

# HIGHLIGHTS FROM INTERNATIONAL NEUROSCIENCE MEETINGS

## *The 8th Annual Meeting of the Saudi Association of Neurological Surgery: “Aspire, Inspire, Innovate” Riyadh, Kingdom of Saudi Arabia, April 15-17, 2014*

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The 8th Saudi Association of Neurological Surgery (8th SANS) meeting was held in Riyadh, Saudi Arabia on April 15-17th 2014, organized by the National Neurological Institute, King Fahad Medical City, Riyadh, Saudi Arabia. The theme was “Aspire, Inspire, Innovate” covering state of the art technology in different sub-specialties of neurosurgery. The scientific program was packed with innovative presentations on clinical and practical management topics critical to neurosurgery today. The included abstracts were selected and reviewed by a committee based on their scientific value and contribution to the field of neurosurgery.

### *Abstracts*

#### **ONCOLOGY**

##### **From idea to clinical integration: a neurosurgical odyssey**

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To improve upon intra-operative lesion localization and resection control, the idea of translating MR-imaging technology into the operating room was germinated. The systems were initially of an open configuration and contained relatively low field magnets. Signal to noise and contrast to noise were improved with the evolution of iMRI systems with higher field magnets, which are closed systems. These closed systems interrupted surgery for imaging, and therefore the systems are generally used to evaluate the extent of surgery rather than to guide surgery. In order to fully utilize the rich array of images, surgery must occur inside the magnet while images are being produced. A robotic system would theoretically provide the ability to perform surgery inside the magnet so that surgery and imaging can occur simultaneously. A multidisciplinary collaboration provided the capacity to design and build, for the first time, an MR compatible neurosurgical robotic system. Serendipitously, the remote workstation from which the surgeon teleoperates the robotic manipulators, centralizes and fuses the imaging data. This enables the surgeon immediate access to current patient information as well as digitized knowledge from the global community. Contemporary MR compatible robots take advantage of the many ongoing advances in material science, audio-visual systems, and haptics. Miniaturization of components enables the process towards creation of

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dexterous manipulators similar to the human hand. Furthermore, technology offers the possibility of accessing visual, tactile, and audio information outside the range of human senses. When current advances in molecular imaging technology combine with these advances in robotic surgery, this paradigm has the potential to convert the scope of surgery from the present level of the organ to the cellular dimension. **Synopsis.** This lecture will present contemporary interoperative MRI technology and the evolution of MR compatible robotics. The technologies are rapidly progressing towards the ultimate goal of merging diagnosis with therapy. These technologies reflect multidisciplinary collaboration with the convergence of advances from multiple fields. Surgery will be augmented by mechanical sensory information that has the potential of surpassing human capability.

## Stereotactic robot-guided biopsies of brain lesions: experience with 4 cases

*Ahmed Lary, Adel Alzahrani, Ahmed Alahmary, Mohammed Alshardan, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

**Background and Purpose:** Biopsies of brain lesions are useful for histopathological analysis, which guide appropriate treatment. For the past few years, a frameless stereotactic robot, the NeuroMate robot (Renishaw, UK) has also been used for brain biopsies. We report a retrospective study of 4 patients who underwent NeuroMate robot-guided biopsies of brain lesions to evaluate the efficiency and safety of the system. **Methods:** From January 2014 to March 2014, 4 adult patients underwent 4 biopsies of supratentorial brain lesions. The biopsy procedure comprised 4 stages: image acquisition, preoperative planning, patient-to-image registration, and operative procedure. A single burr hole was the entry point of each patient. **Results:** All biopsies were positive for histopathological diagnosis from the first trial. All biopsies correlated precisely to preoperative biopsy planning. There was no operative mortality or morbidity. **Conclusions:** The frameless NeuroMate robot is an efficient and safe instrument for biopsies of brain lesions. We believe that the use of frameless stereotactic techniques for brain biopsies could increase the number of biopsies and therefore improve the diagnostic yield and accuracy of the technique.

## Surgery for deeply located intracranial lesions under intraoperative MRI guidance

*Yasser Orz, Abdulrahman J. Sabbagh, Ahmed Lary, Mahmoud Al-Yamany, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

**Objective:** Image-guided neurosurgery includes all neurosurgical procedures, which in some way are assisted by the availability of images, regardless of whether the images are acquired before or during the surgery. This study was carried out to evaluate the effects of using intraoperative MRI on the degree of removal of deeply located intracranial lesions. **Methods:** During the last 5 years we operated on nearly 500 patients with intracranial lesions using intraoperative MRI guidance, 90 of them had lesions deeply located intracranially. Twenty patients had thalamic tumors, 10 had pineal body tumors, 30 had sellar lesions, and 30 had brain stem lesions. **Results:** Gross total excision of the lesion was achieved in 75 patients with good neurological outcome in all of them. In the remaining 15 patients, a small residual was left because of attachment to critical structures. **Conclusion:** Advantages of image guided neurosurgery are many as it allows lesion location promptly, allows tumor removal with respecting the normal brain and vascular anatomy, allows a more complete tumor removal, and the relatively inoperable deeply seated benign lesions can be removed with image guided techniques. Image guided surgery helped us to achieve total removal of most of these relatively difficult located lesions with good neurological outcome for most of the patients.

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## **TMS: a non-invasive cortical mapping system**

*Labbib Soualmi, Ahmed Lary, Abdullah AlDhafyan, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

Transcranial magnetic stimulation (TMS) is a powerful, non-invasive tool that is more frequently used in clinical applications for studying the human brain functions. TMS has the potential to probe the function of many different parts of the cerebral cortex, in ways not feasible with other techniques, such as functional neuroimaging. The TMS system uses a special representation of the 3D rendered MRI of the patient, to view the brain at any desired intracranial depth. The TMS coil generates a magnetic field that induces current flow that can temporarily excite or inhibit specific areas of the cortex. The induced electric field is accurately displayed on the MRI of the patient using the stereotactic coil localization module. The patient responses to the stimuli are detected by the surface electrodes that are placed over the appropriate studied muscles. Once the representation area for the target muscle is found, the system reliably measures MEPs allowing the high spatial resolution required for precise mapping. The resulting TMS mapping is then exported to a Neuronavigation platform to help achieve the maximum tumor resection while preserving a good outcome especially for tumors in the vicinity of vital eloquent cortex. In this paper we will address the single pulse TMS corticomotor mapping over the primary motor cortex that is used in our institution for the first 20 patients. The use of this non-invasive modality will undoubtedly expand as it clearly supplements other functional modalities.

## **Pilomyxoid astrocytomas: diagnosis, prognosis, and management**

*Abdulrahman Al-Anazi, Dammam University, Dammam, Kingdom of Saudi Arabia*

Tihan and colleagues in 1999 first described reports pointing out unusual features of some pediatric astrocytomas, particularly those within the hypothalamic/chiasmatic region, but did not specifically use a term to distinguish them. Under the current WHO grading scheme, PAs are designated Grade I and PMAs are designated Grade II neoplasms. Recent reports show it behaves more aggressively than PA, with a decreased duration of disease-free survival and higher mortality rates. Their histological features distinguish PMAs from typical PAs. Magnetic resonance spectroscopy showed elevated Cho/Cr outside their enhancing margins, which may be related to their more aggressive behavior when compared with PA. Original report on PMA consisted of tumors located exclusively in the hypothalamic/chiasmatic region, later PMA was also described in the posterior fossa and in the spinal cord. The mean age at diagnosis for patients with PMA is 18 months, but it may present throughout childhood. In conclusion, a younger age, more frequent occurrence at the suprasellar area, mainly solid mass containing non-enhancing portion, and more frequent leptomeningeal dissemination are helpful differential features of PMAs as compared with PAs.

