

## Poster Abstracts

### F1

#### **Central Neural Substrates of Cardiorespiratory Control During Slow Breathing and Hypoxic Challenge**

*Alessia Nicotra, MD; Hugo Critchley, MD; Patrizia Chiesa, MD; Yoko Nagai, MD; Marcus Gray, MD; Ludovico Minati, MD; Luciano Bernardi, MD*

Controlled slow breathing (at 6/min) can have beneficial effects on cardiovascular function, including responses to hypoxia. We tested neural substrates of cardiorespiratory control in 20 healthy subjects (F=8; age =  $35 \pm 10$  yrs) during paced (slow and normal rate) and unpaced spontaneous breathing of normoxic and hypoxic (13% inspired O<sub>2</sub>) air using functional magnetic resonance imaging. Cardiovascular and respiratory measures were acquired synchronously. Peripherally, slow breathing was associated with increased tidal ventilatory volume; hypoxia suppressed heart rate variability and increased heart rate. Centrally, slow breathing activated dorsal pons, cerebellum, periaqueductal grey matter, hypothalamus, thalamus, lateral and anterior insular cortices. Blocks of hypoxia induced activation of mid pons, bilateral amygdalae, anterior insular and occipitotemporal cortices. Interaction between slow breathing and hypoxia was shown in ventral striatal and frontal polar activity. Across conditions, within brainstem, dorsal medullary and pontine activity correlated with tidal volume and inversely with heart rate. Activity in rostroventral medulla correlated with beat-to-beat blood pressure and heart rate variability. Our study outlines slow breathing effects on central and cardiovascular responses to hypoxic challenge. The findings show involvement of discrete brainstem nuclei to cardiorespiratory coupling and corticostriatal circuitry during physiological responses accompanying breathing regulation in hypoxic challenge.

### F2

#### **The Effects of Hypoxia on TRPC4 Down Regulation in an Invitro BBB Cell Model**

*Nida Pasha, MD*

Many studies have confirmed an increase in paracellular permeability after a hypoxic or ischemic event. In particular a new superfamily of cation-permeable channels TRP are of particular interest as they are expressed on BBB endothelial cells, previous studies indicate TRPC4 regulates vascular permeability in lung during hypoxia. However the role of TRPC4 in BBB permeability is unknown. ECV304 cells were used to set up an in vitro BBB model, after which they were used to measure monolayer permeability after 3, 6, 24, 48 hours of hypoxic/ anoxic exposure. The monolayer permeability was quantified by calculating the flux of Na-F across the monolayer. Knock down of TRPC4 gene expression using siRNA was used to investigate the role of this channel, for which a new siRNA delivery method was optimized. Western blot analysis was carried out on these knock down cells in order to quantify the efficiency of TRPC4 knockdown. Monolayer permeability and cell viability was assessed after 24 & 48hours of hypoxic exposure. Results suggested that 48 hours of hypoxia caused a significant increase in monolayer permeability compared to control. Although there was no difference in permeability during 3-6 hours of hypoxic exposure, there was a fall in cell viability and protein concentration at 24 hours. The transfection of siRNATRPC4 resulted in cells that were more resistant to 48 hours of hypoxia compared to wild type cells. The transfected cells exhibited a lower permeability and higher cell viability compared to wild type cells. This study indicates the importance of TRPC4 in mediating the disruption of BBB permeability following prolonged hypoxia and the channel may be a useful therapeutic target for stroke.

### F3

## **A Computational Analysis of Potential Mechanism of Action in High Frequency Spinal Cord Stimulation**

*Jay L. Shils, MD; Lonzhi Mei, MD; Kris Carlson, MD; Jeff Arle, MD*

Introduction: High frequency (HF) (>1000 Hz) spinal cord stimulation (SCS) is a new technique for treating neuropathic pain (NP) without the standard side effects of paresthesias typical of lower frequency (F) SCS. The specific neurophysiologic mechanisms that allow for reduction of NP with generating the paresthesia side effect are not known. Using computational modeling techniques we have determined the specific ionic gate dynamics combined with the geometry based activating function (AF) for different axonal fibers diameters (D) are potentially the primary mechanism behind this therapy. Methodology: A 50 node active model of an axon was created that allowed for variations in D, intermodal length, (IL) and multiple ionic gate sub-component parameters. Using spatially correct electric field data from a model of the spinal cord the dynamics of multiple axons D were studied. From the spatial geometry, the AF, and the temporal response of the axon, down to the level of the H, M, and N gate the system dynamics were calculated at various stimulation F, pulse widths (PW), and amplitudes (A) as well as axon diameters. Results: By varying the stimulation F, A and fiber D, axons can be excited or blocked including the blocking of large D fibers while still allowing for transmission through smaller D fibers. The data demonstrates that the specific F where the HF stimulation starts to cause a complete conduction in the 14µm fibers is around 4200 Hz which coincides with the time constant of the m-gate and its ability to reset within the stimulation period. Conclusion: Present single pulse trained neuromodulation techniques act by either generating trains of action potentials in axons following a large to small D recruitment order or by caused anodal blocking. Our model proposes that for HF stimulation the blocking mechanism is a function of the gate dynamics and the AF side bands.

## **F4**

### **Generalized Periodic Discharges in Antibiotic-Induced Neurotoxicity**

*Justin Cheongsiatmoy, MD; Chutima Saipetch, MD; Dawn Eliashiv, MD, FACNS; John Stern, MD; Marc R. Nuwer, MD, FACNS*

Generalized Periodic Discharges (GPDs) can occur in anoxic injury, metabolic encephalopathy, drug toxicity, CNS infections, and neurodegenerative disorders. We describe a 60-year-old woman with end stage renal disease on peritoneal dialysis who was admitted for induction chemotherapy for acute myeloid leukemia. The hospitalization was complicated by bacteremia and rapid clinical decline after initiation of culture-sensitive vancomycin and cefepime. Although her neurological exam was intact prior to receiving antibiotics, she quickly worsened into a state of minimal responsiveness with myoclonus over the course of four days. Brain MRI and lumbar puncture did not reveal structural lesions or CNS infection. Repeated blood cultures were negative and renal function remained at baseline. An initial EEG demonstrated intermittent, sharply contoured waves with triphasic morphology. Subsequent EEG monitoring showed electrographic progression into unremitting and synchronous 2.5 Hz GPDs without evolution. GPDs persisted despite empiric treatment with IV lorazepam, levetiracetam, and valproic acid. Due to family wishes against intubation, burst suppression was not pursued and the family placed the patient in hospice. In retrospect, we postulate that cefepime toxicity may be a contributing factor to this patient's course. Encephalopathy and myoclonus are known manifestations of cefepime-induced neurotoxicity. EEG findings include triphasic-like waveforms as well as continuous, generalized, sharply contoured complexes with associated slow waves. In this patient, there was a progression from the former to the latter which correlated with her clinical decline. Physicians should be aware of the potential for pharmacological neurotoxicity and remain vigilant when observing abnormal electrographic features in this setting. Clinical outcomes may improve if offending agents are promptly identified and withdrawn.

## **F5**

### **Small Fast Rhythmic Eye Movements (SFREM) Misdiagnosed as Frontal Seizures**

*Ana Tercero, MD; Carles Gaig, MD; Alex Iranzo, MD; Juan Bernardo Gómez, MD; Joan Santamaria, MD*

AMPA-R encephalitis is an infrequent disease and its clinical presentation, course and prognosis are not well known.

Electroencephalographic changes reported are nonspecific. We report a 23 year-old patient with AMPA-receptor encephalitis who

developed prominent small fast rhythmic eye or eyelid movements (SFREM) in the EEG that were misdiagnosed as frontal seizures. The artifact was seen in the EEG channels as intermittent runs of low voltage theta activity at 6 Hz that did not change in frequency, and initially occurred associated with jaw rhythmic movements, yaws, and drowsiness (image 1). The background EEG of the patient was low amplitude and this fact probably allowed seeing this eye movement artifact better. Recording the eye movements with a piezoelectric transducer showed that the low voltage theta activity in the frontal channels was synchronized with similar frequency motions as seen by the transducer. This misdiagnosis caused changes in the therapeutic attitude. Our case emphasizes the need to recognize SFREM and to differentiate them from frontal seizures.

## F6

### **EEG Findings May Predict Outcomes of Herpes Simplex Encephalitis**

*Daiki Fujii, MD; Hitoshi Mori, MD; Katuru Shindo, MD;*

**Introduction:** Herpes simplex encephalitis (HSE) is a severe life threatening disease. Although acyclovir has significantly improved the outcome, mortality rate and risk of neurological sequela remain high. Quick diagnosis and treatment are inevitable. HSE shows various types of electroencephalogram (EEG) findings, but the relationship between EEG findings and prognosis is obscure.

**Methods:** We retrospectively identified HSE patients admitted in our hospital between December 2004 and September 2014. We assessed clinical courses, modified Rankin scale at discharge, initial EEG findings, brain imagings, and cerebrospinal fluid (CSF) findings. EEG findings were classified into four categories as follows, 1)burst suppression, 2)bilateral periodic lateralized epileptiform discharges (biPLEDs), 3)PLEDs, and 4) intermittent slow waves (IS).

**Results:** 9 patients were enrolled. 5 were men, and mean age was 53.7 years old. 4 patients were diagnosed by positive CSF HSV PCR, and 5 by rising titer of CSF HSV antibody. All patients showed abnormalities on brain MRI. One patient showed burst suppression, and mRS at discharge was 5. 2 showed biPLEDs, and mRS was 4 and 4. 3 showed PLEDs, and mRS was 3, 3, and 1. 3 showed IS, and mRS was 1, 0, and 0.

**Conclusions:** Abnormal EEG findings tend to indicate bad outcomes. Initial EEG findings may be an independent prognostic factor of HSE.

## F7

### **Paroxysmal Generalized Electrographic Delta Activity with Confusion During Natalizumab Infusion**

*Hamid Kadiwala, MD; Ryan S. Hays, MD; Paul C. Van Ness, MD; Mark Agostini, MD; Benjamin Greenberg, MD; Kan Ding, MD*

**Introduction:** Natalizumab infusion is a FDA approved treatment for relapsing-remitting multiple sclerosis (RRMS). This is the first reported case of a suspected natalizumab infusion related encephalopathy.

**Case:** A 35 year-old woman with a history of RRMS was referred to the Epilepsy Monitoring Unit (EMU) for characterization of her spells. Episodes of confusion and shaking would exclusively occur within two hours after natalizumab infusion; but she would subsequently return to baseline within 24 hours. The most recent episode occurred three days prior to her EMU admission. 48-hour video-EEG monitoring (vEEG) was non-diagnostic, since no events were captured and the interictal EEG was normal. On the date of the next scheduled infusion, she was at neurologic baseline with clear mentation; she was treated with ibuprofen, acetaminophen, and cetirizine prior to natalizumab per infusion protocol. An EEG obtained during infusion demonstrated generalized 2-3 Hz polymorphic delta activity; these EEG changes were accompanied by her typical spell within 15 minutes of infusion completion. During this time she became confused, agitated, and subsequently pulled off her electrodes eight minutes later. Her mental status returned to baseline after 24 hours.

**Discussion:** This case illustrates transient non-epileptic encephalopathy as a potential reversible complication of natalizumab infusion.

## F8

### **Clinical and EEG Features in Autoimmune Encephalitis**

*Michael Mendoza, MD; Robert Beach, MD; Kiran Aravapalli, MD*

Prognosis of autoimmune encephalitis depends on early clinical recognition. Electroencephalography and Long term monitoring are important to guide treatment in cases with equivocal imaging and CSF results. Retrospective chart review of 7 patients admitted at SUNY Upstate Medical Center admitted between 2011-August 2014 with a (+) serum antibody for P/Q VGCC, VGKC or NMDA receptor. The age range was 2-61 years old with 4 males/ 3 females. The most common presenting symptom was seizure preceded by behavioral or movement disorders. MRI imaging and spinal fluid were mostly normal. Serum P/Q-type VGCC (2/7), VGKC (3/7) and NMDA (2/7) were detected. Normal EEG, generalized slowing, focal slowing, and epileptiform abnormalities mostly involving the temporal head region were seen on EEG. Long term video EEG monitoring showed electrographic seizures (3/7) and non-epileptic events (4/7). Metastatic screening revealed malignancy or suspected mass in 2/7 cases. MRS on discharge range was 2-5. Brain Imaging was normal in most cases implying that these antibodies cause a functional or micro- structural change. Long term Monitoring is important to delineate seizures from non-epileptic events which prevents inadvertent use of AEDs. Patients with abnormal EEG had poorer functional outcome on discharge.

## F9

### **Clinical, Electroencephalographic and Radiologic Features of HHV6 Encephalitis: Case Series of Five patients.**

*Ahmed Yassin, MD; Sudhakar Tummala, MD*

Objective: To report clinical, electroencephalographic and radiologic features of HHV6 encephalitis in leukemic patients who underwent stem cell transplantation.

Methods: Retrospective review of five leukemic patients with HHV6 encephalitis complicating their post-transplant course. Patients were seen in MD Anderson Cancer Center in the past few years.

Results: Three patients had CML, one had CLL and one had ALL. All of them presented a few months after transplantation with altered mental status. Other clinical features were seizures, headache, fever and one with extrapyramidal features. Four needed ICU admission with intubation. Comorbidities included: pancytopenia, sepsis, graft versus host disease, and multi-organ failure. EEG showed focal electrographic seizures coming from temporal lobes in two patients, periodic epileptiform complexes in three patients, focal slowing in two patients and diffuse slowing in three patients. MRI brain showed T2/FLAIR hyperintensities in four patients: two of them in bilateral temporal lobes with corresponding diffusion restriction, one in the thalamus/hypothalamus/brainstem/cerebellum/basal ganglia (the one who presented with extrapyramidal features) and one in the periventricular areas. Spinal fluid showed pleocytosis, high protein and positive HHV6 PCR. Foscarnet was used as anti-viral agent in all of them. Anti-epileptics used were phenytoin, levetiracetam and valproic acid. Four patients died in few months and one completely recovered.

Conclusions: HHV6 encephalitis can add significant morbidity and mortality to leukemic patients following transplantation. Patients usually present with altered mental status, seizures, headache and/or fever. Salient EEG characteristics are periodic epileptiform complexes or overt temporal lobe seizures. MRI findings are T2/FLAIR signal hyperintensities mainly in the temporal lobes.

## F10

### **Emergent EEG- Utility During Business Versus Non-business Hours**

*Gowri Lakshminarayan, MD; Thandar Aung, MD; Laura L. Lehnhoff, MD*

Introduction: Emergent EEGs are ordered for rapid diagnostic and treatment decisions. Not all hospitals have the capability to perform this highly valuable tool during non-business hours in their clinical setting due to lack of available man power. In order to determine the yield of this test, we reviewed the results of 3 months of emergent EEGs in our tertiary epilepsy facility.

