internal necrosis. Tumor volume decreased in the first 3 months after surgery. Follow up was 5 months for both patients, with no recurrence/progression.

Conclusions: Our experience appears to confirm that MRgLITT is an effective first- or second-line treatment for select pediatric brain tumors. It can be joined with frameless stereotaxy to obtain tissue for diagnosis.
**PP156**

**Sodium fluorescein in paediatric brain tumour surgery: A pilot study**

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POSTER TRACK 3.3: Epilepsy, Mexico 6, 2020, 9:35 πμ - 10:00 πμ

**Introduction:** Brain tumours are the most common solid tumours in the paediatric population. For affected patients, the extent of resection (EOR) is a strong predictor of overall survival, disease prognosis and adjuvant treatment efficacy. A key challenge for EOR is identifying the interface between brain and tumour tissue during maximal safe resection. In recent years, sodium fluorescein (Na-Fl)—a sodium salt and an organic fluorescent dye, has been described as a safe and useful neurosurgical adjunct in the resection of adult brain tumours. However, its use has yet to be fully established in paediatric brain tumours. We designed a pilot study to investigate the feasibility of intraoperative Na-Fl in paediatric brain tumour surgery.

**Methods:** This is a single-institution, prospective study for paediatric brain tumour patients managed by the Neurosurgical Service, KK Women’s and Children’s Hospital. Inclusion criteria involves patients undergoing surgery for suspected brain tumours from 3 to 18 years old. Patients who have known allergic reaction to Na-Fl or other significant comorbidities are excluded. After anaesthesia induction, 2 mg/kg of 10% Na-Fl is injected intravenously through a peripheral venous cannula. Following craniotomy, surgical resection is performed under alternating white light and YELLOW-560nm filter illumination.

**Results:** A total of 5 patients were recruited for the use of intra-operative Na-Fl for their surgeries. These included 2 glioblastoma, 1 ganglioglioma, 1 pilocytic astrocytoma and 1 cavernoma. For all the cases except for the cavernoma, there was good discrimination between the normal brain parenchyma and bright yellow stained lesional tissue. Surgical aims were achieved for all five patients. All patients in our study did not have any side effects from the use of Na-Fl.

**Conclusion:** Preliminary findings from our pilot study demonstrated the safe and efficacious use of intraoperative Na-Fl for brain tumours as a neurosurgical adjunct in our paediatric patients.

POSTER TRACK 3.4: Neuro-oncology II

**PP2**

**Evaluating the utility of post-operative magnetic resonance imaging for paediatric cerebellar pilocytic astrocytomas**

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**Introduction:** Magnetic resonance imaging is routinely used as a surveillance tool to detect asymptomatic recurrence of cerebellar pilocytic astrocytomas (CPAs). Where it is hypothesised that earlier re-operation may lead to better clinical outcomes. The Children’s Oncology Group recommend MRI is performed at 48 hours, 3 and 6 months following complete resection of CPAs. The frequency of imaging beyond this period is uncertain. There is no guidance outlining a surveillance regimen if sub-total resection is achieved. This study analyses the recurrence pattern of CPAs in order to propose an appropriate surveillance MRI schedule following their surgical resection.

**Methods:** A retrospective review was performed of 25 paediatric patients, with a histopathological diagnosis of CPA, that underwent surgical resection at St. George’s Hospital London between 2005 and 2015. Early post-operative imaging, together with the surgeon’s operation note, divided individuals into two groups depending on whether total or sub-total resection of the primary tumour was achieved. Surveillance MRI and tumour recurrence were subsequently documented for all patients.

**Results:** 25 children who underwent surgical resection of their CPA were identified. 13 had no residual tumour on immediate post-operative imaging. Surveillance MRI of these patients was uniformly negative for recurrent disease at an average of 5 years follow-up. The first craniotomy provided sub-total resection for 12 patients. Tumour recurrence was detected on MRI in 10 of these patients, on average 31 months (Range: 5 – 54 months) following primary surgical resection.

**Conclusion:** This study illustrates that children who have undergone total resection of their CPA may not benefit from routine post-operative surveillance MRI, due to low recurrence rates. The benefits of a more stringent regimen include reducing costs, risk of anaesthesia and anxiety amongst families. Patients in which sub-total resection is achieved may benefit from more frequent neuroimaging within the first five years following primary operation.

**PP99**

**Cerebellopontine angle lipoma as secondary cause of trigeminal neuralgia**

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**Introduction:** Trigeminal neuralgia consists of a recurrent excruciating in one or more divisions of the trigeminal nerve. The pain must be recurrent in paroxysmal attacks and severe. Only 1.5% of the cases occurs before the age of 18 years. Cerebellopontine angle lipomas are very uncommon, overall as case of trigeminal neuralgia in children.