## **The shift in the surgical management in craniopharyngioma**

*Areej Faqih, Ayman AlBanyan, Basim N. Elabi, Maqsood Ahmed, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

**Introduction:** The aim of this study is to review pediatric craniopharyngioma cases, with an attempt to correlate preoperative MRI grading with surgical intent in order to minimize the high postoperative complication rate previously described with craniopharyngioma resection. **Methods:** Retrospective database review was carried out for 11 cases from 2006 to 2014 at the Pediatric Neurosurgery Department, NNI, KFMC. Variables studied were demographics, clinical presentation, preoperative MRI grading, surgical management, complications, and outcome. The preoperative MRI grading was correlated with the surgical management, complications, and outcome. The MRI

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grading system was defined according to the pediatric craniopharyngioma classification and treatment according to the degree of hypothalamic involvement into: grade 0 = no hypothalamic involvement, grade 1 = hypothalamus displaced by tumor, grade 2 = hypothalamic involvement by tumor. Surgical management was divided into: GTR, STR+XRT, intratumoral chemotherapy (Interferon) via Ommaya reservoir. **Results:** The median age at diagnosis was 7.4 years ( $\pm 2.7$ ), the median follow up duration was 31.5 months ( $\pm 30.9$ ). Eight cases were grade 2 on preoperative MRI, 2 cases were grade one, and only one case was grade 0. Three cases underwent GTR, 4 cases underwent STR + XRT, and 3 cases underwent intratumoral chemotherapy (Interferon) via Ommaya reservoir insertion. One case had only STR alone. Six cases out of 11 developed postoperative complications in GTR and STR groups. None of Ommaya reservoir cases developed complications and all of them improved clinically. All GTR (100%) cases with preoperative MRI grade 2 developed hypothalamic injury postoperatively, while only one case of STR+XRT with preoperative MRI grade 2 developed hypothalamic injury (25%). No cases in either group developed new visual disturbances postoperatively. Six cases (54%) had panhypopituitarism. All GTR (100%) of cases with preoperative MRI grade 2 developed panhypopituitarism, while 75% of STR+XRT with preoperative MRI grade 2 developed panhypopituitarism. V-P shunt was required in 3 cases. **Conclusion:** We recommend STR + XRT for preoperative MRI grade 2 and GTR is reserved for grade 1, while Ommaya reservoirs are reserved for the cystic type to minimize the high percentage of hypothalamic injury.

### SPINE

#### Is there a light of hope: reconstruction of the severely injured spinal cord by using stem cells?

*Ahmed Ammar, Yaser Abdulraouf, Dammam University, Dammam, Kingdom of Saudi Arabia*

**Introduction:** Severe injury of the spinal cord is a devastating injury. There are several trials to improve the spinal function by using stem cells. We have had successful experience with reconstruction of 4 patients who suffered complete transection of the spinal cord, by using stem cells to restore some functions of the spinal cord. **Methods:** The Ethical committee approved this procedure. There are 3 stages for this treatment; first stage: preoperative preparation to increase the number and mobilize the stem cells in the peripheral circulation 5 days prior to surgery. Second stage: Prepare mixture of stem cells, rich fiber protein, and from the patient blood+NGF. The patients were monitored for MEP, SEP, and D wave. The mixture is inserted in the injured area after neurolysis. Third stage: clinical and neurophysiological follow up. **Results:** The EMG and evoked potentials showed improvement in 3 cases in neurological condition. One patient improved from grade A to grade C, 2 showed improvement from grade A to grade B, and one did not improve. **Conclusion:** Stem cells are a promising tool for spinal cord reconstruction. These 4 cases may open the window for reconstruction of the spinal cord. However, there is still a lot to be done to solve problems.

#### Internal metal fiducials with intraoperative CT-navigation reduces radiation during cervical spine instrumentation with improved accuracy

*Amro Al-Habib, Salah Alakkad, King Saud University and Saudi Aramco, Riyadh, Kingdom of Saudi Arabia*

**Introduction:** Intraoperative CT with navigation demonstrated improved spine instrumentation accuracy. However, accuracy decreases when the target level is far from the reference frame (RF). The current study evaluates the usefulness of fixed surface marker screws (internal metal fiducials - IMF) in enhancing Medtronic O-arm registration accuracy and, potentially, reduction of intraoperative radiation. **Methods:** Six fresh-frozen human torsos were utilized. Following posterior C1-T2 exposure and insertion of IMFs (3 titanium screws per level, 3mm long each), images acquired by O-arm were transferred to Medtronic navigation StealthStation. Two registration

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methods registration were utilized: autoregistration (AR) and point-registration using IMF (IMFR). Accuracy was compared using IMFs on the left side (C2-T1). Pedicle screws were inserted into C2, C4, C5, and C7 based on the 2 registration techniques (3 cadavers each) with RF on C7 then on C2. Results: Mean registration error was less with IMFR compared to AR ( $0.35 \text{ mm} \pm 0.5$  and  $2.35 \text{ mm} \pm 0.8$  respectively,  $p=0.0001$ ). Thirty-four pedicle screws were inserted (AR 18, IMFR 16). Final screw placement was comparable to navigation approach images in both groups. There were no medial screw violations. Lateral violations were observed in 4 IMFR screws (1-2 mm) compared to 5 violations in the AR group (2-3 mm). Re-registration after moving RF using surface screws in IMFR group avoided taking new O-arm image compared to the AR group. **Conclusion:** The accuracy of screw placement was no different between the 2 groups. Point registration using IMF provided better registration accuracy and less radiation exposure when instrumenting a long spine segment.

### Pediatric neck deformity: review of causes and management

*Mohammad AlFawarah, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

Sagittal balance of the cervical spines usually in lordosis, kyphosis of the cervical spine is always pathological, but rare. Neck kyphosis can be classified according to the cause, either congenital or acquired. Congenital can be as part of a syndrome; like Larsen's syndrome, diastrophic dysplasia, chondroplasia punctate, Conradi's syndrome, Camptomelic dysplasia, and neurofibromatosis. Acquired kyphosis can be due to trauma, or postlaminectomy. Clinical presentation of neck kyphosis is usually obvious deformity, chin near to chest, in addition to signs and symptoms of the associated syndrome, like dysmorphic features, hypotonia, low hairline, frontal bossing. Management is usually challenging and needs a high level of suspicion, cervical x-ray usually diagnoses the deformity, CT scan makes the abnormality clear, MRI will evaluate the amount of compromise on the spinal cord. Management is usually a combination of traction, bracing, and surgical management, surgery can be anterior, posterior, or combined.