Results: Emergent EEGs done over 3 months (N=168) were analyzed retrospectively. N=122 from business hours (7AM-7PM) and N=46 from non-business hours (7PM-7AM).

Discussion: Two-thirds of the emergent EEGs were ordered during regular business hours and one-third during non-business hours. The most common reason for the request in either group was altered sensorium. Electrographic seizures were seen in 4% of the studies in each group. There was higher incidence of normal studies (15% vs 8%) during non-business hours (perhaps to facilitate ER discharges overnight). One fourth of the recordings in each group showed epileptiform abnormalities, suggesting that emergent EEGs are a valuable tool in the appropriate clinical setting.

## F11

### **EMG Findings of Radiation Induced Myopathy Mimicking ALS**

*Irisa Devine, MD; Devon Rubin, MD*

Introduction: Myopathy is a rare effect of radiation therapy and the clinical and EMG features of radiation myopathy are not well described.

Objective: To describe a case of a patient with clinical features suggestive of ALS, in whom needle EMG findings helped confirm radiation induced myopathy.

Case Report: A 54-year-old woman with remote past medical history of breast cancer, Hodgkin's lymphoma, and radiation therapy to the entire spine 25 years prior to presentation, developed a 10 month history of right leg weakness, falls, and camptocormia.

Neurologic examination demonstrated severe axial weakness, right leg weakness, hyperreflexia, and bilateral triple flexion responses. She was referred for EMG with a presumptive clinical diagnosis of ALS. Needle EMG revealed severely short duration motor unit potentials in the cervical and thoracic paraspinal muscles with a few fibrillation potentials and no myokymic discharges. The EMG was consistent with radiation induced axial myopathy. MRI of the spine revealed a normal spinal cord, with severe atrophy of the cervical and thoracic paraspinal muscles.

Conclusion: Radiation myopathy can mimic other neuromuscular diseases, such as ALS. Needle EMG is an important ancillary test that can help distinguish radiation induced myopathy from other mimicking disorders.

## F12

### **Masseteric Contraction or Motor Imagery Enhances Ulnar Nerve F Wave**

*Motohiko Hara, MD; Miki Kawamata, MD; Mizuki Kobayashi, MD; Rina Yoshida, MD; Jun Kimura, MD*

Background: We tested the validity of instructing patients to clench the teeth to facilitate F-waves recorded from a limb muscle in clinical practice.

Objective: To study effect of motor imagery and voluntary contraction of the masseter muscles on F waves recorded from the first dorsal interosseous muscle.

Methods: In 7 healthy subjects, 50 F waves each were recorded at rest, during motor imagery and during voluntary contraction monitored by a force transducer to maintain the level at 10% of maximal effort.

Results: F-wave persistence increased significantly ( $p < 0.05$ ) from  $33.7 \pm 21.4\%$  (mean  $\pm$  SD) at rest to  $44.3 \pm 22.8\%$  during motor imagery, and  $54.9 \pm 27.9\%$  during voluntary contraction. The F-wave amplitude and latency revealed no significant changes.

Discussion: We have previously shown that motor imagery or slight voluntary contraction of the target muscle enhances F-wave persistence. The current study indicates the same process involving a non-target muscle can also cause a transient increase in distant motoneuron excitability, similar to Jendrassik maneuver. Conclusion: Central drive directed to the masseteric motoneurons can enhance the excitability of ulnar nerve anterior horn cells as evidenced by an increase of F-wave persistence.

### F13

#### **Biopsy and EMG Findings in a Case of Late-Onset Dropped Head Syndrome after Mantle Field Radiotherapy**

*Amro Stino, MD; Mark Ross, MD, FACNS*

We present the case of a 66 year old lady with a chronic dropped head syndrome initially misdiagnosed as dystonia. She had received mantle radiation therapy from her chest up for stage IIA Hodgkin's Lymphoma. Cancer recurrence in 2006 was treated with chemotherapy alone. Multiple treatments, including Botox, and physical therapy failed to improve the head drop. Bedside examination at our institution showed weak and atrophic sternocleidomastoid and trapezius muscles with paraspinal cervical muscle atrophy, with no associated anterocollis and a normal exam otherwise. EMG/NCS showed normal spinal accessory and suprascapular nerve responses with fibrillation potentials and myopathic units in the cervical paraspinals with occasional similar changes in the trapezius. No myokymia was seen. An infraspinatus muscle biopsy showed a mixed neuromyopathic picture with type I fiber grouping with slight myopathic features. This case is unique in that it provides biopsy and electrodiagnostic evidence to support the growing body of literature that suggests a mixed neuromyopathic (Leeuwen-Segarceanu, et al, 2012) picture in patients with late onset radiation therapy head drop. This is a diagnosis that needs to be entertained in the setting of head drop syndrome, as Botox therapy, used for presumed dystonia, may exacerbate patient complaints.

### F14

#### **Hemifacial Spasm or Epilepsia Partialis Continua**

*Tammam Dayyoub, MD; Sarita Maturu, MD; Andrew J. Zillgitt, MD*

Introduction: Epilepsia partialis continua (EPC) is a form of focal motor status epilepticus that may be seen in the adult population following stroke. Hemifacial spasm (HFS) is a movement disorder characterized by recurrent contractions of muscles innervated by the facial nerve. Although these two conditions are distinctly different, when facial muscles are affected, EPC may be mistaken for HFS.

Case Presentation: A 79 y.o. woman with a history of left HFS presented with a right MCA acute ischemic stroke and facial twitching. An initial EEG revealed 5 seizures and she was loaded with phenytoin. Her spells continued and levetiracetam was added to phenytoin. She was placed on cEEG monitoring and a total 187 spells of left facial contractions were recorded over 2 days. Her spells did not improve despite aggressive treatment with levetiracetam, phenytoin, and lacosamide.

Discussion: HFS is a form of segmental myoclonus of muscles innervated by the facial nerve, while EPC is a form of focal motor status epilepticus that is most commonly seen in adults following stroke. Usually EPC consists of continuous focal jerking of a limb, but when the facial muscles are affected, EPC may be mistaken for HFS. Only 1 case describing chronic isolated HFS as a possible manifestation of EPC was identified after a literature review.

Conclusion: This case involved a woman with chronic HFS who presented following an ischemic stroke with stereotyped spells of left hemifacial contractions. Although her presenting history was suggestive of EPC, it was difficult to ascertain a definitive diagnosis in light of her history of left HFS. Her course did not improve with aggressive seizure medication trials and after further review of her neuroimaging, there was an extensive right MCA stroke with little preservation of cortical tissue. In light of these findings it was felt that these spells were less likely seizures and more consistent with HFS.

### F15

#### **Adult Onset Electrographic Status Epilepticus of Sleep**

*Ursula Thome MD; Paula Klima MD; Ahsan Moosa MD; Ajay Gupta MD; Elia M. Pestana Knight MD*

Continuous Spike and Wave during Sleep is a childhood epileptic encephalopathy defined by the presence of Electrographic Status Epilepticus of Sleep (ESES) in the EEG, seizures and neurocognitive/behavioral changes. Reports of adult patients with ESES are rare in the literature. We report a 27 year-old woman with history of childhood onset epilepsy who developed cognitive decline and worsening of seizures at age 21 years. Seizures increased progressively to daily. In the last 2 years, she had neurological regression in

language, motor skills and cognition. She also developed excessive daytime sleepiness. Video-EEG monitoring showed rare spikes when awake and ESES pattern during sleep (Figure 1A and B). Continuous spike and wave discharges were present in more than 85% of slow waves sleep. EEG improved after treatment with oral diazepam 20mg at night. She became more alert and her speech improved. Our case and the ones reported in the literature indicate that ESES can be a cause of neurocognitive, behavioral and motor decline in adults. Recognition of the syndrome in adults needs to be encouraged to provide adequate and effective treatment.

## F16

### **A case of Tuberous Sclerosis Complex with First Clinical Presentation in her 40s.**

*Thandar Aung, MD*

Intro: TSC is initially recognized as childhood disease. We present a 45-year-old woman, with normal intelligence and no personal or family history of TSC, presented with this neurocutaneous disorder.

Case: A 45-year-old woman presented after experiencing first-time unprovoked complex partial seizures. In ER, she had another seizure. Benzodiazepam and phenytoin were given intravenously. She returned to her baseline. She had two small nodules on the left iris, a nodule on the nose and several ash leaf spots. Brain imaging showed scattered areas of dystrophic coarse parenchymal calcification in the subependymal region and in the cerebellar hemisphere. Innumerable bilateral subcortical and cortical T2/Flair hyperintensities (cortical tubers) were found which consistent with TSC according to the diagnostic criteria of Roach et al., 1998. Seizure was controlled with one AED. Nothing was found on her liver, kidney and heart. TSC2 gene was found to be mutated.

Diss: TSC is a neurocutaneous autosomal dominant genetic disorder with an incidence of approximately 1 in 5000 to 10,000 live births. Diagnosis of TSC in adult can be difficult because of variable expressivity and incomplete penetrance. Two thirds of TSC cases result from sporadic genetic mutations in TSC1 or TSC2 but their offspring may inherit it from them. Neurological presentation of tuberous sclerosis occurs typically in children with seizures and intellectual impairment. However approximately 50% of patients who fulfill the diagnostic criteria have normal intellect and 15% remain free from seizures. The exceptionally mild disease in our patient may simply be an example of variation in expression characteristic of tuberous sclerosis observed between affected members of the same family or due to somatic mosaicism where a postzygotic new dominant mutation only affects a proportion of cells and to a varying extent in different tissues

## F17

### **Automated Information Extraction from Clinical EEG Reports**

*Siddharth Biswal, MD; Junior Valdery Moura, MD; Zarina Nip, MD; Eric Rosenthal, MD; M Brandon Westover, MD, PhD*

Introduction: Our EEG lab has over 100,000 free-text reports, written by dozens of authors over >2 decades. Manually extracting information for research purposes typically requires weeks to months of labor. As a first step toward reducing this effort, we have created a system to automatically determine whether an EEG report describes a seizure.

Methods: We labeled 3,492 reports, 313 of which described seizures. For report preprocessing we developed a customized spell corrector and stemmer, and removed rare words. We created candidate features by joining all words from the pre-processed documents with all word sequences  $w_1 \dots w_2$ , where “...” indicates intervening words ( $n=7-10$ ). We used backward pruning and cross validation (CV) to select final features for training Naïve Bayes classifiers. We assessed performance using repeated 2-fold CV.

Results: From 31,751 candidate features, backward pruning and CV yielded classifiers with 50 final features. Median [95% CI] performance on the training data was 99.998% [99.975, 99.999], and on testing data, 98.984 [97.960, 99.991].

Conclusion: Our automated system is able to determine which free-text EEG reports contain seizures with very high sensitivity and specificity, despite highly variable report wording. We are working to extend this technique to extract other key pieces of information.

## F18

## **Volumetric Analysis of Focal Epilepsy in Children**

*Nasser Kashou, MD; Allison Dixon, MD; Gogi Kumar, MD*

**Objective:** To perform a volumetric analysis of the lobe(s) and hemisphere where the epileptiform abnormalities originated and compare to the other hemisphere and corresponding lobe(s) to identify differences in patients where epileptiform abnormalities are localized to one hemisphere with normal magnetic resonance imaging (MRI). Also, to see any differences in the size of the thalami, gray and/or white matter volume between hemispheres.

**Background:** A small portion of children with focal epilepsy have spikes localized to one hemisphere with normal MRI.

**Methods:** We reviewed charts of children age 0-18 years diagnosed with focal epilepsy and identified patients with normal MRI and focal spikes and seizures originating from one hemisphere, excluding patients meeting criteria for Benign Focal Epilepsy of Childhood based on clinical presentation and EEG.

We identified 10 children who met these criteria. 3D spoiled gradient echo (SPGR) MRI datasets acquired from a 1.5T GE scanner were analyzed with image processing techniques. Cortical reconstruction and volumetric segmentation was performed with Freesurfer Software Suite.

**Results:** 10 patients met the criteria. Age range was 5-18 years, seizure onset ranged from 1 to 17 years of age. 2 had seizures originating from the frontal lobe, 4 from the temporal region, 2 from the occipital region and 2 from the parietal area. 7 patients had seizures originating from the left hemisphere, while 3 originated from the right.

We did not find a statistically significant difference between the symptomatic hemisphere and lobe and the control hemisphere and lobe when hemispheric volume, lobar volume, volume of the thalami, volume of gray or white matter were compared.

**Conclusion:** We will perform further data analysis and enroll more patients in this study to find out whether volumetric analysis could be useful as a marker of focal epilepsy and correlate this with clinical presentation.

## **F19**

### **A Case of Status Epilepticus in Adult from Post-viral Influenza A H1N1 Vasculitis**

*Thandar Aung, MD*

**Introduction:** Influenza-related neurologic complications are rare, especially in immunocompetent adults.

**Case:** A 57-year-old female, with past medical history of atrial fibrillation and hypertension, was admitted to hospital with H1N1 influenza pneumonia. Hospital course was complicated by secondary bacterial pneumonia, ARDS, and bilateral DVTs with pulmonary embolism for which she required tracheostomy with full ventilation support. She was transferred to long term care facility after receiving intensive treatment for six weeks. Two weeks later, she experienced first new onset seizure which progressed into SE. Brain imaging showed diffuse subcortical edema throughout the brain descending of 4mm cerebellar tonsil through foramen magnum. The diffuse effacement was seen along the perivascular spaces which followed the pattern of vasculitis. CSF analysis showed unremarkable including viral studies except from nucleated cell count of 3/uL with elevated protein of 97.6 mg/dL. Electroencephalogram showed multi-focal spike wave discharges. IV high dose steroid was started. Her mental status clearly improved on two epileptic medications and repeated MRI showed complete resolution of edema.

**Discussion:** This is a first case report on H1N1 post viral related CNS vasculitis in adult. Febrile seizure was reported as most common influenza-related neurologic complication in pediatric population. In adult, there are case reports regarding influenza associated with encephalopathy, meningoencephalitis, transverse myelitis, and Guillain-Barre syndrome. However, the pathogenesis of the CNS illnesses associated with influenza remains poorly understood. In our case, patient developed post viral CNS vasculitis after eight weeks of first symptoms which resolved with steroid. The presence of inflammation with negative influenza assay has led to the view that inflammation is of post-viral autoimmune in origin.

## **F20**

### **Usefulness of 3T MRI in Detecting Lesion in Medically Refractory Epilepsy Patients**



*Deepal Shah, MD; Abuhuziefa Abubakr, MD*

Rationale: To show that 3T MRI with thick slices and high interslice gap has a higher failure rate in detecting lesions and emphasize the need to use thin slices (1-1.5 mm) and no interslice gap in every institution.

Method: Retrospective review of medical records of medically refractory epilepsy patients who underwent surgery at UMC between 2012 and 2013. Review their MRI (3-4 mm thickness, 3-4 (3.5) mm slice space) and pathology findings. Primary objective to ascertain percentage of correlation between MRI and pathology findings.