**Methods:** A 11 years old boy presented to clinic with a 2-month history of recurrent stabbing pain in the left jaw and cheek pain. At worst, three or four episodes were clustered together per day with spontaneous resolution. Pain episodes were triggered by eating and swallowing T1 MR brain imaging showed a small hiperintense lesion on the left pons cerebellum angle, adjacent to V-VIII nerves exit zone.

**Results:** The boy was offered retrosigmoid craniotomy to decompress trigeminal nerve. A exploration of the left trigeminal nerve from the root entry zone was carried out. Superficial lipoma coagulation was made, and Merocel sponge was placed between the loop of anterior inferior cerebellar artery and nerve. Recovery was uneventful and was discharged homeon postoperative day 6. Postoperative review at 6 months revealed continued pain relief off analgesia.

**Conclusions:** Microvascular decompression remains the mainstay for decompression of the trigeminal nerve, overall in secondary causes such as cerebellopontine lipoma. Complete lipoma removal may cause neurological deficits and partial shrinkage of the lesion is enough to decrease the nerve compression with good clinical results.

**PP114**

**Hospitalization and outcome of children with operated tumors of the central nervous system in a Greek PICU over the last four years**

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**Introduction:** Magnetic resonance imaging is routinely used as a surveillance tool to detect asymptomatic recurrence of cerebellar pilocytic astrocytomas (CPAs). Where it is hypothesised that earlier re-operation may lead to better clinical outcomes. The Children’s Oncology Group recommend MRI is performed at 48 hours, 3 and 6 months following complete resection of CPAs. The frequency of imaging beyond this period is uncertain. There is no guidance outlining a surveillance regimen if sub-total resection is achieved. This study analyses the recurrence pattern of CPAs in order to propose an appropriate surveillance MRI schedule following their surgical resection.
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Introduction: Pediatric C.N.S. tumors are the most common solid tumors in children and comprise 15% to 20% of all malignancies in children. The majority of these children will undergo neurosurgery and some will require hospitalization in a pediatric I.C.U.

Methods: This is a retrospective study of the registry of children with CNS operated tumors, who have been treated in our unit from 2016 until today.

Results: 28 children were hospitalized during this period. 18 of them were male (64%) and 10 were female (36%). Their ages ranged from 5 months to 14 years. The total days of hospitalization were 770. The days of mechanical ventilation were 658. 18 children had a posterior cranial fossa tumor. In 7 children the tumor was located supratentorially. 2 children were found with optic nerve glioma and 1 child had neuroblastoma. CSF drainage was placed in 21 children. 12 of them were external and 9 were ventriculoperitoneal shunts. Various complications occurred in 12 of the 28 children. The main ones were tumor recurrence, hydrocephalus, complications from drainages and seizures. Emergency and scheduled readmissions amounted to 6. 8 children underwent tracheostomy. Finally, mortality rate was approximately 21.4% (6/28 children).

Conclusion: For modern clinicians charged with the care of critically-ill children, the protection and restoration of neurologic function involves increasingly sophisticated management strategies and technologies. For this reason, the collaboration of neurosurgeons, pediatric oncologists and pediatric intensivists is essential for the best possible outcome for children with CNS tumors.

PP204

Prenatally diagnosed suprasellar arachnoid cyst: when to treat?

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Introduction: Suprasellar Arachnoid Cysts (SAC) are rare heterogenous entities that can be diagnosed and treated prenatally or postnatally, depending on their type and symptoms. We report a case of a prenatally diagnosed suprasellar arachnoid cyst treated postnatally.

Case illustration: The cyst was diagnosed on a routine ultrasound at 22 weeks of gestation. It was a very large cyst in the prepontine region, compressing the brain stem and the 4th ventricle, causing a ventriculomegaly. The cyst was rapidly evolutive in the ultrasounds and the MRI of the 29th week which showed difficult access to treat the cyst antenatally. It then became symptomatic at 30 weeks with episodes of bradycardia, independent to the uterine contractions, leading to deliver the baby despite the prematurity by C-section. Though well tolerated postnatally, the cyst continued to grow. The progressive ventriculomegaly that had started prenatally was monitored; it allowed us to perform a ventriculo-cysto-cisternostomy on the 5th day of birth. Despite a progressive reduction of cyst, residual brainstem compression lead us to perform a transient extrathecral internal shunting.

Discussion: SAC are rare lesions without a consensus for treatment. The numerous case series and reports allow a better theoretical understanding of the disease but cannot predict the best practical type or time for treatment, especially with the dynamic effect due to their size, that caused a hydrocephalus in our case.