### Single-stage combined posterior-anterior decompression and instrumented fusion for management of cervical pathologies

*Khaled Abdeen, Ihab Zidan, Ahmed Farhoud, Neurosurgery Department, Alexandria University, Alexandria, Egypt*

**Introduction:** Surgical treatments of cervical spinal pathologies can be challenging operations. Surgical treatment can be divided into anterior, posterior, or combined procedures. The aim of the study was to evaluate the applicability and safety of single-stage combined posterior-anterior decompression and instrumented fusion for management of cervical pathologies. **Methods:** This prospective study was carried out on 18 consecutive patients who had been operated with single-stage combined posterior-anterior decompression and instrumented fusion. The indications for surgery included traumatic fractures in 8 cases, cervical spondylitis in 7 cases, and cervical tumors in 3 cases. The posterior stage was performed first together with lateral mass fixation followed by the anterior stage and anterior cervical plating. All patients were followed up for 11 months on average. Fusion was assessed by plain x-ray films and CT scan, and the neurological outcome by ASIA impairment scale. **Results:** All patients were safely operated with circumferential instrumented fusion. There were no surgery-related complications. Postoperative complications were reported in 5 patients. One patient showed transient neurological deterioration, 2 cases had wound infection, one patient with CSF leak, and one patient had deep vein thrombosis. The mean operation time was 220 min (range 200-280 min) and the mean volume of blood loss was 485 ml (range 190-1100 ml). Regarding the ASIA impairment scale, 11 patients showed improvement, while 7 patients remained stationary at the same grade. Satisfying fusion and reduction were obtained in 15 patients (83%). There were no cases of graft extrusion, or plate or screw looseness or fracture. **Conclusions:** The single-stage combined posterior-anterior decompression



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and instrumented cervical fusion represents a viable option in the treatment of a group of patients with different cervical pathologies. The technique provides immediate rigid stabilization of the cervical spine, as it treats the anterior and posterior pathology simultaneously and corrects deformity.

## **Leiomyoma of the neck and cervical spine**

*Rami Alshamrani, Amro Al-Habib, Saleh Aldhabri, Mohammad Aleissa, Hisham Alkhalidi, King Saud University, Riyadh, Kingdom of Saudi Arabia*

Leiomyomas are benign tumors arising from the smooth muscle, most commonly seen in the uterine myometrium, gastrointestinal tract, skin, and the lower extremities of a middle age woman. Leiomyoma are uncommon in the head and neck region accounting for less than 1% of all leiomyomas. In this article, we are reporting a case of leiomyoma in a 12-year-old girl that occupied most of her neck and extended to her cervical spine engulfing the vertebral artery and causing severe difficulties in swallowing and respiration. We are going to discuss the preoperative care and preparations, the multidisciplinary approach to this case, post-operative care, and the histopathological diagnosis.

## **Percutaneous fixation of thoracolumbar fractures: KFMC experience**

*Mohammed Halawani, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

Numerous improvements in minimally invasive spine surgery (MISS) have been made during the last decade in thoracolumbar spine trauma management with less morbidity. The increased use of MISS technologies in spine trauma has been correlated to the availability of more versatile instrumentation, which makes the fixation of all thoracic and lumbar levels possible. Balloon-assisted techniques have been used to support the anterior column in a stand-alone manner or in combination with open or percutaneous pedicle screw fixation. NAVIGATION-assisted pedicle screw insertion is associated with less pedicle wall violation when compared with open surgery. The advantages of percutaneous pedicle screw fixation relative to open surgery are discussed: preservation of posterior musculature, less blood loss, shorter operative time, lower infection risk, less postoperative pain, shorter rehabilitation time as well as shorter hospital stay. Limitations of percutaneous fixation include the inability to achieve direct spinal canal decompression and not having the option to perform a fusion. Nevertheless, these limitations can be addressed by combining MISS with open techniques. The benefits of percutaneous spinal fixation for unstable spine fractures in polytrauma patients are also discussed. Posterior instrumentation can be easily removed after bone union to allow young patients to regain their mobility.

## **Spinal cord tumor surgeries, transient paraplegia, and prevention with intra-operative neurophysiology**

*Muhammad T. Intiaz, Mazhar Mobin, Aneel Kumar, Mohammad S. Bin Saad, Ahmed Lary, Yasser Orz, Mahmoud Al-Yamany, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

**Introduction.** Intraoperative neurophysiology monitoring (IOM) of the spinal cord sensory and motor pathways has dramatically evolved over the past decade, offering unique opportunities in applying basic neurophysiological principles of the spinal cord to clinical surgical practice. Through IOM, we have learned some of the neurophysiological mechanisms behind the changes in the postoperative neurological outcome of patients operated on the spine or with spinal cord pathologies specially tumors. Similarly, the clinical importance of the “transient paraplegia” phenomenon has provided new insights into the basic pathophysiology of the spinal cord (Deletis, et al). Sensory (stimulating peripheral nerves and recording at various levels as the signals ascend to the generator on the post central gyrus via scalp electrodes) and motor evoked potentials (stimulating the generator in the pre central gyrus via scalp electrodes and record from the muscles) are an integral component of spinal cord monitoring

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during spinal cord tumor surgeries. It not only it provides information about the integrity of the dorsal column and corticospinal tracts in real time but also serves as a quick litmus test to identify ischemia in the spinal cord during a procedure (Epstein et al, 1993). Specifically, also, during spinal cord tumors, myelogenic motor evoked responses (also called as D Waves) add precious information where a limited area of a few centimeters proximal to the tumor is stimulated and waves recorded directly distally from the tumor while removing the tumor. At our institution (National Neurosciences Institute at the King Fahad Medical City Riyadh Saudi Arabia) we routinely perform multi modality intra operative neurophysiological monitoring during spinal cord tumor surgeries. As suggested (Sala et al, 2006), it seems that the benefit of IOM becomes evident only a few months after surgery for spinal cord tumors (specifically intramedullary spinal cord tumors), while early neurological outcomes are similar in monitored and non-monitored patients; clinical data likely reflect the “transient paraplegia” phenomenon. Monitored patients, where the comprehensive neurophysiological monitoring including the D-wave has been preserved at the end of the procedure, retain the potentiality for clinical recovery in all patients. Accordingly, we have learned that the preservation of the D-wave represents a very strong prognostic indicator of a good long-term motor outcome so far. **Conclusion:** In short, IOM has fast become a standard of care in certain patients undergoing neurological/spinal surgeries. Its miraculous help can only be appreciated once emphasis is given to it by the surgical community.

## Morphometry of vertebra in the Saudi population

*Mohammed A. Hasen, Husam Alhabib, Fadhel Molani, King Fahad Specialist Hospital, Dammam, Kingdom of Saudi Arabia*

**Introduction:** Precise anatomical knowledge of human vertebra is necessary for the safe placement of screws, pre-surgical planning, and designing surgical instruments. There are no existing reports on the morphometry of vertebra in the Saudi population. **Objective:** To perform morphometric analyses for the thoracolumbar vertebrae in the Saudi population. **Methods:** This is a descriptive study. A total of 50 spine CTs were collected from the PACS system and reviewed for any abnormal pathology. Any CT with major pathology like tumor, fracture, and deformity was excluded. Each vertebra was measured for the following parameters: 1. Pedicle width. 2. Distance from pedicle to ant. vertebrae. 3. Ant. vertebrae width. 4. Canal diameter. 5. Height of pedicle. 6. Angle of pedicle. All data were entered in a statistical analysis program and compared to the existed date of other populations.