Results: Out of 15 patients who underwent surgery, 14 patients had lesional MRI. In 8 out of 14 patients (57.14%), there was no correlation between their MRI and pathology. In 6/8 patients (75%), diagnosis was missed (2 FCD, 2 MTS, 2 FCD+MTS). 2/8 patients (25%) were misdiagnosed (HS instead of FCD, FCD when there was no FCD on pathology).

Conclusions: Despite small sample size, study shows that MRI (3-4 mm thickness, 3-4 (3.5) mm slice spacing) has a high failure rate > 50% in identifying lesions correctly, which indirectly affect identification of potential surgery candidates. Therefore, we recommend the universal use of standard 3T MRI epilepsy protocol with 1-1.5 mm thin slices with no interslice gap.

## **F21**

### **The Cessation of CSWS Following a Temporal Lobectomy**

*Brian D. Moseley, MD; Radhika Dhamija, MD; Elaine Wirrell, MD*

Introduction: The role of respective surgery in epilepsies with generalized EEG patterns such as continuous spike wave in slow wave sleep (CSWS) has not been robustly explored. We report a case of CSWS that was secondary to focal pathology and treated with surgery.

Methods: Case-report/literature review.

Results: An 11-year-old boy presented with medically refractory focal onset seizures since the age of 2 years. At age 10, he developed decreased attentiveness and increased aggressiveness. Based on his clinical picture and an EEG demonstrating electrical status epilepticus in slow wave sleep (ESES), he was diagnosed with CSWS. This failed to respond to high dose diazepam.

MRI revealed prior right basal ganglia and thalamic infarcts and right mesial temporal sclerosis. During repeat EEG monitoring, he had nearly continuous generalized spike and wave discharges during sleep. He had one seizure of right midtemporal onset. He underwent a right temporal lobectomy. Postoperatively, he was seizure free, with improved attention and behavior. Repeat EEG revealed no further ESES.

Conclusions: Our case provides evidence that epilepsy syndromes with generalized discharges can be secondary to focal pathology amenable to surgery. The postoperative normalization of his sleep EEG suggests temporal lobe structures are involved in the network generating CSWS.

## **F22**

### **The Correlation of Epileptiform Discharges in Sleep with Ictal Onset in Schizencephaly**

*Marjan Dolatshahi, MD; Alexei Yankovsky, MD; Marcus Ng, MD*

Schizencephaly is a common developmental cause of epilepsy. In most cases, the cortical structural abnormalities may be diffuse or multifocal. When refractory to medication, delineating the zone of ictal onset for the purpose of epilepsy surgery may be challenging. Sleep has shown promise in localizing the zone of ictal onset in other diffuse and multifocal developmental epileptogenic conditions, such as tuberous sclerosis. We sought to determine the impact of different stages of sleep on the electrographic extent of epileptiform discharges in schizencephaly patients. Then we sought to correlate the zone of ictal onset with the extent of these epileptiform discharges in sleep. In a retrospective chart review, we found 9 patients with open-lip or closed-lip schizencephaly and associated polymicrogyria. We will present the fields of epileptiform discharges in various stages of sleep and wakefulness, zones of ictal onset, and radiographic abnormalities for each patient. We will interpret these findings in relation to the role of sleep in predicting the zone of ictal onset for these patients.

## F23

### **Comparison of Transcranial Electrical Motor Evoked Potentials (TcMEPs) from Different Hand Recording Montages**

*Ricardo Bravo, MD; Laurence McKinley, MD; Jaime R. López, MD, FACNS*

TcMEPs are widely used for direct monitoring of corticospinal motor pathways in a variety of surgical procedures. However, there is no published recording technique indicating the optimal electrode placement for recording myogenic responses from the hand. The purpose of our study was to compare three different hand recording montages recorded simultaneously. Data from 12 patients undergoing a variety of thoracic or lumbar spinal column surgeries were prospectively collected. TcMEPs from each hand were obtained using standard stimulation techniques. All patients underwent same anesthetic regimen. Simultaneous recordings were acquired from the following electrode sites, using subdermal needle electrodes: APB-1stDIO, APB-ADM, and APB-thumb. TcMEP peak-trough amplitudes were analyzed for each recording montage. APB-1stDIO had the largest average amplitude on either hand, left-1811.3 uV (69.1-9963.2 uV), right-1974.8 uV (40.4-7688.1 uV); followed by APB-ADM, left-1651.2 uV (63.5-8029.5 uV), right-1864.4 uV (54.2-7867.7 uV); and lastly APB-thumb, left-1341.2 uV (70.9-5230.2 uV), right-1799.9 uV (39.5-7334.6 uV). However, paired t-test between each montage showed no significant differences. Although the findings are not statistically significant, the results may be influenced by the wide range of amplitudes and the relatively low number of patients studied. Further study is warranted to clarify if a particular recording montage is superior.

## F25

### **Increased Spinal Canal Compression from Patient Positioning Detected by Intraoperative MEP and SEP Monitoring**

*Alan D. Legatt, MD, FACNS; Jonathan Nakhla, MD; Michael A. Weicker, MD; Reza Yassari, MD*

A 42-year-old woman with persistent back pain had sudden-onset left leg weakness and numbness. MRI showed extensive osseous destruction at L2-L3 with a large epidural abscess causing severe thecal sac compression. The patient was positioned prone for laminectomy, decompression, and spinal instrumentation/fusion. Large tibialis anterior and abductor hallucis MEPs and posterior tibial nerve SEPs were present initially, but deteriorated and disappeared bilaterally during the soft-tissue dissection; upper-limb MEPs and SEPs were unchanged. The surgeons were notified and performed the laminectomy before placing the pedicle screws, the reverse of the usual sequence. When the laminectomy was done, the lower-limb MEPs and SEPs reappeared and recovered fully to baseline. MEPs and SEPs were then stable during washout of the abscess and the instrumentation/fusion. Postoperatively, the patient recovered full strength in the left leg and her sensory exam was improved. The pathologic diagnosis was Pott's disease. Changes in spinal curvature with positioning on the operating table most likely increased the spinal canal compression in this patient, leading to the loss of lower-limb MEPs and SEPs. The neurophysiologic monitoring findings led to performance of the laminectomy about 90 minutes earlier than it would have otherwise been done, potentially contributing to the good neurologic outcome.

## F26

### **Somatosensory and Transcranial Motor Evoked Potential Changes During Sitting Position Craniotomy**

*Ana Tercero, MD; Josep González, MD; Eliseo Jorge Torales, MD; Ricard Valero, MD; Joan Santamaria, MD*

Surgical procedures of the posterior cranial fossa are preferably performed with the patient in the sitting position and somatosensory evoked potentials (SSEP) and transcranial motor evoked potentials (t-MEP) are usually recorded in these cases. Nonspecific SSEP and t-MEP changes have been reported. Posterior tibial nerve SSEP changes have never been reported before. We analyzed median and posterior tibial nerve SSEP and t-MEP changes of 7 patients who were operated in a sitting position. Median and posterior tibial nerve SSEP amplitudes decreased in 6 of them. The partial loss of posterior tibial nerve SSEP amplitude was always seen in the Ci-Cc channel but curiously it increased in the Cz-Fz channel. MEPs changes were observed only in 4 of 7 patients. These changes were not related with neurological impairment and all of them appeared few minutes after opening the dura mater. We recommend to record SSEP at least in two cortical channels and emphasize the need to be cautious with the interpretation of certain SSEP or MEP changes during surgeries performed in sitting position because they could not be associated with postoperative neurological deficits.

## F27

### **Intraoperative Monitoring of Simultaneous Cases: A Risk-Based Approach Utilizing Monte Carlo Simulation**

*Stephen Fried, MD*

Although utilization of Intraoperative monitoring continues to grow, the number of reading physicians is limited, often necessitating the monitoring of simultaneous cases. While risk grows as the number of simultaneous cases increases, how can that risk be quantified? To evaluate the risks involved, our model asks: for N simultaneous cases, given the probability(P) of a significant change in any case at any given time, and amount of time(T) that increased attention needs to be paid to a case once a change occurs, what is the likelihood(L) that any two time periods will overlap with concurrent changes requiring increased attention? A Monte Carlo simulation (one million trials) was performed for P=0.1, 0.15, and 0.2, using T=60 minutes as well as T=time until case ends(Tmax). A value of 1% of time monitored was set as the threshold for L. For T=60 minutes, L crosses threshold at N=8, 5, and 4 cases for the three values of P respectively. For T=Tmax, L crosses threshold at N=4, 3, and 2 cases respectively. This model may be useful to evaluate the risks involved with most commonly monitored procedures, which require straightforward evoked response evaluation, but would be limited in more complex monitoring cases.

## F28

### **The Off-label Use of External Cardiac Pacemaker Electrode for D-wave Intraoperative Monitoring: A Common Practice in Economically Developing Countries**

*Paulo A. Kimaid, MD; Rafael De Castro, MD; Charles M. Nascimento, MD; Rodrigo N. Cardoso, MD; Rinaldo Claudino, MD; Marcondes Franca, MD*

**Background:** D-wave intraoperative monitoring is accessed by an epidural electrode (EE) which costs 3 to 4 times more than an external cardiac pacemaker electrode (ECPE). Considering also the similarity of their technical properties, ECPE is being largely used instead of EE in economically developing countries.

**Purpose:** The aim of our study is to present D-wave data obtained with the off-label use of ECPE in cases of spinal tumor surgery.

**Methods:** Ten patients with spinal tumor were submitted to tumor resection under intraoperative monitoring with our standard protocol for spinal tumors: upper and lower limbs SSEP and TcMEP with muscle and epidural registration. We used the external cardiac pacemaker electrode to register D-wave, positioned under direct vision in the midline, distal to the tumor, instead of the EE.

**Results:** In 8 cases we could register an easy to identify D-wave. In 2 cases, as we couldn't obtain the traces we decided to exchange the ECPE for an EE in order to exclude any technical problem, but D-wave still could not be registered.

**Conclusion:** D-wave monitoring can easily be registered with ECPE reducing the costs of IONM without detriment to the technique.

Despite the small number of cases, our data agreed with previous reports warning that D-wave can be absent in 20% of spinal tumor patients.

## F29

### **Correlation Between Bispectral Index and the Quality of the Electrocorticography During Epilepsy Surgery.**

*Daniel S. Orta, MD; Laura R. Rodríguez Arias, MD; Arely Osorio Santiago, MD; Alejandro Lopez Pizano, MD; Roberto C. Llerenas Zamora, MD; Rafael Vazquez Gregorio, MD; Dulce Espinoza Lopez, MD; Carlos Trenado, MD*

Introduction. The Electrocochography (ECoG) is useful to identify the epileptic zone during epilepsy surgery and the Bispectral Index (BIS) allow the hypnotic anesthesia component monitoring, however, the correlation between the scores of BIS and the ECoG patterns to optimizing the quality and time of the ECoG recordings are unknown. Objective. Analyze the correlation between the BIS scores and the duration of suppressions periods (seconds) in the burst-suppression (BS), background frequency (Hz) and type of patterns (1 [normal] to 5 [ECoG seizure]; Bindra A et al., 2012) of ECoG recordings during epilepsy surgery under intravenous general anesthesia with propofol. Material and Methods. Prospective study that included consequently pharmacoresistant epileptic patients who underwent epilepsy surgery guided by ECoG and BIS (September 2008 to October 2012). Results. We included 28 epileptic patients, 15/28 (53.5%) female, age mean 30.5 (13-56) years old, weight mean 68.32 (42-100) kg who underwent 22/28 (79%) temporal and 6/28 (21%) extra temporal epilepsy surgeries with propofol mean plasmatic concentration 3.2 (0.75-4.4) µg/ml and ECoG duration mean 40 (5-178) min. We found on a non-linear relationship (e.g. polynomial cubic) between the mentioned variables by emphasizing that for a BIS range 40-60 the following characteristics follow: ECoG burst suppression periods below 5 s, background brain frequency ranging between 10-17 Hz and 2 ECoG pattern characterized by lacking of >20 Hz background frequencies. Conclusion. Our findings support that the BIS is a non-linear multidimensional measure which possesses high variability, although a BS increasing tendency with respect to the BIS scale appears when comparing to background frequency and ECoG patterns.

## F30

### **Intraoperative MEP Monitoring Beyond the Aortic Clamp Period of Open Thoracoabdominal Aneurysm (TAA) Repair Further Decreases the Risk of Post-operative Paraplegia**

*Oluwole Awosika, MD; Reiner B. See, MD; Richard P. Cambria, MD; Mark F. Conrad, MD; Virendra I. Patel, MD; Glenn M. LaMuraglia, MD; Rae Allain, MD; Mirela V. Simon, MD, FACNS*

Motor evoked potentials (MEP) monitoring promptly detects reversible spinal cord ischemia directly related to clamping of the Aorta in open thoracoabdominal aneurysm (TAA) repair with Atrio-femoral (A-fem) bypass. We hypothesized that extension of MEPs monitoring beyond aortic clamp period (ACP) further decreases the risk of postoperative paraplegia. Methods. We identified 120 patients who underwent open TAA with A-fem bypass and MEPs monitoring at MGH, between Jan 2008-Dec 2012. Using a multivariate logistic regression analysis, we studied the independent effect of MEPs monitoring (ie predictor of interest) beyond ACP, the risk of developing postoperative paraplegia (ie outcome). We used a propensity score analysis to adjust for the potential impact on the outcome of other factors such as presence of acute Aortic dissection, urgent splenectomy, TAA Type, age >65 years, previous TAA surgery, history of poorly controlled hypertension, diabetes, smoking. Results. From 120 patients, 89 (74%) did not have monitoring extended beyond ACP, while 31 patient (26%) did. The proportion of patients who had acute splenectomy was significantly higher in the group which did not receive extended MEPs monitoring (96.88% vs 3.13%,  $p < .0001$ ). Other potential predictors of post-operative paraplegia were present in similar proportions within the two cohorts. MEPs monitoring beyond ACP independently decreased the odds of developing post-operative paraplegia, after adjusting for the other potential predictors (OR=0.11, CI95 [0.001, 0.92]  $p=0.04$ ). Conclusions. By allowing titration of the systemic blood pressure to ensure appropriate spinal cord perfusion in the immediate post-operative period, extension of MEPs monitoring beyond ACP during open TAA repair with A-fem bypass, further reduces the risk of postoperative paraplegia.

### F31

#### **Spinal Intradural Tumours: A Single Center Experience**

*Lidia Cabanes, MD; Ignacio Regidor, MD; Gema de Blas, MD; Federico Abreu, MD; Rodrigo Carrasco, MD; Marta del Alamo, MD; Luis Ley, MD*

Question: Primary spinal cord tumours represent 2% to 4% of all central nervous system neoplasms and are anatomically separable into two broad categories: intradural intramedullary and intradural extramedullary. We present our experience treating this kind of tumours in the last 10 years, with an especial focus on the use of intraoperative neurophysiologic monitoring (IOM).