Conclusion: Our case suggests that these cysts require a continuous management. We should adapt to the anatomy, the rapidity of evolution of the cyst and the symptoms to determine the best timing to treat the patient, whether it is before or after birth.
POSTER TRACK 3.5: Hydrocephalus V

PP23

Endoscopic fenestration of large suprasellar, sylvian fissure and cerebellopontine angle arachnoid cysts–video presentation

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Introduction: Arachnoid cysts are congenital cerebrospinal fluid-filled lesions that arise during development from splitting of arachnoid membrane. Treatment is recommended if they provoke mass effect and symptoms
Endoscopic aqueductoplasty with stenting for isolated fourth ventricle via posterior fossa approach

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Introduction: Endoscopic Aqueductoplasty is indicated mainly for isolated fourth ventricle. The endoscopic approach with stenting is used to communicate formerly isolated ventricular compartments with each other rather than treat hydrocephalus per se.

Methods: We describe three patients with enlarged and isolated fourth ventricle treated by endoscopic aqueductoplasty with stenting. Two patients (16 and 23y/o female) had isolated fourth ventricle due to Dandy-Walker and VP-shunt dysfunction. One patient, 22y/o female, presented isolated fourth ventricle due to an excision of pontine glioma and VP-shunt dysfunction. The purely endoscopic procedure was initiated by a burr-hole on posterior fossa. Inside the fourth ventricle the anatomical landmarks was the floor of the ventricle (the rhomboid fossa) anteriorly, the foreman of Magendie inferiorly and medially, and on both sides the foramina of Luschkae laterally. The endoscope introduced gently a non-inflated Fogarty balloon catheter through the aqueduct. After the communication of fourth with the third ventricle, a conventional 9-cm long (3cm for third and 6cm for fourth ventricle) lumbar drainage catheter stent was used for stenting with the aid of a grasping forceps. Again, TISSEEL was placed along landmarks where this was not possible. Again, TISSEEL was placed along posterior fossa. Inside the fourth ventricle the anatomical landmarks was the floor of the ventricle (the rhomboid fossa) anteriorly, the foreman of Magendie inferiorly and medially, and on both sides the foramina of Luschkae laterally. The endoscope introduced gently a non-inflated Fogarty balloon catheter through the aqueduct. After the communication of fourth with the third ventricle, a conventional 9-cm long (3cm for third and 6cm for fourth ventricle) lumbar drainage catheter stent was used for stenting with the aid of a grasping forceps. Again, TISSEEL was placed along landmarks where this was not possible. Again, TISSEEL was placed along

Results: The postoperative outcome was favorable for all three patients. They relieved from brainstem-tectal compression syndromes. One patient presented transient dysconjugate gaze. There was postoperatively a reduction of fourth ventricle size and the stent remained in correct position.

Conclusions: Aqueductoplasty with stenting is the procedure of choice for the treatment of isolated fourth ventricle. The upward way from the posterior fossa to the third ventricle could be an efficient passage for endoscopic aqueductoplasty.

PP27

Endoscopic third ventriculostomy in a large series of the adults—experience of a single center: Patient selection, technique, outcomes and complications

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Introduction: The application of Intraventricular neuroendoscopy, mainly Endoscopic third ventriculostomy (ETV), in the adults has been less extensive, compared to children. This report is a large adult series during one year February 2018–October 2019 and has the consistency of being performed at one center. We describe the technique, safety, efficacy and outcome of neuroendoscopy in a large adult hydrocephalus patient series at a single neurosurgical center. In addition, to analyze patient selection criteria and clinical subgroups in order to optimize surgical results in the future.

Methods: We conducted a retrospective review of adult intraventricular neuroendoscopic procedures performed at our center between February 2018 – October 2019. 60 patients (18-84y/o) underwent ETV procedure. The cine-MRI was the mandatory tool to investigate the patency of the third ventriculostomy and the improvement of flow in aqueduct of Sylvius by using a standardized mathematic protocol for CSF and cardiac circulation.

Results: The overall rate of success (no further cerebrospinal fluid diversion procedure performed, plus clinical improvement and fluent patency in Cine-MRI) of 60 completed ETVs was 84%. The number of procedures, with the success rate in parentheses, was: obstructive hydrocephalus 33 (82%); communicating hydrocephalus including normal pressure hydrocephalus, 12 (75%); arrested hydrocephalus, 8 (88%); VP–V–A–shunt dysfunction, 5 (100%); post-traumatic hydrocephalus, 2 (100%). There were 5 transient complications in 60 intended procedures (8,3%); 3 intracerebral (5%) and 2 intraventricular hemorrhage (3,3%).

Conclusion: Use of ETV in adult hydrocephalus has broad application with a low complication rate and reasonably good efficacy in selected patients.