## VASCULAR

### Epidemiology of aneurysmal subarachnoid hemorrhage at a University Hospital in Jeddah, Kingdom of Saudi Arabia

*Yasir Bokhari, Abdulaziz Batarfi, Yasir Alnahdi, Saleh Baesa, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia*

**Objective:** To describe patient characteristics and outcome in aneurysmal subarachnoid hemorrhage (SAH). **Methods:** A retrospective chart review was performed of the medical records for all patient with aneurysmal SAH who were treated at King Abdulaziz University Hospital between July 2000 and December 2012. Data points included patient age, gender, and nationality, time to hospital presentation, clinical presentation, aneurysm demographics, treatment, complications, and outcome. Date was analyzed using the Statistical Package for Social Sciences. **Results:** We included 31 patients. The mean age of the patients was 43.2 (11.5) years. Men comprised 34% of the sample. Twenty-eight patients (68.3%) had risk factors for SAH; 80.5% (n=33) of the cases showed evidence of SAH on brain CT. Fifteen patients (36.6%) had a Glasgow Outcome Score of 4 while 14 (34.1%) had a score of 5. Unfavorable outcome was associated with the presence of postoperative vasospasm ( $p<0.001$ ), cerebral

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edema ( $p=0.001$ ), and hydrocephalus ( $p=0.003$ ). Patients with World Federation of Neurological Surgeons grade 3 and 4 had significantly poorer outcomes ( $p=0.001$ ). Outcome was not associated with patient gender, the presence of risk factors, evidence of SAH on brain CT, or treatment modality. **Conclusion:** The pattern and outcome of aneurysmal SAH are similar to those reported in the literature. Smoking and hypertension are the most common risk factors. Unfavorable outcome is associated with postoperative vasospasm, hydrocephalus, and cerebral edema.

### Concurrent solitaire FR use and carotid stenting in acute tandem carotid occlusion setting

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**Background:** Treatment of tandem acute internal carotid artery (ICA) occlusion and middle cerebral artery (MCA) occlusion represents a challenge from a neurointerventional point of view. Multiple modalities and approaches are described in the literature with limited evidence on each. **Methods:** Seven patients presented with acute stroke symptoms and signs. Computed tomography (CT) and CT angiogram revealed tandem ICA and MCA occlusions. Endovascular treatment was aimed to address MCA occlusion and achieve recanalization distally as a first step; utilizing the solitaire FR revascularization device. After MCA recanalization was restored, the ICA occlusion was treated with balloon angioplasty and stenting during the same setting. **Results:** Seven patients (4 males, 3 females) were treated utilizing the technique described above. The ages were from 45 to 74 years. Near complete or complete recanalization was achieved during the procedure and confirmed with ultrasound during follow up. Follow up CT head revealed only small basal ganglia infarcts with sparing of the remainder of the MCA territory in all treated patients. **Conclusions:** The described endovascular approach above is successful and technically feasible. As the phrase 'time is brain' goes, the authors suggest this approach offers earlier cerebral reperfusion and potentially saves more neuronal tissue as opposed to the reversed approach (ICA stenting followed by MCA recanalization).

### Pediatric intracranial aneurysms: characteristics, presentation, management, and outcome

*Zuhair Hassan, Yasser Orz, Mahmoud AlYamany, Sultan AlQahtani, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

**Background:** Pediatric aneurysms are rare and poorly understood as compared with those in adults. The aim of our study is to characterize the clinical, imaging, presentation, management, and outcome of patients younger than 18 years diagnosed with intracranial aneurysms at our institute. **Methods:** A retrospective review of patients presented with intracranial aneurysms managed in our center from 2007-2013. **Results:** Of 170 patients with intracranial aneurysms managed in our institute during that period, 14 pediatric patients (8.2%) harboring 24 aneurysms were treated using microsurgical or endovascular techniques. Nine patients (65%) presented with subarachnoid hemorrhage. Most of the aneurysms were located at the anterior circulation (87.5%). Eight patients (58%) had their aneurysms located at the carotid artery bifurcation (CAB). Most of the aneurysms were small in size with wide necks and irregular shape, 3 patients had giant non-ruptured aneurysms. One patient had 8 aneurysms located at different locations and he experienced 2 attacks of SAH from 2 different aneurysms at 4-year intervals, and he died due to the second attack. Another patient had 2 SAH attacks with 7 years interval, the second attack was from ruptured do novo right PCom aneurysm. Most of the patients (86%) were treated by microsurgical clipping of their aneurysms. Twelve patients (86%) had good outcome and only one patient died in our series. **Conclusions:** Pediatric intracranial aneurysms pose considerable diagnostic and therapeutic challenges. Good outcome was achieved with both surgical and neurointerventional management of pediatric patients with intracranial aneurysms. Long life follow up with either CTA or angiogram should be considered for these patients.



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## Early abnormal transient hyperemic response test can help predict delayed ischemic neurogenic deficit in subarachnoid hemorrhage

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Delayed ischemic neurological deficit (DIND) due to vasospasm is a common cause of morbidity and mortality in patients suffering from subarachnoid hemorrhage (SAH). In aneurysmal SAH, DIND occurs in 22-30% of patients, while angiographic vasospasm with or without symptoms is reported in up to 70%. The DIND occurs 4 to 21 days after SAH, with a maximum from day 4 to day 7. Clinical presentation includes a change in level of consciousness along with new or worsening focal neurological deficits. There is no perfect diagnostic tool for DIND. A very viable alternative would be the discovery of a test that allows early detection of impending vasospasm and from there, more timely treatment, and reversal of ischemia. Little is known on the initial autoregulation state in patients presenting with aneurysmal SAH. We present our experience in the early use of the transient hyperemic response test (THRT) as a predictor of clinical DIND in a cohort of patients with SAH. We reviewed our prospectively collected THRT examinations performed on patients with subarachnoid hemorrhage (SAH) performed within the first 24-48 hours of admission. A total of 21 patients were reviewed. Of these 40% developed symptomatic DIND necessitating treatment. Two additional patients developed asymptomatic vasospasm seen on routine follow-up vascular imaging with no treatment offered giving rise to a total incidence of vasospasm of 53.3%. In comparing the group of patients with DIND to those without, we found that 5 out of the 6 patients (83%) with DIND had an abnormal THRT ( $p=0.04$ ). Of note is that the 2 patients with asymptomatic vasospasm showed an abnormal THRT as well. Of these 7 patients with abnormal THRT, 3 were grade 1-3 SAH, and 4 suffered a grade 4 or 5 SAH. Early abnormal THRT may predict future development DIND in patients with SAH, independent of flow velocities or the clinical grade of the SAH. A prospective study is needed to confirm this assumption.

## Management of vein of galen malformation: The KFMC experience

*Amal Alyahya, Ayman Albanyan, Sultan Al Qahatni, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

**Introduction:** Embolization of VOGAD is the present treatment of choice and can lead to good outcome. The authors discuss the overall treatment options for the diagnosed patient with long term outcome. **Methods:** A retrospective database review was conducted between 2006 and 2014 on 10 patients diagnosed to have VOGAM in our institute. Median follow-up was 10 months, 70% underwent staged intra-arterial embolization and 30% were managed conservatively. **Results:** A 10% death rate was secondary to heart failure. All non-embolized (30%) showed complete resolution of the diagnosed VGAM. **Conclusion:** Advancement of endovascular embolization as primary therapy for VOGAD. However, the presence of complete resolution with excellent outcome without intervention indicating that exact pathophysiology of VOGAD is not fully understood and clinical judgment from the multidisciplinary team will provide the patient best treatment option.

## PEDIATRICS

### Minimal invasive craniostomosis correction without the use of the helmet: Updates to the technique and avoiding complications

*Khaled B. Aly, Cairo University, Cairo, Egypt*

**Introduction:** Minimal invasive craniostomosis correction has proven to be a valid tool for craniostomosis correction. Our technique is performed without the need for a helmet. **Methods:** Over the past six years, 100

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cases have been operated upon using this technique. Over these years, several difficulties were encountered. Also, technical modifications were adopted for safer surgery and better outcome. *Aim of this work:* Both issues (difficulties and technical modifications) will be discussed. *Conclusion:* Minimal invasive craniostomy correction without a helmet is effective, safe, and probably better than open surgery. However, awareness of some technical points is essential to achieve better results and to avoid serious complications.