Methods: We have performed a retrospective study within our institution, from an epidemiologic, clinical, radiologic and surgical point of view, including the use of IOM.

Results: A total of 93 patients, ages between 22 and 81 years old. The most frequent clinical presentation was motor deficit and pain. There was great histological variation, but neurinomas, meningiomas and ependymomas were more frequent. Multimodal IOM was used in 41% of the cases. We observed that in the group of monitorized patients the rate of neurological sequelae was lower than in the non-monitorized group.

Conclusions: The use of IOM in primary intradural spinal cord tumours reduces the incidence of neurological complications. IOM can identify neurological injury with excellent sensitivity.

### F32

#### **Utility of Lumbosacral Pedicle Screw Electrical Stimulation in a Mexican Community Hospital**

*Alvaro A. Zavala, MD; Sergio Aguilar, MD; Samantha Pineda, MD*

Neurological injury incidence during lumbosacral fusion with pedicle screws can range up to 15%. Injury results from a breach of the pedicle wall potentially injuring the lumbosacral roots. The aim of our study was analyze the usefulness of lumbosacral pedicle screw stimulation using 15 mA as "warning threshold" in a Mexican nongovernmental institution. We stimulated 608 titanium lumbosacral pedicle screws in 125 patients, 56 males, 69 females, ages 25-85 years, using monopolar, cathodal, constant voltage stimulation. Balanced or total intravenous anesthesia was used. Of the 608 pedicle screws, 71 had thresholds below 15 mA, each one was redirected, with re-stimulation levels above 15 mA in 67 and between 12 and 14 mA in 4. Postoperative CT scans were done in all patients showing: medial wall breach of two screws (both patients asymptomatic), 3 screws malpositioned laterally. The four screws between 12 and 14 mA thresholds remained in place. Four false positive and 5 false negative cases were seen, with a negative predictive value of 0.991. Our experience shows the importance of intraoperative testing of pedicle screw placement, the feasibility of performing this possibility of doing in middle income countries, with comparable results to those found in more experienced centers.

### F33

#### **EEG Patterns During Deep Hypothermic Circulatory Arrest: Utility of qEEG**

*Abeer J. Hani, MD; Aatif M. Husain, MD, FACNS*

Objective: To determine the temperature and time course of EEG patterns during deep hypothermic circulatory arrest (DHCA) and to assess utility of quantitative EEG (qEEG) in determination of burst suppression (BS) and electrocerebral inactivity (ECI).

Methods: The charts of 10 patients undergoing DHCA during aortic surgery were reviewed. The onset of periodic discharges (PD), BS and ECI was determined. Using qEEG analysis, BS during cooling was defined as a suppression ratio of about 90% and ECI was defined as suppression ratio of 97-100%.

Results: The mean nasopharyngeal temperature when PD appeared was  $25.9 \pm 1.1^{\circ}\text{C}$ , BS appeared at  $23.0 \pm 0.8^{\circ}\text{C}$ , and ECI appeared at  $17.1 \pm 0.7^{\circ}\text{C}$ . During rewarming BS was seen at  $20.8 \pm 0.6^{\circ}\text{C}$ , and baseline EEG activity returned at  $28.8 \pm 1.2^{\circ}\text{C}$ . Using qEEG, ECI could be determined about  $11.4 \pm 3.2$  minutes earlier than when using raw EEG.

Conclusion: The temperatures at which the various EEG patterns were observed are similar to that of previous studies. Use of quantitative EEG may assist in standardizing the time of determination of ECI.

### F34

#### **Utilization of Free Running EMG and SSEP Recordings for Spinal Cord Stimulator Placement and Optimization Under General Anesthesia**

*Emily B. Kale, BS, CNIM; Aatif M. Husain, MD, FACNS; Lindsay Rambeaut, MD*

Introduction: Spinal cord stimulator (SCS) placement under general anesthesia (GA) reduces the means by which SCS leads can be ideally placed and optimized since patient feedback is unavailable. Neurophysiologic recordings taken before, after, and during lead placement and activation are complementary and often a more sensitive means of SCS lead placement and optimization.

Methods: Ten thoracic SCS leads were placed using tibial and ulnar somatosensory evoked potential (SSEP) recordings and free running electromyography (EMG) recordings to aid in lead placement and optimization. Lead placement over the midline of both dorsal columns was determined by radiography and bilateral activation of EMG channels in the lower extremity. SSEP recordings were taken before, during and after lead activation to assess optimal interruption of sensory input during lead activation.

Results: EMG findings were complimentary to radiographic images, but indicated that small adjustments should be made to SCS lead placement to maximize activation of both dorsal columns. SSEP recordings taken before during and after lead activation demonstrated interruption of sensory pathways with decreased amplitude and increased latency or total interruption of sensory signals.

Conclusion: SSEP and EMG recordings taken before, after, and during lead placement and activation are complementary and often a more sensitive means of SCS lead placement and optimization.

### F35

#### **NIOM for Spinal Cord Stimulator Placement - Detection of an Unusual Complication**

*Jose Devesa, MD; Emily B. Kale, BS, CNIM; Aatif M. Husain, MD, FACNS*

Introduction: Neurophysiologic intraoperative monitoring is used during spinal cord stimulator (SCS) implantation to optimize lead placement. The lead is placed epidurally, and injury to the spinal cord is unlikely. We present a case of an unusual complication during SCS placement.

Case Report: A 57-year-old male presented for revision of a thoracic SCS due to lead fracture. No motor or sensory deficits were noted prior to surgery. During the procedure lower extremity electromyography (EMG) and ulnar and tibial somatosensory evoked potentials (SEP) collision technique were used for optimal lead placement. After lead placement, SEP were monitored, and during closure a significant amplitude decrease of both cortical tibial SEP was noted. Significant motor deficits were noted in both lower extremities after the patient was awakened. The patient was immediately re-intubated SCS lead removed. Thereafter strength in both lower extremities improved.

Conclusion: In addition to assisting with optimal lead placement during SCS implantation procedures, NIOM may detect inadvertent injury to the spinal cord.

### F36

#### **Variability of Motor Evoked Potentials Under Steady-State Anesthesia During Scoliosis Surgery: Are All Muscles the Same?**

*Stephen Fried, MD; Alan D. Legatt, MD, FACNS; Diane Smith, MD*

Intraoperative monitoring of corticospinal tract motor pathways with motor evoked potentials (MEPs) reduces the likelihood of neurological deficits following scoliosis surgery. The most commonly used warning criterion for MEP changes is a significant amplitude drop, though what constitutes "significant" is not universally agreed upon and may, in fact, be different in different muscles. We compared the run-to-run variability of MEPs across three muscle groups (thenar/hypothenar, tibialis anterior, and abductor hallucis), recorded under steady-state propofol infusion during 30 surgeries for idiopathic scoliosis in which MEPs remained present throughout and there were no post-operative neurological deficits. For each muscle group, there was no significant difference in the coefficient of variation (CV) between the left-sided and right-sided MEPs (Wilcoxon rank-sum). The thenar/hypothenar MEPs showed the greatest variability, with an average CV of 48%. This was significantly larger than the average CV within the abductor hallucis MEPs, 35% ( $p < 0.001$ ). This, in turn, was significantly larger than the average CV within the tibialis anterior MEPs, 27% ( $p < 0.001$ ). We conclude

that, due to differences in run-to-run variability across muscle groups, MEP warning criteria might best be tailored to the particular muscle group being monitored.

### **F37**

#### **Success Rate of Obtaining Baseline SEP & MEP in Consecutive Cranial and Spinal Surgeries**

*Brian S. Droker, MD; Andres A. Gonzalez, MD, MMM, FACNS; Parastou Shilian, DO*

**Introduction:** Intraoperative monitoring (IOM) has been documented as an adjunctive technique used to minimize neurologic deficit during brain and spinal surgeries. IOM is predicated on the patient acting as an internal control, and that obtaining reliable baseline potentials is essential for effective monitoring. Previous studies reported success rates in MEP as low as 66.6% in the lower extremities and these rates are associated with preexisting neurologic deficits.

**Study aim:** To evaluate the current rates of obtaining SEP and MEP baselines.

**Methods:** Chart review of consecutive cranial and spinal cases from January 2010-2011. SEP and MEP baselines were after initiation of general anesthesia and before skin incision. Anesthesia consisted of TIVA or TIVA with halogenated agents with less than 0.5 MAC.

**Outcome measures:** Primary: Success rate in obtaining SEP and MEP in all subjects. Secondary: Rates by preoperative surgical diagnosis.

**Results:** 695 cranial and spinal cases that required IOM were reviewed. Greater than 90.1% success rate in both SEP and MEP. For cranial surgeries the success was more than 93%. In spinal surgeries, a similar success rate was seen in deformity and degenerative cases. However, a decrease in success rate was noted in patients with either trauma or infection.

**Discussion:** Our success rates were higher than previously reported. Success rates in spinal infection and spinal trauma cases were lower than previously reported; perhaps reflecting the disease process. Though preexisting deficits are associated with reduced success rate, preoperative diagnosis seems to serve as an indicator as well.

**Conclusions:** Success rate of obtaining baselines is higher than previously reported. The preoperative diagnosis may predict the success rate. With this information, the monitoring team can have a more reasonable expectations of IOM based on the particular surgery.

### **F38**

#### **Laryngeal TcMEP Technique: From the EMG Lab to the OR**

*Paulo A. Kimaid, MD; Rafael de Castro, MD; Charles Nascimento, MD; Rodrigo N. Cardoso, MD; Rinaldo Claudino, MD; Marcondes Franca, MD*

**Background:** Laryngeal electromyography (LEMG) is a routinely and valuable technique to evaluate diseases of laryngeal nerves and muscles in the EMG laboratory (EMG LAB). The technique of percutaneous approach of laryngeal intrinsic muscles is easy to apply and uses cheap needle electrodes.

**Purpose:** The aim of this study is to describe the technique we adapted from EMG LAB to register corticobulbar laryngeal motor evoked potentials (CoLMEP) in the vocalis muscle complex (VOX) after transcranial electric stimulation (TES).

**Methods:** A retrospective review of 30 cases of cerebellopontine angle or brainstem tumors undergoing tumor resection with our standard protocol of intraoperative monitoring: upper and lower limbs SSEP and TcMEP, free-running EMG of muscles innervated by cranial nerves V, VII, IX, X, XI e XII, updated with a protocol of cortical motor evoked potentials registered in orbicularis ori (ORI), vocalis muscle (VOX), trapezius muscle (TPZ) and tongue were studied.

**Results:** In all cases we used the adapted technique with VOX percutaneous approach and it was easy to identify CoLMEP after TES.

**Conclusion:** The proposed technique is trustful and can be easily reproducible. It is also cheaper than the previously described techniques. In our opinion it should also be tested in Direct Cortical Stimulation.

## F39

### **Utility of Beamformer Source Analysis in Clinical MEG**

*Paul Ferrari, MD; Douglas Cheyne, MD; Mark Mcmanis, MD; Mark Lee, MD; Dave Clarke, MD; Fredrick F. Perkins, MD*

MEG beamformer source localization provides a high temporal- and spatial-resolution source estimation of brain activity and has the special property of being robust in the presence of interfering noise. While the beamformer's use in mapping epileptiform activity and eloquent cortex has been demonstrated the technique has yet to be widely validated for clinical applications. We first show, through simulation, that event-related beamformer reconstruction accurately localizes transient activation at various locations within the brain, even at low signal to noise. We then present specific case studies demonstrating the utility of the beamformer method in practice, applied to datasets where various sources of interfering noise distort or preclude the equivalent current dipole model. We subsequently show examples of how source level multivariate spatiotemporal decomposition can be applied to enhance our description of multifocal epileptiform discharges, reveal hyperactive epileptiform networks during quiescent resting state, and also provide an intuitive analysis of event-related language late-fields for assessing language laterality. We conclude that the MEG beamformer, used judiciously, has a unique and complimentary role in clinical MEG analysis.

Cheyne D, et. al., Clin Neurophysiol. 2007 ;118(8):1691-704

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## F40

### **Low and High Frequency Oscillations Reveal Distinct Absence Seizure Networks**

*Jeffrey Tenney, MD; Hisako Fujiwara, MD; Paul Horn, MD; Jennifer Vannest, MD; Jing Xiang, MD; Tracy Glauser, MD; Douglas F. Rose, MD*

**Objective:** The aim was to determine the frequency-dependent, spatiotemporal involvement of corticothalamic networks to absence seizure generation.

**Methods:** Magnetoencephalography was recorded in 12 subjects (44 seizures) with untreated childhood absence seizures. Time-frequency analysis of each seizure was performed to determine significant power at ictal onset. Source localization identified regions contributing to generalized spike and wave discharges (SWDs).

**Results:** Significant power was seen in 1-20 Hz, 20-70 Hz, and 70-150 Hz bandwidths. Sources localized to the frontal cortex similarly for the low and gamma frequency bandwidths, while at the low frequency bandwidth (3-20 Hz) significantly more sources localized to the parietal cortex (OR=16.7) (Fig 1). Cortical high frequency oscillations (HFO) (70-150 Hz) localized primarily to the frontal region compared to the parietal (OR=7.32) or temporal (OR=2.78) areas.

**Interpretation:** Neuromagnetic activity in frontal and parietal regions confirms hemodynamic changes reported using functional MRI. The frequency dependent nature of these networks has not previously been reported and the presence of HFOs during absence seizures is a novel finding. Co-occurring frontal and parietal corticothalamic networks may interact to produce a pathological state which contributes to SWDs.

## F41

### **Proximal Median Neuropathy a Complication of Reverse Shoulder Arthroplasty**

*Reiner B. See, MD; Bashar Katirji, MD; David C. Preston, MD; Barbara Shapiro, MD*

Reverse shoulder arthroplasty (RSA) is indicated for rotator cuff-tear injury. It reverses the physiologic ball and socket, resulting in distal displacement of shoulder joint's centre of rotation, increasing the lever arm of deltoid muscle for more muscle fiber recruitment for shoulder elevation & abduction. A 72 y/o lady, underwent left RSA surgery, 10 days after surgery developed left hand grip weakness, EMG study revealed left proximal median mononeuropathy at/above the pronator teres muscle. Mechanism likely from traction injury,



demonstrated on a 3D computerized model that calculated strain after prosthesis placement (VanHoof et al). Results show median nerve's medial (19%) and lateral (15%) root strain.

To the authors' best knowledge, this case is the first report of proximal median mononeuropathy from RSA.