PP68

Multi-layered closure of intraventricular neuroendoscopic procedures in infants under one year of age: a technique to minimise cerebrospinal fluid leak

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Introduction: Neuroendoscopic techniques are used increasingly in the management of hydrocephalus and related intraventricular pathologies in children. An important complication of intraventricular endoscopy is post-operative cerebrospinal fluid (CSF) leak, which puts the child at risk of wound breakdown and meningitis. The overall risk of this complication is 1.7%, with individual reports as high as 5.2%. We present a multi-layered closure technique to be used in endoscopic procedures which is designed to be as watertight as possible and may reduce the risk of CSF leak.

Methods: A single-centre retrospective case series analysis was conducted of twenty-five infants under one year of age who underwent intraventricular neuroendoscopic procedures with a stereotyped multi-layered closure method between February 2015 and November 2019. In all cases, the corticotomy edges were brought together and then glued with TISSEEL fibrin sealant (BAXTER). The dura was sutured with 4-0 PDS as a continuous layer. The bone was placed in its original position overlying the dura and the edges sealed with TISSEEL. The pericranium was then closed with 4-0 PDS in a continuous layer, or with interrupted sutures where this was not possible. Again, TISSEEL was placed along...
the edges. The galea was closed continuously with 3-0 Vicryl and the skin as the final layer with continuous 4/0 Monocryl.

**Results:** There were no cases of post-operative CSF leak, wound breakdown or infection in this series.

**Conclusion:** Our multi-layered closure method may potentially minimise the risk of post-operative CSF leaks in infants under one year of age undergoing intraventricular neuroendoscopic surgery.

**PP146**

**Third ventriculostomy in pediatric age: Results of 74 patients grouped according to age**

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Success rate of endoscopic third ventriculostomy (ETV) for treatment of obstructive hydrocephalus is reported lower in pediatric patients compared to adult cases. In this retrospective study, we investigated the results of 74 pediatric cases treated with ETV. Patients treated with ETV in the last 19 years and younger than 18 years were included. Patients were divided into three groups according to age. First group was defined as patients younger than 6 months old. Second group consisted of patients whose age was between 6 months and 2 years. Last group consisted of patients aged 2-18 years old. Clinical and radiological features and results of these patients have been analyzed according to age groups. Success of procedure was defined as elimination of need for shunting. Mean follow up period was 14 months. In the first group, there were 6 male and 10 females. Nine patients had congenital aqueduct stenosis (AS), four had lomber meningomyelocele. A small percentage of patients were diagnosed with neoplastic pathologies. One had galen vein aneurysm. Six patients needed to undergo shunting. Success rate was 10/16 (63%). There were 19 patients in the second group, 11 male and eight females. Eight patients had space occupying lesions such as arachnoid cysts, medulloblastomas and anaplastic ependimomas. Ten patient needed further shunting operation with a success rate of 47% (9/19). The third group consisted of 39 patients, out of which 27 were male. Contrary to previous groups, superiority of patients had neoplastic lesions (20, 51%). Only 30% of patients underwent further shunting, being the least ETV failure rate, compared to previous groups. ETV is a successful minimally invasive technique for treatment of obstructive hydrocephalus. Unfortunately, success rate is lower in small children than in adults. More clinical studies may be helpful to identify the ETV indications according to age.

**PP198**

**Early neuroendoscopic lavage for the treatment of post-hemorrhagic intraventricular hemorrhage causing hydrocephalus in premature neonates**

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**Introduction:** In recent years early endoscopic lavage is gaining momentum in the treatment of neonatal intraventricular haemorrhage (IVH) of prematurity, in the hope that it will reduce the rate of need for permanent shunting. We analyse the results of our first three patients.

**Methods:** Between September 2017 and September 2019, 3 premature neonates with post-hemorrhagic hydrocephalus were treated with neuroendoscopic lavage for removal of intraventricular blood clot remnants. Two patients were 26 days old and one was 10 days old at first operation. One patient had both ventricles cleared from the right side, the contralateral ventricle through a septostomy. The other two patients had a second operation on the other side to clear the contralateral ventricle. All patients had insertion of ventricular access device and postoperative ventricular tapping.

**Results:** All patients tolerated all procedures very well with no systemic or procedural complications. Two of the three patients did not require a shunt insertion at latest follow up (3 and 27 months respectively) and have normal size ventricular system without loculations. The shunted patient has not developed loculated ventricles (latest follow up 18 months), but required shunt revision.

**Conclusion:** Early neuroendoscopic lavage of intraventricular blood degradation products and residual hematoma is feasible and safe for the treatment of PHH in neonates with IVH. Early results are promising with regard to shunt avoidance.