### Is shunt series x-ray necessary before revision of obstructed ventriculoperitoneal shunt?

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*Objectives:* The purpose of this study is to estimate whether routine preoperative shunt series (POSS) lead to clinically relevant new information that helps in the management of ventriculoperitoneal shunt (VPS) obstruction, focusing on its role in diagnosing mechanical causes of shunt obstruction. *Methods:* Retrospective review of 64 consecutive patients who underwent revision of obstructed VPS in the Neurosurgery Division, at King Saud University, Riyadh, Saudi Arabia, between June 2002 and December 2011, assessing the proportion and impact of abnormal findings in the POSS. *Results:* Sixty-nine POSS were performed for 64 patients before revision of obstructed VPS. Their mean age was 11.8 years, and 25 patients among them were females. Seventeen (24.6%) POSS had abnormal findings, which were statistically significant ( $p=0.005$ ), and only 10 of them influenced the surgical technique or choice of therapeutic procedure ( $p=0.0001$ ). Positive findings were in the form of broken/disconnected catheter ( $n=4$ ), intra-abdominal migration of peritoneal catheter ( $n=4$ ), coiled/extra-peritoneal distal catheter ( $n=2$ ), short peritoneal end ( $n=1$ ), and retained catheter/more than one shunt ( $n=6$ ). However, the majority of shunt series (75.4%) were normal. *Conclusion:* Routine shunt series x-ray alone is not a diagnostic tool for shunt malfunction, and POSS should be reserved for patients with proven shunt failure on CT or MRI scan. There was a significant impact of POSS on the operative decision for those undergoing revision for VPS obstruction.

### Predictors of postoperative infection after neurosurgical repair of open myelomeningocele

*Amal Alyahya, Ayman AlBanyan, Ali Aljuzair, Noha Alsaydalani, Abdulrahman J. Sabbagh, Maqsood Ahmed, National Neuroscience Institute, King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia*

*Introduction:* The purpose of this study was to review the postoperative infection rate in the surgical repair of open myelomeningocele, and determine factors which predict infection after the surgery. *Methods:* Retrospective database review was conducted for the period from January 2006 to February 2014 on 79 consecutive cases that underwent repair of MMC at the Pediatric Neurosurgery Department, National Neurosciences Institute, King Fahad Medical City. Another 3 cases were excluded because the repair was carried out in another hospital, or the infection preceded the repair. The postoperative infection rate (dependent variable) was determined, independent variables studied were: time of repair, timing of CSF diversion, size of defect. Postoperative infection was defined as: meningitis (positive CSF culture) or local wound infection (positive culture from wound) during the first 60 days after the repair. Type of closure was determined by the size; where primary closure was achieved with defects less than 5cm maximum diameter, and closure using a myocutaneous flap for defects larger than 5cm diameter. *Results:* The overall postoperative infection rate was 23% (meningitis 9%, wound infection 15%) within the first 60 days after the repair. Timing of the repair ( $p=0.004$ ), type of repair ( $p=0.03$ ), were both predictive of postoperative infection (multivariable logistic regression analysis). 10% of cases repaired within the first 24 hours developed an infection, while 30% repaired later developed an infection. 9% of small defects closed primarily developed an infection while 32% of large defects closed using a myocutaneous flap developed an infection. Timing of CSF diversion was not predictive of postoperative infection ( $p=0.083$ ). *Conclusion:* Early closure of myelomeningocele

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within the first 24 hours of birth, and primary closure (when possible) significantly decreases the rate of meningitis and wound infection within the first 60 days after closure of the myelomeningocele.

### **Multiloculated hydrocephalus in children: does neuroendoscopy make a difference?**

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**Introduction:** The purpose of this study was to assess the role of endoscopy in the surgical treatment of multiloculated hydrocephalus, and whether it has an effect on the number of VP shunts implanted, future shunt revision rate, and to establish variables leading to repeated fenestrations. **Methods:** Retrospective database review was conducted for the period of 2008 to 2014 on 15 consecutive cases of multiloculated hydrocephalus that underwent endoscopic fenestration at the pediatric neurosurgery department, NNI, KFMC. Preoperative variables studied were age, etiology, CSF analysis, and radiological characteristics. Postoperative variables were number of VP shunts inserted, number of repeated fenestrations, and future VP shunt revision rate. Multiloculated hydrocephalus was defined as 2 or more isolated (non-communicating) cystic dilatations on MRI. Cases of single cyst or a single entrapped ventricle were excluded (9 cases). Cases were divided based on radiological characteristics into: complex (with 4 or more cysts, involving both supra and infratentorial compartments, and distorted ventricular anatomy) or simple, in addition to presence or absence of cystic wall enhancement. **Results:** The mean age in our series was 8.4 months ( $\pm 7.7$ ). The mean follow-up was 55 weeks ( $\pm 71$ ). Ten cases underwent endoscopic fenestration and insertion of only one VP shunt; another 4 cases underwent endoscopic fenestration and insertion of 2 VP shunts, while only one case underwent endoscopic fenestration with no VP shunt insertion. Two cases in our series required mini-craniotomy in addition to endoscopic fenestration. The etiology was meningitis (7 cases), IVH (5 cases) and post VP shunt infection (5 cases). Out of 9 complex cases, 4 required insertion of 2 VP shunts, while all simple cases (6 cases) required insertion of only one VP shunt. Forty percent (2 out of 5) with enhancing cystic wall required 2 shunts while only 20% (2 out of 10) required 2 shunts in non-enhancing cystic wall. Sixty percent of cases with enhancing cystic wall required repeated fenestration, while only 10% of cases with non-enhancing cystic wall required repeated fenestration. **Conclusion:** Endoscopic fenestration is effective in minimizing the number of shunts in multiloculated hydrocephalus. Simple multiloculated hydrocephalus cases may have an advantage over complex cases regarding number of shunts. Complex multiloculated hydrocephalus and enhancement of the cyst wall may be predictors for the need of future multiple fenestrations, and the number of shunts inserted.

### **Duration of preoperative external ventricular drain in pediatric posterior fossa tumors – does it matter?**

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**Objective:** The aim of the study was to assess the duration of preoperative external ventricular drain (EVD) as a predictor for permanent cerebrospinal fluid (CSF) diversion in pediatric posterior fossa tumors. **Methods:** The study was conducted in the Department of Pediatric Neurosurgery, National Neuroscience Institute, King Fahad Medical City, Riyadh, Saudi Arabia from January 2010 to December 2013. The data were collected retrospectively. It was registered on the proforma. All the data were reviewed from the clinical, operative, and radiological records. The patients who had insertion of EVD before the definitive posterior fossa tumor surgery were included. The patients who were managed without EVD or with intraoperative insertion of EVD, who had shunt insertion before posterior fossa tumor surgery and who had recurrence were excluded from the study. After analyzing the data the conclusion was made. **Results:** The preoperative insertion of EVD was carried out in 38 patients with posterior fossa tumors. The patients were divided in 2 groups. Group A consists of those patients who had

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duration of preoperative EVD equal or less than 7 days. Group B includes those patients who had duration of preoperative EVD more than 7 days. Group A has 16 patients while Group B has 22 patients. Mean age was 4.5 year in Group A, and 5.5 year in Group B. The male to female ratio was 1:0.6 in Group A and 1:0.8 in Group B. The signs of raised intracranial pressure (ICP) were seen in 81.25% of patients in Group A and 77.27% of patients in Group B. Most of the patients presented with short duration of symptoms in both groups and had midline tumor. Gross total resection was achieved in 81.25% in Group A, and 81.82% in Group B. Medulloblastoma was the predominant histopathologic diagnosis in both groups. CSF leak was observed in 18.75% in Group A, and 9.09% in Group B ( $p=0.632$ ). Pseudomeningocele was seen in 12.5% in Group A, and in 18.18% in Group B ( $p=0.635$ ). Preoperative EVD related infection was seen in one patient in Group B. There were 3 patients in each group who had postoperative EVD related infection with 18.75% in Group A, and 13.64% in Group B ( $p=0.644$ ). Ventriculoperitoneal (VP) shunt was required in 31.25% of Group A patients, and 18.18% of Group B patients ( $p=0.350$ ). **Conclusions:** There are a well-known number of factors that can determine the need for permanent CSF diversion in patients with posterior fossa tumors. The preoperative EVD; however, better controls the symptoms of obstructive hydrocephalus. There is no effect of preoperative duration on EVD in determining the requirement of postoperative VP shunt.