#### **F42**

##### **Hypoglossal Nerve Palsy is Associated with a Variety of Etiologies and Sometimes Results in Tongue Myokymia**

*Amro Stino, MD; Benn Smith, MD;*

We present a case series of 7 patients seen at the Mayo Clinic in Arizona over a 27 year period diagnosed with hypoglossal nerve (CN XII) palsy. Three were radiation induced, with one patient having CN V + XII involvement, a second having CN XI + XII involvement, and a third showing isolated disease of CN XII. All three had myokymia on tongue EMG. Vascular causes ranked second, with one patient developing CN XI + XII palsy from an internal carotid artery dissection and a second developing hypoglossal nerve palsy from medulla compression by an enlarged vertebral artery. One patient presented with a unique acute onset case attributable to a synovial cystic compression of the right hypoglossal canal coupled with congenitally narrowed hypoglossal canals in the setting of platybasia. Of note, no such case has been previously reported to our knowledge, including in a case series of 100 patients by Keane et al (1996). One case remained indeterminate with regards to etiology. Most patients presented either in the setting of a known cancer, prior external beam radiation or as chronic headache with imaging diagnostic of vascular etiologies.

#### **F43**

##### **Idiopathic Peripheral Neuropathy and Subsequent Diabetes Mellitus**

*Ritika Mahajan, MD; Molly King, MD; Madeleine M. Grigg-Damberger, MD, FACNS*

**Objectives:** Determine how often and when patients with idiopathic sensorimotor axonal neuropathy (IPN) confirmed by nerve conduction studies (NCV) will subsequently develop diabetes mellitus type-2 (DM2).

**Methods:** Retrospectively searched electronic medical records of NM VA Health Care System from 1995-2013 for veterans diagnosed with IPN by history and NCV. Collected Hemoglobin A1c (HgbA1c) near time of initial diagnosis, and subsequent visits until 2013. Using 2010 American Diabetes Association guidelines, classified HgbA1C 5.7-6.4% as prediabetic, > 6.5% as diabetic. Excluded veterans whose initial HgbA1c was >6.5%, taking antidiabetic medications, or developed another IPN cause.

**Results:** 283 veterans initially diagnosed with IPN (median age 65 years, 95% men). When diagnosed, 156 (55.1%) were normoglycemic, 127 (44.9%) prediabetic. On followup 36.5% initially normoglycemic became prediabetic, 10.3% diabetic, 37.2% normoglycemic, and 16% no data. 18.9% of initially prediabetic became diabetic, 54.3% remained prediabetic, 7.9% normoglycemic, and 18.9% no data. Kaplan-Meier analysis showed 46.8% with IPN became prediabetic or diabetic in a median of 6.5 years.

**Conclusion:** Nearly half of military veterans with IPN will develop prediabetes or diabetes within a median of 6.5 years. Lifestyle modifications and surveillance are needed to reduce risk for subsequent DM2 in IPN.

#### **F44**

##### **Sonography in the diagnosis of Neurolymphomatosis**

*Joy Vijayan, MD*

Nerve ultrasonography is a sensitive and useful investigative tool in the evaluation of neuropathic symptoms in patients with a diagnosis of Lymphoma. Neurolymphomatosis is an uncommon clinical complication of Non-Hodgkin's Lymphoma and is characterized by infiltration of lymphomatous cells into the peri- and endoneurium of peripheral nerves. Confirmation of a clinical diagnosis is based on MRI and PET scan studies which are followed by invasive histopathological studies. We present three patients with a history of lymphoma who were seen in the Neurodiagnostic Laboratory for electrodiagnostic evaluation of presumed radiculopathies. Electrodiagnostic studies proved involvement of the peripheral nerves. Ultrasonography showed nerve thickening with increased blood flow in those sites which were electrodiagnostically abnormal. Further histopathological studies confirmed diagnosis of neurolymphomatosis. Nerve ultrasonography is a useful tool in evaluating neuropathic symptoms in patients with Lymphoma.

## **F45**

### **An Alternative to Collodion**

*Esperanza E. Wagner, MD*

Purpose: Improve Electrode Application for Long-Term EEG/Video Monitoring without using Collodion.

Method: Prepare the skin as usual. Cut gauze into one inch by one inch squares. Fill a 10 mm electrode cup with a conductive paste (Ten20(R) conductive paste or Elifex (R) just enough to fill the cup. Squeeze a bit of cream (EC2(R)genuine Grass electrode cream) on a piece of gauze to hold the electrode down for about 10 seconds, which dries up fast. This method does not actually "mix" conductors, since there is almost no contact between the two. One conductor is inside the electrode cup and the other one is on the outside and not serving any conducting function. The electrode impedance should be less than 5.000 Ohms and balanced. After the impedances are found to be satisfactory, apply a piece of 3MTTM Mixepoew™ Microporus Hypo-Allergenic Surgical Tape over the electrodes on forehead and the temples, e.g., F7, Fp1, Fp2, F8, T1 and T2. Now you are ready to wrap the head. Two 4 inch self-adhering, conforming bandages are used. Tape the head wrap for security and then place a net over the head, which is very convenient, especially for children. Eight patients per week were monitored and evaluation for diagnosis of Epileptic seizures vs. non epileptic spells.

Results: This method is fast, easy and convenient with no Collodion odor, no skin breakdown and easy electrode removal with just water. The electrodes remain secured on patients with severe epileptic seizures and autistic children. Electrodes continue with low impedance and practically no repairs on patients monitored for 3 to 4 days. This procedure is also for patients who are allergic to Collodion.

Conclusion: Most of the recordings are of high quality and the Epileptologists are able to see the beginning, evolution and end of the seizure.

## **F46**

### **Brain Seizing Heart Ceasing- Revisiting Changes In Seizure Semiology**

*Sally V. Mathias, MD; Sammy Claude Elayi, MD; Isabel Derera, MD; Meriem Bensalem-Owen MD, FACNS*

Rationale:

Seizure induced asystole is rare and could be responsible for increased risk of morbidity and mortality associated with epilepsy.

Methods:

Case report of two patients with established epilepsy who developed de novo "drop attacks" characterized by brief loss of consciousness prompting the need for repeat video-EEG monitoring and concomitant cardiac monitoring.

Results:

The first patient is a 60 year old woman with an established diagnosis of focal onset epilepsy, during video-EEG monitoring, had one stereotypical event that was consistent with a focal seizure of left temporal origin associated with 16 seconds asystole on the single lead ECG. The second patient is a 48 year old woman with history of well controlled seizures of right temporal origin. Repeat video-EEG monitoring captured a subclinical seizure originating from the right temporal region that was associated with significant bradycardia detected by cardiac telemetry. A holter monitor completed a day before monitoring recorded 3 syncopal episodes with asystole up to 20 seconds. Both patients had a pacemaker inserted with resolution of arrhythmias.

Conclusions:

Repeating video-EEG monitoring while paying close attention to concomitant ECG is critical in the evaluation of epilepsy patients who develop a sudden change in seizure semiology particularly drop attacks.

## F47

### **Advocating Cardiac Telemetry in EMU Based on Case Reports**

*Aradia Fu, MD; Laura L. Lehnhoff, MD*

**INTRODUCTION:** Cardiac arrhythmia and asystole are well recognized phenomena in patients undergoing long-term video-electroencephalography. However, the current monitoring protocols used in many epilepsy monitoring units (EMUs) nationwide do not require continuous cardiac telemetry (CCT).

#### **CASE DESCRIPTION:**

**Case 1:** An 85 year-old male with no known cardiac arrhythmia presented to EMU for characterization of spells. We captured an event where the patient was unresponsive and shook in all four extremities. During the event, the electroencephalography (EEG) showed diffuse attenuation, and the one-lead electrocardiogram (ECG) showed atrioventricular block leading to 40-second asystole. The patient underwent pacemaker placement the next day.

**Case 2:** A 57 year-old female with no known cardiac history presented to EMU for characterization of seizure like episodes. On day two of admission, she felt dizzy, became unresponsive, and had a brief full body myoclonic jerk. During the event, the background EEG activity was completely suppressed, and the one-lead ECG showed bradycardia evolving to 37-second asystole. The patient had pacemaker placed the following day.

**DISCUSSION:** We strongly advocate for CCT as part of a standardized protocol for patients undergoing EMU admissions to mitigate the potential mortality from cardiac events associated with seizures or from previously unrecognized cardiac conditions.

## F48

### **Myoclonic Jerks and Generalized Tonic-Clonic Seizures – The Diagnostic Dilemma.**

*Inna Keselman, MD; Rafael J. Lopez-Baquero, MD; Yana Bukovskaya, MD; Joaquin Barreda, MD; Christina B. Baca, MD*

Juvenile myoclonic epilepsy is a genetic generalized epilepsy syndrome characterized by myoclonic jerks and generalized tonic-clonic seizures (GTC) with electroencephalogram (EEG) showing irregular 3–6 Hz generalized spike/poly-spike and wave (SW/PSW) discharges. Focal semiological and interictal EEG findings have been recognized; focal semiology, however, typically correlates with generalized ictal EEG activity. We describe a 27 year old man with a presumptive diagnosis of generalized epilepsy who was admitted to our epilepsy monitoring unit for differential diagnosis of GTCs unresponsive to anti-epileptic drugs (AEDs). His GTCs started at age 23 and were preceded by myoclonic jerks. His brother also had unclassified epilepsy since his early twenties. Brain magnetic resonance imaging was non-lesional and positron emission tomography was normal. Interictal EEG showed bursts of either bisynchronous or left sided 3-4 Hz PSW complexes. The patient had two symmetric myoclonic jerks, one correlating with a large amplitude bifrontal SW complex, and the other with a large amplitude left hemispheric SW discharge. The patient had one generalized tonic-clonic seizure characterized by a generalized myoclonic jerk followed by confusion, head version to the right and “figure 4” sign, followed by generalized tonic-clonic movements. Ictal EEG revealed left-sided semi-rhythmic 4-5 Hz slow waves over Fp1, F7, F3 at onset. Behavior and ictal EEG suggest focal epilepsy with secondary bilateral EEG synchrony. The patient was discharged home on levetiracetam and lamotrigine and has not had a GTC in one year. Video-EEG monitoring is essential for characterization of ictal behavior and EEG in patients with presumed generalized epilepsies that are unresponsive to AEDs to assess for focal epilepsy with rapid bilateral EEG synchrony or co-existent focal epilepsy.

## F49

### **Invasive Monitoring and Surgery for Isolated Epileptic Auras**

*Vinita J. Acharya, MD; Michael Sather, MD; Krishnamoorthy Thamburaj, MD; Jayant Acharya, MD*

**Background:** Invasive monitoring and surgery are rarely performed in patients with isolated epileptic auras. We report a patient with disabling psychic auras, who underwent surgery after stereo-EEG.

Case Report: A 22 year old woman developed staring spells at age 6. She was placed on antiepileptic drugs (AEDs) after EEG showed right frontotemporal spikes, but was resistant to multiple AEDs. MRI showed a right mesial temporal ganglioglioma, which was resected. Staring spells stopped, but she developed frequent, disabling sensations of déjà vu, anxiety and fear. On noninvasive video-EEG monitoring, she had interictal sharp waves in the right temporal region but no ictal EEG changes during multiple events. MRI showed residual tumor in the right uncus. Stereo-EEG was performed with 5 depth electrodes in the right temporal and orbitofrontal regions. She had six typical events with ictal EEG onset in the right amygdalar and anterior hippocampal depth electrodes. There were no changes on scalp EEG. She underwent right amygdalo-hippocampectomy with removal of tumor. Postoperatively, she remains aura-free for more than 2 years, with significant improvement in quality of life.

Conclusions: Invasive monitoring and epilepsy surgery can be performed in patients with isolated epileptic auras if they are frequent and disabling, there are no scalp ictal EEG changes, and there is an MRI lesion. Invasive monitoring is useful to confirm the epileptic nature of isolated auras, study the relationship between the epileptic focus and MRI lesion, and to plan surgery.

## F50

### **A Complex Epileptogenic Network Involving Periventricular Nodular Heterotopia**

*Jessica Templer, MD; Jay Gavvala, MD; Elizabeth Gerard, MD; Micheal Macken, MD; Aditi Narechania, MD; Stephen A. VanHaerents, MD; Stephan S. Schuele, MD, MPH, FACNS*

Periventricular nodular heterotopia (PNH) is a neuronal migration disorder often associated with medically refractory epilepsy. Prior studies have shown that patients with PNH can have several possible epileptogenic foci: the periventricular nodule itself, cortex overlying the nodule, or distant structures. We present the case of a 23-year-old right-handed woman with a three year history of focal seizures and a single generalized convulsion. Clinical semiology consisted of déjà vu followed by nausea and occasional vomiting with subsequent loss of awareness associated with automatisms. Frequently, she would have a post-ictal headache. MRI demonstrated two discrete nodular foci of heterotopic gray matter along the lateral aspect of the right temporal horn. Initially, it was thought that the ictal onset zone was one or both of the periventricular nodules. Stereo EEG revealed that the epileptogenic network included not only the anterior focus of gray matter heterotopia, but independently involved the mesial hippocampal and basal temporal structures. Stereo EEG with depth electrodes allowed for adequate identification of the complex epileptogenic network without the morbidity associated with subdural grid placement. Epileptologists should be vigilant in their pursuit of a true ictal onset zone despite the presence of a probable lesion.

## F51

### **A New Waveform: The Texting Rhythm**

*Benedetto S. DiCiaccio, MD; William O. Tatum, DO, FACNS; Kirsten Yelvington, MD; Valerie Davis, MD; Shannon Anderson, MD*

Objective: To describe a previously unidentified "texting rhythm" (TR).

Methods: 66 patients (51 F; mean age 34.74 years) with paroxysmal events (38 with epileptic (ES) and 23 with non-epileptic seizures (NES)) were admitted for video-EEG monitoring. The TR is a generalized burst of 5-6 Hz theta maximal in the fronto-central head regions during active texting. Other methods of activation included finger tapping/swiping, mathematic computation, scanning eye movements, speech/cognitive testing, and audio telephone conversations. The presence of a TR was compared between patients with ES and NES and between methods of activation.

Results: The TR was highly specific to texting without the appearance of a similar waveform during mental activation or audio cellphone use ( $p < 0.0001$ ). A TR was present in 44.0% of patients lasting from 2 seconds to continuous runs during the activity. It was present in 57.9% of patients with ES but only 17.4% of patients with NES ( $p = 0.0019$ ). Additionally, the average age for those with a TR was 30.45 yrs while those without a TR was 38.11 yrs ( $p = 0.0117$ ).

Conclusions: The TR is a new and specific waveform linked to using new technology associated with text messaging. It likely reflects a visual-cognitive network activation unique to cellphone use.

## **S1**

### **Unilateral Independent DiPLEDs and SPECT Imaging**

*Whitney Griffith, MD; Bruce Fisch, MD, FACNS; Joanna Fair, MD*

Periodic lateralized epileptiform discharges (PLEDs) are associated with hypermetabolism on PET imaging, and increased cerebral perfusion on SPECT imaging, although not invariably. Different PLED patterns vary in significance within the ictal-interictal continuum according to certain electrographic features (e.g., PLEDs Plus). We present acute SPECT and EEG findings in a unique case in which 2 independent periodic epileptiform patterns occurred within the same hemisphere. A 57 year old man with a history of left sided craniotomy for subdural hematoma developed a subdural empyema and presented with convulsive status epilepticus. Convulsive status resolved following the administration of lorazepam, levetiracetam and phenytoin. The patient subsequently appeared to be alert but was unable to follow commands. Continuous video and EEG monitoring revealed left hemispheric PLEDs in 2 independent locations associated with 2 discrete areas of increased perfusion on SPECT imaging (illustrations to be presented). Our case demonstrates that in a setting of acute neurological impairment following convulsive status, multiple PLEDs can be associated with multiple independent areas of hyperperfusion. We believe additional studies using nuclear imaging are indicated to determine the pathophysiological correlates of nonconvulsive epileptiform patterns encountered in the ICU setting and their possible implications for treatment.

## **S2**

### **EEG Characteristics in Therapeutic Hypothermia—Cooled and Warmed**

*Kyung-Wha Kim, MD; Elayna Rubens, MD; Douglas Labar, MD*

Electroencephalogram (EEG) monitors brain activity continuously in therapeutic hypothermia (TH) patients where obtaining neurological exam and brain imaging are difficult. To better understand the effects of temperature on the brain, we retrospectively characterized EEG patterns during the cooled and subsequent warmed phases of 12 TH patients in a blinded fashion. For each patient, we analyzed six 30-minute segments (three cooled and three warmed) of EEG. We characterized and systematically classified EEG on the following criteria: continuity, background frequency, inter-ictal epileptiform discharges (IEDs), and discrete seizures. All EEGs were abnormal, and they did not necessarily improve upon warming. Group improvement was seen on continuity and seizures: number of at least “nearly continuous” records improved from seen in 6/12 to 9/12 patients; seizures declined from seen in 2/12 to 0/12 (but warmed group was on antiepileptics). Group worsening was seen in presence of IEDs: these increased from seen in 2/12 to 6/12 patients. There were no deaths during EEG, but only three patients survived to hospital discharge. Upon warming, only 1/3 survivors developed new IEDs. However, 5/9 non-survivors developed new or more active IEDs. EEG is a dynamic functional test, whose characterization during temperature changes may elucidate better understanding of brain activity.

## **S3**

### **EEE Periodicity Checker**

*Fumisuke Matsuo, MD; Michael Ball, MD*

Recent examinations of interictal epileptiform transients suggested that PGCO (polygraphic channel overlay) offered advantages for some applications (J Clin Neurophysiol 2014; 31: 289). When configured to cover prolonged time period in one display, PGCO can make realistic inspection of entire EEG of prolonged duration for periodic transients, simple or complex in waveform. Figure illustrates

transition between periodic and electrographic seizure discharges in 500-s PGCO in serial bipolar derivations (A). Hemispheric asymmetry can only be appreciated in conventional display (B). Underlined 10-s segments in A and B correspond. Applications of PGCO to be presented from intensive care EEG monitoring have revealed wide variations of phase relationship among diffuse periodic discharges, including triphasic transients. Change in phase relationship infers change in EEG generator configuration. PGCO may contribute to case-controlled study of acute epileptiform encephalopathy.

#### **S4**

##### **Incidence and Risk Factors for Skin Breakdown During Continuous EEG Monitoring**

*Christine Scott, MD; Lidia Moura, MD; Junior Valdery Moura, MD; M Brandon Westover, MD*

Purpose: 'Skin breakdown' during continuous EEG monitoring (cEEG) in acutely hospitalized patients has recently become a topic of national concern. We measured the incidence and possible factors responsible for cEEG-related skin breakdown.

Methods: We tracked skin breakdown among 1024 patients who underwent cEEG over 9 months. Variables analyzed included cEEG duration, patient age, within-hospital location, electrode type, adhesive type, and technologist who applied the electrodes. After univariate analysis, we included significant variables in a Cox regression model to estimate the time-dependent risk of skin breakdown. Key Findings: cEEG-related skin breakdown occurs in <10% of patients overall. Predictors of skin breakdown in univariate analysis include age (most cases occurred in elderly patients); location (most cases occurred in ICUs); technologist (more experienced technologists had fewer cases), and electrode type (most cases involved MRI-compatible electrodes). Average overall risk was stable from month to month around 8%. One cEEG day confers an 8% average risk.. Patients undergoing prolonged monitoring experience a cumulative risk over 10 days of 30%.

Significance: Technologist experience/technique, electrode type and monitoring duration appear to be important modifiable risk factors for cEEG-related skin breakdown. Other potential factors that we are currently investigating include pressors, nutritional status, fever, and allergies.

#### **S5**

##### **EEG Monitoring in Critically Ill Patients**

*Ammar Kheder, MD*

Objective: The objective of this study was to estimate the burden of electrographic seizures in consecutive adults who underwent EEG monitoring and were admitted to non-Neurological ICUs.

Setting: Medical, surgical and cardiac intensive care units at Massachusetts General Hospital

Patients: 166 consecutive patients in non-neurointensive care without known acute neurologic injury between January and September 2013.

Main Results:

The Mean age was 60.39 years old. 56% were male and 44% were females.

There was a total of 240 days of monitoring and the mean duration of monitoring was 1.44 days.

The main indication for performing studies was altered mental status (144 patients 87%). The majority of patients had an underlying infection or sepsis 39(23%). Other common diagnoses included: structural brain abnormalities or prior stroke diagnosed by imaging 21% (35), metabolic disturbances 9% (15), and substance abuse or overdose 7%. Fifteen patients had seizures (9%). Seizures were recorded from patient with sepsis 6, brain metastases 3, prior stroke 3, hyponatremia 1, known epilepsy 1, and unknown cause 1. Seven of those had electroclinical seizures and eight had electrographic seizures (4.8%). Time to detect the first seizure was less than 6 hours in 12 of 15 (80%). Of the remaining two seizures; one was captured within 24 hours and the other within 48 hours. Epileptiform discharges detected included sharp waves in 53 patients (32%), lateralized periodic discharges (LPDs) in 20 patients (12%), and generalized periodic discharges in 26 (16%).

Conclusion: In an unselected cohort of critically ill adults; seizures were detected in 9%. Purely electrographic seizures without apparent clinical accompaniment were present in 4.8 %. Further larger prospective studies are required to evaluate the prevalence and the burden of electrographic seizures in critically ill patients without obvious acute neurological disorder.

## S6

### **Cardiac Complications in Convulsive and Nonconvulsive Status Epilepticus**

*Yara Nazzal, MD; Kanika Arora, MD; Mohammad R Haider, MD; A K M Arifuzzman, MD; S Pati, MD; M. Brandon Westover, MD*

Objectives: Cardiac complications in status epilepticus(SE), especially in convulsive SE(CSE) are well known. Our goal was to assess the patterns of cardiac complications in non-convulsive SE(NCSE) and compare them with CSE. We hypothesized that cardiac complications in NCSE differ in type and frequency from CSE.

Study methods: A single centre, retrospective study involving 47 consecutive patients (adults and children) admitted in the neuroscience intensive care unit following diagnosis of CSE and NCSE. Cardiac complications were assessed by EKG, echocardiogram, and troponin values.

Results: 70% (N=33) had CSE and the remaining 30%(N=14)had NCSE. The most common etiology of SE was intracranial bleed (42%). Average length of stay in the ICU was 9.7 days. Cardiac complications were seen in 43% (N=6) of NCSE and 55% (N=18) of CSE patients. Cardiac complications included: cardiomyopathy or left ventricle hypokinesia, elevated troponins, and EKG abnormalities. Cardiomyopathy was predominantly seen in CSE (33%) VS 0% in NCSE while malignant arrhythmias were commonly seen in NCSE (28%) VS 0.09% in CSE .

Conclusion: The frequency of cardiac complications in NCSE was similar to CSE. However patterns of cardiac complications in NCSE were clearly different from CSE. These findings suggest that the underlying mechanisms and optimal methods of monitoring to detect and prevent adverse cardiac outcomes may be different for CSE and NCSE. These preliminary findings should be confirmed in a larger cohort.

## S7

### **Clinical Performance of a Prospective Continuous Electroencephalography (cEEG) Ischemia Monitoring Service for Predicting Neurologic Decline after Aneurysmal Subarachnoid Hemorrhage (SAH)**

*Eric S. Rosenthal, MD; Kathryn L. O'Connor, MD; Sahar F. Zafar, MD; Siddharth Biswal, MD; M. Brandon Westover, MD;*

Introduction: Retrospective analysis has identified various cEEG features associated with delayed ischemic neurologic decline (DIND) or delayed cerebral infarction (DCI) after SAH. We evaluated the performance of clinical neurophysiologists in clinical practice prospectively reporting cEEG for SAH ischemia monitoring.

Methods: Nontraumatic Hunt-Hess Grade 4-5 or Fisher Group 3 SAH patients met inclusion criteria for clinical cEEG monitoring. cEEG was scored in the clinical neurophysiology report for prospective determination of: percent alpha variability decline from baseline; new alpha-delta ratio decrement or asymmetry; new focal slowing; new epileptiform discharges; or new subjective impression of focal electrographic worsening. Maximal daily TCD peak systolic velocity (PSV) was recorded. DIND/DCI events occurring after the initial day of cEEG monitoring and before cEEG discontinuation were prospectively recorded by daily clinician interviews and multi-rater adjudication. Events were classified as Global Neurologic Decline (DIND-G), Focal Neurologic Decline (DIND-F), or Radiologic Delayed Cerebral Infarction (DCI).

Results: 34/71 (48%) patients undergoing cEEG monitoring over 2 years developed DIND/DCI, which was more common when preceded by cEEG deterioration vs. not (71.4% vs. 25.0%). cEEG had good sensitivity (Se 76%) and positive predictive value (PPV 69%) in clinical practice for detecting DIND/DCI, improving pre-test probability by >40%. TCD PSV>200 cm/sec provided only 48% Se and 38% PPV.

Conclusion: cEEG findings documented in clinical practice increase DIND/DCI prediction over the baseline prevalence. The biologic mechanism mediating these findings may include vasospasm-related ischemia, cortical spreading depolarizations, and events on the ictal-interictal continuum.

## **S8**

### **The Time Course and Prognostic Values of Electroencephalographic Patterns after Anoxic Brain Injury**

*Adithya Sivaraju, MD; Emily J. Gilmore, MD; Jeremy J. Moeller, MD; David M. Greer, MD; Lawrence J. Hirsch, MD, FACNS Nicolas Gaspard, MD, PhD*

Objective: To study the prognostic value of continuous electroencephalographic (cEEG) patterns in patients with post anoxic brain injury.

Methods: Prospective cohort study of all consecutive post anoxic patients undergoing cEEG monitoring at Yale-New Haven hospital between May 2011 and June 2014 (n = 100). 5 minute clips taken at 6(+/-1), 12(+/-2), 24(+/-2), 48(+/-2) and 72(+/-2) hours after return of spontaneous circulation (ROSC) were reviewed. EEG background was classified according to the latest version of the ACNS Critical Care EEG Terminology. Clinical outcome was assessed using Glasgow Outcome Scale (GOS) within 3 months after discharge, dichotomized as good (GOS 4-5: low to moderate disability) vs. poor (1-3: severe disability to death).

Results: Table 1A & 1B: Patient characteristics, Fig 1A: Temporal evolution of EEG patterns, Fig 1B: Prognostic value of different patterns. Non-Vfib arrest, longer time to ROSC, absence of brain stem reflexes, extensor or worse motor response, lower Ph, higher lactate, & lower mean arterial pressure requiring >2 pressors were characteristics of the poor outcome group. EEG patterns change over time; all patients with Suppression-Burst (zero false positive rate) and all but two patients with suppression had a poor outcome. Any other background pattern was more likely to have a good outcome, if present at ≤ 24 hrs, and this prognostic significance markedly decreased at later time points (see Fig 1B). Overall, EEG patterns at ≤ 24hrs are more reliable for predicting final outcome.

## **S9**

### **QEEG in Psychopath Women**

*Ana A. Calzada Reyes, MD*

Objective: The aim of the present study is to find out whether there are differences in quantitative EEG spectral parameters and intracranial distribution of QEEG activity during the rest condition, between psychopath and non psychopath female inmates Methods: The resting EEG activity and LORET A for the EEG spectral-slow bands were evaluated in 35 violent female offenders, 12 with and 23 without psychopathy according to the Hare Psychopathy Checklist-Revised. All subjects were assessed using the DSM IV-R criteria. The EEG visual inspection characteristics and the use of frequency domain quantitative analysis techniques (Narrow band spectral parameters) are described. Results: QEEG analysis showed a pattern of excess of theta activity on the the right frontal region. LORETA revealed an increase of -theta activity (3.906 Hz) in psychopath group relative to non-psychopath female group within fronto-temporal regions. Conclusions: These findings indicate that QEEG analysis and techniques of source localization may reveal differences in brain electrical activity among female offenders with psychopathy, which was not obvious to visual inspection. Taken together, these results suggest that abnormalities in a fronto-temporal network play a relevant role in the neurobiological basis of psychopathy .

## **S10**

### **Automatic Detection of Burst-Suppression Patterns in Scalp EEG**

*Franz Fürbass, MD; Manfred Hartmann, MD; Hannes Perko, MD; Johannes Koren, MD; Johannes Herta, MD; Andreas Gruber, MD; Christoph Baumgartner, MD; Tilmann Kluge, MD*



The occurrence of burst-suppression patterns in the EEG of ICU patients is usually associated with poor outcome if induced by pathological conditions. To avoid exhaustive manual evaluation of the EEG, we developed an automatic and parameter-free method to detect burst-suppression patterns. To assess the detection performance of the method, continuous scalp EEG of 64 consecutive patients was recorded at two ICUs sites resulting in 3962 hours of EEG in total (min 6h, max 192h). A clinical neurophysiologist was asked to manually review the first minute of each recording hour in the EEG and to mark these segments as burst-suppression or normal EEG. The results of our automatic detection method were compared to the manual annotations to define detection performance by means of sensitivity and specificity. During manual review burst suppression patterns were found in 21 patients, segments without burst suppression were found in 63 patients. The average detection sensitivity was 82% (95% confidence interval from 70-90%). The average specificity was 80% (95% confidence interval from 73-85%). Our fully automatic detection method for burst-suppression patterns showed high sensitivity and specificity on unselected consecutive long term EEG recordings and will support automated EEG evaluation in the clinical setting.