### The introduction of selective dorsal rhizotomy in Saudi Arabia

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**Introduction:** The purpose of this study is to report and discuss the first 3 cases of SDR carried out in Saudi Arabia, including the presentation, selection criteria, the surgical technique and outcome. **Methods:** We report the initial results of the first 3 SDR cases of an ongoing combined study between the Pediatric Neurosurgery Department, NNI, and the Rehabilitation Hospital, KFMC. All 3 cases were selected for surgery as part of a structured multidisciplinary spasticity program for children at KFMC. Variables discussed are: preoperative assessment, selection criteria, surgical technique, and outcome. The preoperative and postoperative assessment was performed by one physiotherapist in all patients and included: degree of spasticity (Ashworth scale), gait analysis, power assessment, and functional score (GMFM, WeeFIM, ADL). The same assessment was repeated postoperatively in 6 and 12 months. **Results:** All 3 patients showed improved gait analysis and GMFM. Two out of the 3 had also improved WeeFIM and ADL, while the third had no change in both WeeFIM and ADL. There were no postoperative complications. All 3 cases were transferred to the rehabilitation hospital within one week postoperatively. **Conclusion:** SDR has been proven to improve functional outcome in selected cases of spasticity in children, and its introduction in Saudi Arabia is long overdue. Our initial positive results will hopefully encourage the spread of this surgical modality.

### Selective dorsal rhizotomy (SDR) in patients with spastic diplegia; state of the art neurosurgery with a neurophysiology perspective

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Selective dorsal rhizotomy has been the main use of applying specific rhizotomy techniques for neurosurgeons specializing in cerebral palsy (CP); performed with the assistance of a trained neurophysiologist. With approximately 200,000 new patients every year and an incidence rate of 2.5/1000 live births, CP can be extremely debilitating to deal with both for physicians and communities worldwide due to its magnitude and involvement of multiple body systems. Cerebral palsy refers to a static lesion of the CNS; not resulting from a recognized malformation



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and producing chronic problems with motor strength/control (Continuum, CP, AAN). Cerebral palsy can present in many forms, but primarily manifests in >70% patients as disruption of motor function characterized by increased limb rigidity primarily in the lower extremities (spastic diplegia). Sherrington et al (1898) first reported that spasticity could be relieved by segmental dorsal rhizotomy (lesioning problematic nerve roots) in decerebrate animals, indicating the underlying mechanism was hyperactive reflexes due to loss of descending inhibitory inputs. Physiologically, facilitation from muscle spindles ascending up from the muscles to the cord is balanced by inhibition from descending tracts producing normal muscle tone in healthy subjects. To achieve best results from SDR, correct patient selection is most important - whereby spasticity is the main handicapping factor. Peacock et al published that spasticity stayed reduced 10 years post op in all his patients. Eighty percent of patients showed significant improvement in motor function. Sensory disturbances were insignificant. Less than 2% had bowel and bladder issues when SDR was performed with comprehensive intraoperative neurophysiology set up and performed by a trained neurophysiologist. In SDR with intra-operative neurophysiology, sensory nerve roots (where spasticity is located) are first separated from the motor ones at the conus (Park et al) or in the cauda equina (Abbot et al, Peacock et al). The spastic sensory roots are then selectively identified and confirmed via electromyography and divided into multiple rootlets (3-8) at each level bilaterally from L2-S1/S2. All these rootlets are then tested using an advanced EMG testing technique with specific parameters under 50 or 60 Hz stimulation and the ones producing spasticity are then selectively lesioned using a spasticity grading criteria (Park et al). These over-firing, non-GABA-absorbing nerves (rootlets) generate unusual electrical activity during EMG testing phase, and are thus considered to be the source of the patient's hypertonia. **Conclusion:** In general, SDR is an outstanding technique, requires a team effort from different neurosciences professionals but produces outstanding Results: Considering the abundance of CP patients around the world and especially in the Middle East and many presenting with spastic diplegia, it is pertinent that young neurosurgeons understand SDR and learn this state of the art but yet simple procedure.

### **Pediatric skull base chordoma: report of 4 cases and review of the current literature**

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**Introduction:** Chordomas are extremely rare tumors among childhood and adolescents, to our knowledge there have been only 2 reported cases of chordoma among the pediatric age group in Saudi Arabia published more than 20 years ago. **Methods:** The research criteria were designed to look for patients among the pediatric age group (0 – 16 years) at time of diagnosis of pathologically confirmed chordoma who were treated at the Pediatric Neurosurgery Department, National Neuroscience Institute (NNI), King Fahd Medical City (KFMC). A retrospective database review was conducted for the period from 2007 to 2013. Variables reviewed were: clinical presentation, surgical technique, complications, degree of resection, adjuvant treatment, and follow-up. Review of the current literature was also conducted. **Results:** Four cases were identified that met the inclusion criteria. Three were females and one male. The mean age at time of diagnosis was 8.1 years (range 4 -15). The mean follow-up was 39 months ( $\pm$  22.6). All cases of chordomas were involving the clivus. Three patients presented with symptoms related to cranial nerves palsies, while one presented with chronic headache. All patients underwent partial surgical resection and postoperative radiation therapy. No patient received chemotherapy. Pathological report including immunohistochemistry revealed chordoma of the conventional type in all reported patients. There were no reported deaths in this series. No cases showed progression of disease with last follow-up.



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## Endoscopic management of third ventricular arachnoid cyst mimicking aqueductal stenosis

*Bilal K. Afridi, Mohammad I. Khan, Mumtaz Ali, Lady Hospital, Peshawar, Pakistan*

**Objective:** To investigate third ventricular arachnoid cysts (AC) presenting as aqueductal stenosis (AS). **Methods:** This cross-sectional study was conducted in our department between May 2010 and February 2014. All the patients who had undergone endoscopic treatment for hydrocephalus were reviewed regardless of gender and age. Those patients who had an AC of the third ventricle treated endoscopically were included and those with primary stenosis were excluded from the study. The clinical sheets were reviewed and the mode of diagnosis; namely, whether pre-op imaging or per-op endoscopy were recorded. Operative notes were also retrieved and type of the procedure and complications if any were also recorded on a designed proforma. Data were expressed in the form of frequency and percentages. **Results:** Of the total 218 patients treated endoscopically for AS during the study period 13 (5.96%) were harboring an AC. The age range was from 3 to 14 years with a mean age of 6 years. There were 8 males and 5 females with a male to female ratio of 1.6:1. Pre-op imaging in the form of CT or MRI was carried out in all (100%). The AC was diagnosed on pre-op imaging in 8 (61.53%), while in 5 (38.47%) it was diagnosed per-operatively. All patients (100%) underwent ventriculostomy with coagulation of the cyst wall and cystocisternotomy (CC). The patients remained admitted for 2 days and one patients developed meningitis (7.69%) and succumbed to it. No CSF leak was observed. **Conclusion:** The AC can mimic AS in a small but considerable number of patients, and AS should be preferably treated endoscopically to prevent diagnostic dilemma and management pitfalls.