## S11

### **Passive Intracranial EEG Based Localization of the Central Sulcus during Sleep**

*Rafeed Alkawadri, MD; Hitten Z. Zaveri, MD; Jason L. Gerrard, MD; Lawrence J. Hirsch, MD, FACNS; Dennis D. Spencer, MD*

We report the results of a pilot study to test the performance of a new operator-independent method for passive identification of the central sulcus (CS). We studied 7 patients with intractable epilepsy undergoing intra-cranial EEG (icEEG) monitoring at Yale, in whom CS localization was obtained by standard methods. Our method takes advantage of inherent properties of the primary motor cortex (MC), which exhibits enhanced icEEG-high gamma power and coherence across the CS. For each contact  $x$  we calculated the z-score of a composite power and synchrony value  $\log_{10}(p_x) * c_x$ , where  $p_x$  is sum of the root mean square of the icEEG in the high gamma band [80-115] Hz for contact  $x$  over the 6-10 mins of NREM sleep studied, and  $c_x$  is the mean magnitude squared coherence in the same band using a 500-ms Hamming window between contact  $x$  and all other contacts. Z-score values lower than threshold ( $th$ ) were set to 0. Finally, we calculated a metric  $m = z/d$ , where  $d$  is the mean Euclidian distance of each contact from contacts with z scores greater than 0. The last step was implemented to emphasize local network activity. The sensori-motor (SM) cortex exhibited higher EEG-gamma power compared to non-SM cortex ( $p < 0.0002$ ). There was no significant difference between the motor/pre-motor and sensory cortex ( $p < 0.47$ ). CS was successfully localized in all patients with thresholds between 0.4-0.6. In 2 patients, knowledge of anatomy was needed to distinguish the MC from adjacent epileptic foci. The primary hand and leg motor areas exhibited the highest metric values consistently followed by the tongue motor area. Higher threshold values were very specific (94%) for the anterior bank of the CS but not sensitive. Intermediate threshold values achieved a reasonable trade-off (0.4: 89% specific and 70% sensitive). This method can be used for passive identification of the CS, including possible use in the OR.

## S12

### **What's your EEG number? Resident Training & Competency**

*Lynn Liu, MD; Adam Juersivich, MD; Thomas Wychowski, MD*

Objective:

Assess resident electroencephalogram (EEG) training experience and correlate experience to self-assessment of competency.

Background: Many procedural specialties have a specified number of procedures required to demonstrate competence. There are no data to generate such numbers for EEG interpretation. Exposure during Neurology residency can vary between 0-3 months. Quantity and diversity of cases can be a matter of chance. A neurology graduate should be competent in reading EEGs.

Design/Methods: Twelve University of Rochester neurology residents over 2 years completed their 4-10 weeks EEG rotation. Each investigator scored EEG reports by degree of abnormality for each subject's experience then assigned them a rank based on their case-mix. Using a 4-point Likert scale each subject assessed their skills in interpreting reports and basic EEG milestones: normal EEG, common artifacts, normal variants, and common and uncommon abnormalities. To correlate the degree of complexity of the EEG experience and subject self-assessment, rank correlation was attempted using Spearman's Rank-order Correlation.

Results: The total EEGs read range from 88-355 studies with abnormal studies representing 34-68%. Residents felt comfortable interpreting EEG reports and normal EEGs but were less comfortable with normal variants and uncommon abnormalities. Due to lack of degree of separation in self-assessments scores Spearman's Rank-order Correlation could not be used.

Conclusions: Despite the lack of correlation between self-assessment score and EEG experience, this study raises important considerations to determine competency. Program directors sign off based on supervisor opinions potentially flawed by recall bias. Self-assessments may be limited by in insight. Current summative testing lacks specificity. Formative and summative assessment during the rotation should be validated and correlated with EEG experience.

## S13

### **Brief Potentially Ictal Rhythmic Discharges (BIRDs) in the Epilepsy Monitoring Unit**

*Ji Yeoun Yoo, MD; Lara Marcuse, MD; Madeline Fields, MD*

Background: Brief potentially ictal rhythmic discharges (BIRDs) and their association with seizures have been described in neonates and recently in critically ill patients. We aimed to identify BIRDs in non-critically ill patients and explore their association with seizures and other findings.

Methods: We prospectively identified BIRDs in patients who received long term video or ambulatory EEG monitoring from July 2013 to September 2014. Patients with status epilepticus or altered mental status were excluded. BIRDs were defined as rhythmic discharges of theta or higher frequency lasting less than 10 seconds.

Results: BIRDs were identified in 6 out of 620 patients (1%). Typical frequency and duration of BIRDs were theta/alpha frequency and 0.5-4 seconds. All patients had epilepsy and 4 of them were medically refractory; 3 of the 4 were non-lesional. In the 3 patients with lesions (2 benign tumor resection, 1 prenatal cerebral hemorrhage), BIRDs co-localized to them. BIRDs were extra-temporal (1 frontal, 4 centro-parietal) in all but one (frontotemporal) who had a tumor resection. Three had recorded seizures which co-lateralized to the BIRDs; in these patients, BIRDs preceded the seizure onset. All had co-localizing interictal epileptiform discharges, except in one who had independent sharp waves in the other hemisphere; in this patient, clinical seizures co-lateralized to the BIRDs.

Conclusion: This data demonstrates the presence of BIRDs in patients with epilepsy, more often associated with extra-temporal in origin and medically refractory in nature. Further study is needed to better understand their clinical and prognostic significance.

## S14

### **The Practicality and Diagnostic Yield of Ambulatory Electroencephalography (aEEG)**

*Kader AbdeleRahman, MD; Madeleine M. Grigg-Damberger, MD, FACNS*

Background: The University of New Mexico Hospital (UNMH) inpatient video EMU covers a wide under-served area. Current waiting time at the UNMH EMU is approximately 6 months. Outpatient ambulatory EEG may serve as a cost-effective and convenient alternative to inpatient video EEG monitoring.

Objective: To investigate our institution's experience, utilization, and indications for outpatient aEEG in the diagnosis and management of epilepsy and to assess the diagnostic yield and limitations of aEEG.

Methods: Retrospective EMR and EEG database review of all patients undergoing aEEG at UNMH from 01/2008 to 04/2014. Variables analyzed included age, gender, presence of IEDs, habitual and/or non-habitual events, diagnostic yield, and limitations.

Results: 46 met inclusion criteria: 61 % pediatric and 39% adults, 56 % of the studies performed had a recording duration < 48 hours, remainder >48 hours. 39 studies were performed to characterize spells; habitual event(s) were captured in 51%, but only 15% of those were associated with ictal EEG correlates. 6 aEEG studies were performed for quantification of seizures and IEDs for management purposes. One aEEG study was performed in a patient undergoing epilepsy surgery evaluation in whom no seizures occurred during one week of inpatient video monitoring. Focal seizures with ictal correlates were captured by the aEEG.

Conclusion: Outpatient aEEG is under-utilized at our institution. Physicians are more likely to refer those with nonepileptic spells to aEEG than to the EMU. However, in the absence of video or a good clinical description, events without EEG correlation can only offer a presumptive diagnosis of nonepileptic spells. Outpatient aEEG can provide useful clinical information for the management and localization of patients already diagnosed with epilepsy. The addition of video to the outpatient setting will surely add to the diagnostic yield.

## S15

### **Intracranial Recording of "14Hz positive spikes" During Stereoelectroencephalogram Evaluation- A Case Study**

*Lazarus Mayoglou, MD; Juan Bulacio, MD; Jorge Gonzalez-Martinez, MD; Ahsan Moosa, MD*

Recognition of normal variants on EEG is critical to avoid misdiagnosis. 14Hz positive spikes are frequent in older children and are readily recognized by most electroencephalographers on scalp EEG. Literature on this variant with intracranial EEG recording is limited. We report a 7yr old child with non-lesional focal epilepsy who had an intracranial evaluation using bilateral stereo EEG implantation for epilepsy surgery. Stereotyped 0.5 - 1s bursts of sharp spindle like discharges were recorded from body and tail of the right hippocampus. They occurred in a monomorphic fashion of around 14Hz and were noted only in certain stages of sleep. They were high amplitude, up to 4-5mV. No independent sharp waves were noted in the right hippocampus. Concomitant scalp EEG showed typical patterns of 14Hz positive spikes in the right temporo-parietal region. Invasive evaluation suggested seizure onset from the left frontal lobe that lead to a focal resection. Patient remains seizure free 4 years after surgery. Recognition of such benign patterns may be important to avoid potential misdiagnosis of the epileptogenic zone.

## S16

### **New Quantification Methods of EEG Spikes in Patients with ESES**

*Ahmet Tanritanir, MD; Michele Jackson, MD; Lindsay St. Louis, MD; Jacquelyn Klehm, MD; Tobias Loddenkemper, MD, FACNS*

Rationale: This study aims to describe the correlation of 3 EEG features in ESES, spike-wave index (SWI), spike frequency (SF) and one hour spike frequency (OHSF) in sleep and wakefulness periods and to present a novel quantification tool, the sleep to wakefulness ratio (SWR) for clinical use in evaluating the treatment of ESES.

Methods: We retrospectively evaluated SWI, SF and OHSF in 15 patients diagnosed with ESES who had overnight video-EEG monitoring at a tertiary center from 2012 to 2014. We included patients with at least 50% spike percentage in slow wave sleep. We determined the correlation between SWI and SF for 1st 5 min of sleep and a 5 min period of wakefulness and the correlation with OHSF for longer period of 1 hr in sleep and wakefulness. The SWR for SWI, SF and OHSF was evaluated. SWI was defined as

percentage of 1-sec bins with at least 1 spike-wave complex for a 5 min period. SF was defined as spike count in same 5 min period and OHSF was defined as spike count in a 1 hr period.

Results: Median age was 7.73 (Range: 3 -11, SD: 2.7) yrs and 66.7% were males. Median SWI was 70.7 (IQR: 52-83, SD: 15.4) in sleep and 24 (IQR: 9.7-43, SD: 16.8) in wakefulness. Median SF was 265.5 (IQR: 235-335, SD: 102.9) in sleep and 100 (IQR: 30-200, SD: 83.1) in wakefulness. Median OHSF was 2650 (IQR: 1976-4322, SD: 1651.4) in sleep and 879 (IQR: 326-2001, SD: 1172.6) in wakefulness. SWI and SF in sleep (Spearman correlation coefficient,  $R = 0.921$ ;  $p = 0.0001$ ) and wakefulness ( $R = 0.971$ ;  $p = 0.0001$ ) correlated well. OHSF and SWI correlated in sleep ( $R = 0.771$ ;  $p = 0.001$ ) and wakefulness ( $R = 0.874$ ;  $p = 0.0001$ ). OHSF and SF correlated in sleep ( $R = 0.711$ ,  $p = 0.003$ ) and wakefulness ( $R = 0.886$ ,  $p = 0.0001$ ). The SWR for SWI, SF and OHSF was 3.83, 4.45 and 5.98 respectively.

Conclusions: This biomarker, sleep to wakefulness ratio may provide an additional method for EEG quantification that can be used clinically in evaluating ESES.

## **S17**

### **Ictal Appearing Discharges Terminated with Sensory Stimulations**

*Mark Callow, MD; Jane Mitchell, MD; Dr Abdullah Al Sawaf, MD; Dr Dominic Fee, MD; Meriem Bensalem-Owen, MD, FACNS*

Background: The reverse phenomenon of stimulus induced rhythmic or periodic ictal discharges (SIRPIDs) where ictal appearing discharges are terminated by sensory stimulations has been rarely described. In a series of 33 patients with SIRPIDs, one individual whose epileptogenic activity was aborted with stimulation was reported. Four patients with this unusual electrographic pattern were identified at the University of Kentucky.

Methods: Patients with rhythmic or periodic lateralized epileptiform discharges aborted with various sensory stimulations were identified upon review of either continuous video-EEG monitoring or standard EEG.

Results: Four patients were identified over a period of 8 years. This short series included three males and one female with a mean age of 55.5 years. All patients had various cerebral insults including stroke, traumatic brain injury, dementia and metastasis to the calvarium. Two of these patients had prior SIRPIDs. Demographics, history, and EEG findings were reviewed.

Conclusions: The termination of ictal appearing discharges with sensory stimulations is an interesting and rare phenomenon. The clinical significance and pathophysiology of this electrographic pattern remains however unclear. Future studies directed at determining whether sensory feedback mechanisms are involved in the termination of an ongoing seizure would be helpful and could contribute to improved patient care.

## **S18**

### **Symptomatic Hepatomegaly as a Complication of Prolonged Treatment for Refractory Status Epilepticus**

*Derek Debicki, MD; Teneille Gofton, MD*

Prolonged treatment of refractory status epilepticus (RSE) can result in significant systemic complications. The current abstract reports two patients with new onset refractory status epilepticus (NORSE) syndrome who developed symptomatic hepatomegaly during treatment for prolonged refractory seizures in the intensive care unit (ICU). In both, hepatomegaly contributed to abdominal compartment syndrome; surgical intervention was required for one. Comparison of abdominal imaging at the time of seizure presentation and at the development of abdominal symptoms suggests that the observed hepatomegaly developed during the course of treatment. Both patients required multiple intermittent and continuous anti-epileptic drugs (AEDs) and prolonged use of anesthetic agents to maintain a burst-suppression pattern (>60 days) on continuous electroencephalography (cEEG) for seizure control. In the first case, surgical pathology demonstrated a pattern of cellular proliferation (consent for liver biopsy was declined in the second). Indeed, enzyme-inducing AEDs have been associated with hepatic cellular proliferation in animal models. Although no direct causal relationship can be determined, it is suspected that the prolonged use of AEDs (including enzyme-inducing agents) and/or anesthetic

agents resulted in the iatrogenic development of symptomatic hepatomegaly. This is a significant complication that should be considered in the protracted management of RSE in the ICU.

## **S19**

### **Stereo-EEG and Surgery in Bilateral Perisylvian Polymicrogyria**

*Jayant N. Acharya, MD; Vinita J. Acharya, MD; Frank Gilliam, MD; Krishnamoorthy Thamburaj, MD; Michael Sather, MD*

**Introduction:** Epilepsy surgery is rarely performed in patients with bilateral perisylvian polymicrogyria, and becomes more challenging when there are additional epileptogenic lesions. We report a patient with bilateral asymmetric perisylvian polymicrogyria (BAPSPMG), septo-optic dysplasia and unilateral temporal hypoplasia, who underwent surgery after stereo-EEG (SEEG).

**Material and methods:** Case report

**Results:** A 44 year old man presented with pharmaco-resistant focal dyscognitive seizures since age 23. Brain MRI showed BAPSPMG (left>right), absent septum pellucidum, hypoplastic optic nerves and chiasm, and left temporal hypoplasia. On noninvasive video-EEG monitoring, two left hemispheric onset seizures were recorded. FDG-PET showed left temporal hypometabolism. Wada test and functional MRI revealed bilateral language representation, with severely impaired left and normal right memory. SEEG was performed with 7 depth electrodes in the left temporal and perisylvian regions. Five seizures were recorded with ictal EEG onset in the left neocortical temporal and perisylvian temporal regions. An extensive left temporal lobectomy with removal of opercular tissue was performed. Four months after surgery, he remains seizure-free.

**Conclusions:** Epilepsy surgery can be performed in BAPSPMG on the side with more prominent MRI findings, if there are concordant, unilateral EEG and PET abnormalities. SEEG is useful to study the relationship between the epileptic focus and the lesions, and to plan the extent of resection.