## GENERAL AND TRAUMA

### Management of idiopathic intracranial hypertension: A 19 year experience

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Idiopathic intracranial hypertension (pseudo-tumour cerebri) is a condition affecting predominantly young adults. Although the exact aetiology is not clear in most cases, several possible mechanisms have been proposed. Medical treatment is effective in most cases, but a significant proportion does not respond to or does not tolerate the medications. In such cases, particularly when visual impairment is involved, surgical techniques are indicated. A range of procedures both ophthalmological and neurosurgical have been utilized in these medically refractory cases. We review our experience with surgical management of these intractable cases with cerebrospinal fluid diversion. We also discuss ongoing exploration of interventional neuroradiological techniques at our center in potentially reversing the pathophysiology of intracranial hypertension in these patients.

### Measuring the immeasurable; lights on the Health Care Quality; Neurosurgery as an example

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Quality can be defined as the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs. It was the early twentieth century and just after the First World War, when quality hypothesis came to support the Industrial Revolution. This was also adopted in the healthcare services to improve cost, services, and outcome. As an example the 2001 report of the institute of Medicine, "Crossing the Quality Chasm," indicated that "The American health care system is currently functioning at far lower levels than it could and should." This led to the "establishment of monitoring and tracking processes for use in evaluating the progress of the health system." In this presentation, the impact of adopting the concept of total quality management as proposed by many figures in the field of quality like Ed. Deming's and others. The concept of quality and cost in the healthcare system will be presented and discussed. Neurosurgery services will be taken as an example to illustrate

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such principles. In addition, efforts of the National Neurosurgery Quality and Outcomes Database as a continuous national clinical registry for neurosurgical procedures and practice patterns will also be discussed.

## Prognostic quality of MRI in severe traumatic brain injury patients

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Traumatic brain injury (TBI) represents one of the leading causes of death and disability worldwide. Severe TBI often has dramatic consequences for patients and families. The purposes of this study are to determine the predictive value of the number and location of axonal injuries detected on conventional brain MRI of severe TBI patients' outcome; and if the prognostic value is independent from the other known prognostic factors of TBI. A retrospective review of 81 patients with severe traumatic brain injury. Data regarding outcome predictors including: age, admission GCS, pupils' reaction, blood pressure, injury severity score, CT scan Marshall grade and MRI location and number of axonal injury were collected and correlated with outcome (GOS) at discharge. The number of axonal injuries on MRI was found to be the only significant predictor of death when controlling for the other predictors (OR=1.25, pseudo R2=0.21,  $p=0.002$ ), and was the only significant predictor of death or vegetative state (GOS 1 or 2) when controlling for other predictors (OR=1.29, pseudo R2 of 0.2139,  $p=0.002$ ). The numbers of axonal lesions on MRI and pupils reactivity were the only significant predictors of good outcome (GOS 4 or 5) (OR=0.83, pseudo R2 of 0.240,  $p=0.01$ ). The number of axonal lesions on MRI is an independent predictor of death and vegetative state and predicts good outcome, provided both pupils are reactive.

## Is ventricular drain sampling from the collecting chamber as accurate as the 3-way stopper? A prospective study

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**Introduction:** Frequent CSF sampling from external ventricular drains (EVD) is needed to verify sterility and biochemical changes. The CSF collection is routinely carried out in our institution through the 3-way stopper (3WS) of the CSF collecting system and not usually from the collecting chamber (CCh) thinking that this may give us false Results: Reason being; CSF may get contaminated; cellular and biochemical results may change with time because of sedimentation. Collecting from CCh may be safer as no direct negative pressure that may cause malfunctioning or hemorrhage. **Objective:** To compare the accuracy of CSF sampling from the CCh with 3WS. **Methods:** A prospective comparative study of all the patients with EVD in all neurosurgical or ICU wards at our institution, during the period of April, 2012 to April, 2013. Two CSF samples from every patient: from the 3WS and CCh. The collected samples sent to the lab labeled as samples A and B. These were tested for protein, glucose, Gram-stain culture, and sensitivity, and cell count. All were analyzed by SPSS software through T-test. **Results:** Ninety-five samples were collected, 4 variables were studied; WBC, RBC, protein, and glucose. The samples were taken: from 3WS (sample A) and from CCh (sample B). Both samples were compared. WBC ( $p=0.13$ ), RBC ( $p=0.59$ ), protein ( $p=0.95$ ), glucose ( $p=0.98$ ). All variables did not show statistically significant Results: **Conclusion:** Cell count and biochemical sampling from the CCs of EVDs is not a predictor of death and vegetative state and predicts good outcome, provided both pupils are reactive.

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## FUNCTIONAL

### Surgery of medically intractable epilepsy

*Tomokatsu Hori, Department of Neurosurgery, Tokyo Women's Medical University, Tokyo, Japan*

Among the medically intractable epilepsies, temporal lobe epilepsy and gelastic seizure caused by hypothalamic hamartoma are notorious for their medical intractability. In this communication, various techniques of surgical treatment of temporal lobe epilepsy including subtemporal and transsylvian selective amygdalohippocampectomy will be presented. Especially surgical results of subtemporal amygdalohippocampectomy will be illustrated with their neuropathological analyses. Then, the technique of anterior temporal lobectomy with linear skin incision based on SEEG findings will be presented. Lastly, 2 cases of interhemispheric trans-lamina terminalis approach for hypothalamic hamartoma will be presented. These 2 patients are seizure free now. Not only surgical techniques, but also neuroimaging including FDG-PET findings, EEG recordings, and in some patients SEEG findings are especially important to obtain good surgical Results: Finally, neuropathology of resected specimen is crucial to elucidate the intractability of epilepsy.

### Sacral neuromodulation in neurogenic bladder of incomplete spinal cord injury

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**Objective:** The World Health Organization found Saudi Arabia has the world's highest number of deaths from road accidents in adult males aged 16-36. The Ministry of Health (MOH), Saudi Arabia, has recorded one of the highest rates of spinal cord injuries in the world, mostly resulting from Road Traffic Accidents (RTAs). The prevalence of spinal cord injury (SCI) in Saudi Arabia is 627 patients per million. The incidence of SCI in Saudi, the highest compared with most other countries, over the past years is 38 per million. Spinal cord injury, spina bifida, and myelomeningocele are conditions that have a similar spectrum of symptoms, with a devastating event whose sequelae of paralysis, paresthesia, and bowel and bladder dysfunction have significant lifelong consequences. A common cause of a neurogenic bladder is SCI and is a major contributor to the morbidity and mortality of SCI. Normal lower urinary tract function consists of low pressure storage, and voluntary, coordinated expulsion of urine. Neurogenic voiding patterns range from bladder atony to hyper-reflexia with detrusor external sphincter dyssynergia (DESD) or synergy. Uncoordinated voiding or high storage pressures can cause upper tract deterioration, while high residual urine volumes can lead to recurrent urinary infections. Several factors may act to predispose patients with neurogenic bladder to urinary tract infection (UTI). These are high pressure voiding, large amounts of post-voiding residuals, bladder catheterization, vesico-ureteral reflux, bladder over distension, stones in the urinary tract, and outlet obstruction, recurrent UTI requires multiple courses of antibiotic therapy and high incidence of multidrug-resistant (MDR) infection. In patients with a spinal cord injury, intermittent bladder catheterization (CIC), indwelling catheter, and supra-pubic catheter are used to empty the bladder. Complications of these modalities include urethral/scrotal events that include bleeding, urethritis, stricture, creation of a false passage, and epididymitis. Bladder-related events can cause UTIs, bleeding, and stones. Uncoordinated voiding or high storage pressure can cause upper tract deterioration. In addition to the high cost and poor patient compliance. Sacral neuromodulation (SDM) is the electrical or physical modulation of a nerve to influence the physiologic behavior of an organ bowel, bladder, or penis. Sacral neuromodulation improves neurogenic bladder, intestinal motility, penile erection, and chronic pelvic pain. In addition, SNM has neuroprotective effects of sacral nerve in the SCI patients.

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Its use in neurogenic bladder is unique for the following reasons: to prevent possible life-threatening effects like kidney failure in DSD, to improve quality of life issues (involuntary urine loss, UTIs, frequent catheterization, constipation requiring digital stool removal and a lack of sexual function), to function autonomously, to be able to interact socially, to prevent LUT malfunctions in SCI patients before irreversible effects occur, and finally to reduce the impact on the healthcare system from catheter use. **Methods:** Two patients of SCI and of lumbosacral spina bifida had 2 phases of SNM including voiding diary and urodynamic pre and post-operative. Two with hypo active bladder and one with hyperactive bladder who received more than 10 bladder Botox injections. Two of SCI were catheter dependent CIC and spina bifida with overflow incontinence all underwent IPG implant. The 2 years of follow up have now been achieved. **Results:** The first, a 30-year-old male partial SCI at T12 for 10 years was emptying the bladder completely without catheterization. The second is a female of L4 partial SCI with recurrent febrile UTI, and she is emptying the bladder completely, improved defecation ability, and no UTI. The last patient is a 28-year-old male patient with L4-S1 spina bifida repaired at a younger age, had a male sling for a weak sphincter, he is total continent all after one year of follow up. Post-operative urodynamics for all patients showed an increase of bladder activity. Uroflow shows hypo-activity pattern, taking up to 2 minutes. Voiding time and 10-0 cc post void residual max in all of them. No complications related to surgery or revision. **Conclusion:** Sacral neuromodulation is a promising minimally invasive procedure, cost effective, lower complication rate, with complete control by the patient and fewer complications and UTIs compared with catheter in SCI patients.

### Electrode–brain interface in globus pallidus internus deep brain stimulation

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**Introduction:** Deep brain stimulation (DBS) is a well-established treatment for movement disorders. The benefit of DBS is related to the application of an electrical field that distributes symmetrically in all direction around a specific electrode contact. Here, we analyze the electrode–brain interface (EBI) in the globus pallidus internus (GPI) and the estimated electrical field density geometry and radial extension required to induce an internal capsule and optic tract clinical response. **Methods:** A total of 104 electrode contacts implanted in the GPI were analyzed. The anatomical location of each individual electrode contact was extrapolated using pre- and post- implantation image fusion. The anatomical distance between the center of each contact and the optic tract was measured on the magnetic resonance image (MRI). Monopolar electrical stimulation was applied on each electrode contact with different frequencies and current amplitudes to elicit a clinical response from the internal capsule and optic tract. The threshold-distance data for the estimated electrical field ET (V/mm) and clinical response threshold were calculated. **Results:** Five electrode contacts were excluded due to relatively high impedance. The electrodes have a diameter of 1.27 mm and consist of 4 contacts with a contact length of 1.5 mm and an inter-contact distance of 1.5 mm. Each electrode contact is 6 mm<sup>2</sup>. The mean distance between the distal contact and optic tract was 1.84 mm, and the mean distance from the electrodes' nearest contacts to the internal capsule was 3.4 mm. The DBS stimulation parameters were at 60 us, 130 Hz, and monopolar mode. The clinical response threshold was 0.8 V/mm for optic tract, and 1.2 V/mm for the internal capsule reflecting the electrical density radial extension. The overall estimated isolevel of the electrical field that activated a clinical response around each contact was 2.4 mm at 1 volt stimulation. **Conclusion:** This study revealed the extent of electrical field delivered from a cylindrical electrode contact. Utilizing an electrode with multiple small contacts to steer the electrical field toward the target can minimize the unintended stimulation side effects.

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## Preventing lower cranial nerve injuries during fourth ventricle tumor resection by utilizing intraoperative neurophysiological monitoring (IONM)

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We present 2 cases illustrating the benefit of utilizing intraoperative neurophysiological monitoring (IONM) for preventing injuries to lower cranial nerves during fourth ventricle tumor resection surgeries. Nuclei of multiple cranial nerves are located at the floor of the fourth ventricle and have a high risk of permanent damage during these surgeries without IONM. An 8-year-old, and a 10-year-old male patient presented to the ER with an MRI of the brain showing brainstem/fourth ventricle tumors. After intubation, bilateral posterior tibial nerve SSEP, median nerves SSEP, four-limb and cranial nerves TCeMEPs, auditory evoked potentials (BAER) and s-EMGs were recorded. Electromyogram (EMG) was monitored from cranial nerves V, VII, IX, X, XI, and XII bilaterally. Total intravenous anesthesia was used with Propofol and Remifentanyl infusion. Neuromuscular blockade was used only for initial intubation. A train of four (TOF) was maintained during the procedure. Pre-incision baselines were obtained with good morphology of waveforms. After exposure, the floor of the fourth ventricle was mapped by t-EMG. Responses were recorded from CN VII-XII between 0.4-1.0 mA. In both patients, the tumor was entangled with cranial nerves VII to XII at the floor of the fourth ventricle. Intraoperative spontaneous and triggered EMG was effectively utilized in preventing injuries to cranial nerves during surgical procedures. The surgeon made the decision not to resect the tumor in one case and limiting the resection to 70% of the tumor in the second case on the basis of neurophysiological monitoring. This was decided to minimize any post-operative neurological deficits due to surgical manipulation of the tumor involving the lower cranial nerves. All signals including SSEPs, BAERs, and TCeMEPs remained stable for the duration of the surgical procedure. Postoperatively both patients were well with no additional cranial nerve weakness. At 3 month follow-up, patients continued to have no deficits.

## VNS Therapy, is it still a palliative modality in intractable epilepsy?

*Fadi Alghareeb, Ali Aljuzair, Prince Sultan Military Medical City, Riyadh, Kingdom of Saudi Arabia*

For a long time, VNS therapy was considered as a palliative modality of treatment in intractable epilepsy, the new developments and new understanding of this type of surgical intervention along with the long-term results showed that VNS therapy should be considered as one surgical option earlier. We will discuss our results in PSMMC compared to others published to confirm this theory.

### SUPPLEMENTS

- \* Supplements will be considered for work including proceedings of conferences or subject matter covering an important topic.
- \* Material can be in the form of original work or abstracts.
- \* Material in supplements will be for the purpose of teaching rather than research.
- \* The Guest Editor will ensure that the financial cost of production of the supplement is covered.
- \* Supplements will be distributed with the regular issue of the journal but further copies can be ordered upon request.
- \* Material will be made available on the Neurosciences website ([www.neurosciencesjournal.org](http://www.neurosciencesjournal.org))