## **S20**

### **Lacosamide Associated Sinus Pauses Without Significant PR Change**

*Fawad A. Khan, MD; Michael Bernard, MD; R. Eugene Ramsay, MD; Hina Dave, MD*

**Introduction:** Lacosamide (LCM), a newer antiepileptic drug for the adjuvant management of partial onset seizures, was recently approved for monotherapy. Cardiac conduction disturbances are a known side effect of LCM. We report a case of repeated sinus pauses with LCM.

**Case Report:** A 67 year old male with history of hepatocellular carcinoma and hepatitis C cirrhosis presented with acute alteration of mental status and myoclonus. Based on clinical suspicion for status epilepticus, Levetiracetam (LEV) and LCM were initiated. The EEG failed to show evidence of seizures and LEV was discontinued. Cardiac telemetry recording did not show any cardiac arrhythmias and electrocardiogram showed normal sinus rhythm and right bundle branch block. A mild increase in PR interval was noted following LCM. 5 days later multiple sinus pauses were noted on the telemetry recording requiring transcutaneous cardiac pacing. Within 48 hours of discontinuation of LCM the sinus pauses resolved.

**Discussion:** We observed sinus dysfunction without significant increase in PR interval likely secondary to accumulated toxicity of LCM (dose of 400 mg/day) as a consequence of hepatic dysfunction. Asystole and severe conduction blocks with intoxication of LCM have been previously reported. This case underscores vigilance in cardiac monitoring and appropriate dosing of LCM in patients with hepatic and renal dysfunction to avoid cardiac toxicity.

## S21

### **Pyridoxine Deficiency in Adult Status Epilepticus Patients**

*Hina Dave, MD; Fawad A. Khan, MD; Vivek Sabharwal, MD; R. Eugene Ramsay, MD*

**Background:** We wanted to evaluate pyridoxine levels in adult patients admitted with status epilepticus. **Methods:** With IRB approval, we reviewed the records on patients admitted to the neurological ICU for status epilepticus from January to November 2014 as well as clinic patients from the last three years. Reported normal pyridoxine range is 5 to 50 ug/L. **Results:** In the status population (48 patients), all but four patients had low normal or undetectable pyridoxine levels. 132 adult outpatients were identified. 39% had a low normal pyridoxine level. The mean pyridoxine was 5.5 ug/L in the status group and 25.2 ug/L in the outpatient group. See Figure 1. **Conclusion:** Pyridoxine is a water-soluble vitamin that is naturally present in many foods. The active component, pyridoxal 5' phosphate, binds to intracerebral glutamic acid decarboxylase which is the enzyme responsible for the conversion of glutamate to GABA. See Figure 2. A pyridoxine deficiency was seen in 65.6% of status patients versus 10.6% in the outpatients, a statistical difference to the comparison group. Further studies on the effect of pyridoxine on status control are needed.

## S22

### **Number of Allergies in Epileptic VS Non-epileptic Seizures**

*Aradia Fu, MD; David Denny, MD; Samara Cerven, MD; Naudia Moorley, MD; Steve Chung, MD*

**Objective:** The primary goal was to compare the number of patient-reported allergies within adults with epileptic seizure (ES) and non-epileptic seizures (NES). The secondary goal was subgroup analysis of gender difference.

**Background:** The cost of direct and indirect care for patients with NES are comparable to that of care for patients with intractable epilepsy. Therefore, it is critical that we have reliable indicators for NES in order to establish accurate diagnosis early.

**Methods:** This cohort study collected data from 1,635 epileptic monitoring unit reports of adult patients. We reviewed the number of allergies reported by each patient and the final diagnosis. Patients with ambiguous events, no captured events, and those with both ES and NES were excluded from this study. Patients were divided into four groups: female ES (f-ES), male ES (m-ES), female NES (f-NES), and male NES (m-NES). We used one-tailed T-test when comparing the number of allergies between NES and ES and two-tailed T-test when comparing the gender difference within each ES and NES groups.

**Results:** There was a total of 630 f-NES and 252 m-NES patients within NES group (n=882), and 443 f-ES and 310 m-ES patients within ES group (n=753). The mean reported number of allergies were 1.91 for f-NES (SD = 2.71), 1.14 for m-NES (SD = 1.56), 0.87 for f-ES (SD = 1.73), and 0.49 for m-ES (SD = 0.99). Number of allergies reported by NES patients was significantly greater than that reported by the ES patients ( $p < 0.001$ ), regardless of gender. However, clear gender difference was noted within the two diagnosis groups, with females reporting greater number of allergies in NES ( $p < 0.001$ ) and ES ( $p < 0.001$ ).

**Conclusions:** Patients with NES self-report greater number of allergies than patients with ES. Furthermore, significantly greater number of allergies was reported by the female than male, regardless of the diagnosis of NES or ES.

## S23

### **Intraoperative-ECoG during MRI-guided Stereotactic Laser Thermal Ablation of Mesial Temporal Structures for Intractable Epilepsy**

*Michael Pietak, MD; Matthew W. Luedke, MD; Shervin Rahimpour, MD; Sandra Serafini, MD; Michael Haglund, MD; Saurabh R. Sinha, MD, PhD*

MRI-guided stereotactic laser thermal ablation (Visualase procedure) is a new modality for epilepsy surgery. In trials on patients with intractable localization-related seizures, it has been shown to successfully destroy epileptogenic lesions with less morbidity than conventional craniotomies, and potentially similar rates of seizure freedom. It is gaining favor in the treatment of mesial temporal sclerosis, where the circumscribed epileptic focus is amenable to a stereotactic approach. In some centers, including ours, intraoperative electrocorticography (ECoG) is a standard procedure during amygdalohippocampectomies. Results of intraoperative

ECoG have been used to guide the extent of resection of mesial temporal structures as well as prognostication. Given the limitations of burr-hole access during Visualase procedures, ECoG has not previously been applied. Here we present two case reports involving intra-operative ECoG monitoring with a depth electrode placed into the parahippocampal region, recording before and immediately after thermal ablation of mesial temporal seizure foci. In each case, there were changes in mesial temporal spike and burst activity after laser ablation of the hippocampus. This is the first demonstration of intraoperative neurophysiologic motoring during stereotactic laser thermal ablation. The role of intraoperative ECoG for guiding the extent of ablation and determining prognosis during Visualase procedures remains to be determined.

## **S24**

### **Safety and Pharmacokinetics of IV Loading Dose of Lacosamide in the ICU**

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Rationale: Lacosamide (LCS) is a relatively new AED available for IV administration reported last year to be a fast, effective and safe alternative in emergency situations. This warrants further investigation to better understand the safety and doses which can be used in this situation.

Methods: With IRB approval, patients were identified that received IV LCS in the ICU for acute treatment of seizures in the past 18 months. Selected were those who were give an initial infusion of 400 mg or more. Data collected were age, gender, weight, duration of infusion, change or termination of infusion for side effects (primarily drop in blood pressure), initiation of pressor agents during or up to 2 hrs after infusion completed. On a subset of 41 patients, LCS level had been obtained about 10 minutes after completion of infusion. Results: 94 patients were identified. Demographics were male/female 48/46, average weight 82.0 kg (range 43.7 - 182.3), and average age of 56.1 yrs (24 - 83). Doses were 400 mg (24 pts), 500 (4 pts), 600 mg (31 pts) and 800 mg (4 pts). Weight base dosing ranged was 2.68 to 13.60 mg/kg (ave 6.9). No patient had a change in 1) BP resulting in reduction in or stopping the infusion or 2) starting pressors. LCS levels were obtained in 41 patients post infusion. LCS level correlated well with weight based dosing. Doses above 7 mg/kg produced levels of 10 ug/ml. Average volume of distribution was 0.57 L/Kg.

Conclusions: IV LCS can be safely given up to 1100 mg or 13 mg/kg over 30 min. Vd in ICU patients (0.57) is similar to reported value of 0.6 L/K in healthy volunteers. Weight based dosing should be used to achieve a target plasma level. Steady state LCS levels reported in clinical trials with 200, 400 and 600 mg per day are 4.99, 9.35 and 12.46 u/ml. To achieve high "therapeutic" level post IV load, doses of 8-10 mg/kg should be used which we found to be safe to use. .

## **S25**

### **Hand Signs in Primary and Secondarily Generalized Motor Seizures**

*Jason Siegel, MD; William O. Tatum, DO, FACNS*

Introduction: Localization-related epilepsy (LRE) is diagnosed by combining electroencephalography (EEG) and clinical semiology. However EEG may be non-localizing and non-lateralizing in both seizures of focal and generalized origin. We aimed to assess hand postures to identify differences between primary and secondarily generalized motor seizures.

Methods: We retrospectively identified generalized motor seizures in 16 patients admitted to our Epilepsy Monitoring Unit (EMU) in 2014. Based on video EEG, 6 had a final diagnosis of LRE, 5 had GGE, and 5 had Psychogenic Non-epileptic Events (PNEA). Video analysis examined the angle of the first metacarpophalangeal joint and its relation to the middle finger. Other clinical seizure characteristics and EEG patterns were recorded.

Results: Twenty-three convulsions were reviewed (9 LRE, 5 GGE, 9 PNEA). Unilateral or bilateral finger pointing during any phase of the convulsion was 100% sensitive and 85.7% specific for LRE. In GGE the most common hand position was bilateral fist formation. PNEA patients had a variety of atypical and fist positions. On EEG, 4 LGE seizures had focal onset, though the other 5 had asymmetric

or focal interictal activity or suspicious neuroimaging. All GGE patients had normal backgrounds with generalized interictal epileptic activity and seizure onset. All PNEA patients had normal backgrounds with no change on ictal EEG.

Discussion: Based on these data, patients with extended first metacarpophalangeal digits are likely to have a focal basis for their generalized seizures. These results could implicate a change in treatment when finger pointing >25 degrees is identified.

## **S26**

### **Novel Ambulatory EMG-based GTC Seizure Detection Device for Home & Hospital Use**

*Jose E. Cavazos, MD; Michael Girouard, MD; Luke Whitmire, MD*

Rationale: There are no FDA-cleared devices outside of an epilepsy monitoring unit (EMU) that can reliably alert for generalized tonic-clonic seizures (GTCS) and provide accurate semiological details to physicians. This study was designed to validate the effectiveness of a novel EMG-based, real-time, GTCS detection system that can be discreetly worn without interfering with activities of daily living.

Methods: In this phase III double-blind controlled trial, we tested the sensitivity and specificity of the Brain Sentinel GTCS detection system as compared to vEEG detection in EMUs at 11 NAEC level IV Epilepsy Centers in the U.S.A. Independent ABPN Epilepsy certified neurologists reviewed vEEG records to determine Classic GTCS semiology and timelines,

Results: More than 6000 hours of EMG and vEEG data have been reviewed from 118 subjects. The sensitivity of the GTCS detection system is comparable to FDA-cleared automated EEG seizure detection algorithms while maintaining a high level of specificity. Recorded EMG data preserves clinically relevant semiology of events such as temporal components of motor recruitment during a GTCS and activity following events.

Conclusions: Brain Sentinel's system has promise to provide people with epilepsy greater independence and peace of mind in a home or clinical setting while providing physicians with useful data for seizure management.

## **S27**

### **A Retrospective Study of Continuous EEG Monitoring in a Single Tertiary Care Pediatric Center**

*Arnold Sansevere, MD; Rejean Guerriero, MD; Ivan Sanchez Fernandez, MD; Lindsay St. Louis, MD; Jacquelyn Klehm, MD; Tobias Loddenkemper, MD, FACNS*

Rationale: The main goal of this study is to describe the clinical and electroencephalographic (EEG) characteristics of children who underwent continuous EEG (cEEG) monitoring in the intensive care unit (ICU).

Methods: This is a retrospective descriptive study of patients aged 1 month to 21 years who underwent cEEG (>3 hours) in the ICUs at Boston Children's Hospital in the period of 2011-2013. Patients were excluded if the cEEG was performed as part of an elective admission or if monitoring occurred in the setting of epilepsy surgery evaluations. In patients with multiple episodes of cEEG, only the first trial was considered.

Results: 414 patients with a median age of 4.2 years were included. Thirty five percent of patients had epilepsy, while 45 % of patients had another neurologic disorder. Neuro-imaging was performed in 95% of patients (Table 1). Clinical suspicion of convulsive seizures/characterization of events was the main indication for cEEG (70.5 %), while encephalopathy/concern for nonconvulsive seizures was the second most common indication (Table 2). The etiology of the episode leading to cEEG monitoring was structural in 213 (51%) patients. A burst suppression pattern was seen in 4.4% of patients while 14.3 % of patients had a normal awake and asleep background. Overall, 98 (24%) patients had EEG seizures, of which 22 (22.4%) were solely electrographic. 12 out of 96 (11.5%) of patients met criteria for status epilepticus, defined as a continuous seizure lasting >30 minutes in 6 patients or recurrent seizures totaling >50% of a one hour epoch in the remainder. Mortality was 15 % (59 patients).

Conclusions: We describe a large series of pediatric patients in the ICU who underwent cEEG monitoring. Twenty-three percent of patients had recorded seizures. Solely electrographic seizures are very common, affecting one-fifth of children with recorded seizures.



## **S28**

### **Electrodiagnostic Before and After Spinal Surgery**

*Fernando Rivero-Martinez, MD*

Introduction. Although neuroimaging offer extremely precise anatomic evaluation, EDX testing is still useful. Specifically, SEP can complement and therefore improve the evaluation of patients with lumbosacral pathologies. Objective. Describe EDX results, pre and post surgical in lumbosacral pathologies, with emphasis on findings of tibial SSEP and dermatomal L5/S1. Methods. EMG, NCS, F-Wave/H-Reflex and SEP to 32 adults whose disease had surgical judgment. Results. All patients showed alterations in the EMG neurogenic-pattern characterized by MUAPs markedly polyphase, high amplitude and signs of denervation at rest. NCS with prolongation of latencies and slowed conduction velocities in both motor and sensory nerves. In general, EMG-NCS and late-responses showed improvement at follow-up 6 months after surgery. Cortical responses SEP with marked alterations in the pre surgical evaluation showed more replicable and given lowest latency after spinal surgery answers changes. Conclusions. Clinical and images were accompanied by alterations in the EDX findings, being possible through the latter demonstrate the improvement in response to surgical treatment. Specifically, SEP changes suggest potential markers of functional changes that occur in the posterior cord pathway and that it is only possible to detect a longitudinal study, although it is required to replicate these findings by studying a larger sample.

## **S29**

### **Neurophysiological Profile in Mexican Children with Congenital Hypothyroidism**

*Gabriela Romero, MD; Carmen Sanchez, MD*

Congenital hypothyroidism (CH) is a systemic disease caused by absent or decreased thyroid hormones during pre and postnatal development; is associated with neuronal migration, morphology and connectivity axonal and dendritic growth and myelination, its absence may explain the presence of sequelae such as mental retardation.

Objective: to find functional profiles through EEG, BAEP and VEP in children with treated CH.

Materials and methods: Included 33 children, 26 female and 7 male, 14 under one year, 11 between two and tree years and 8 four years; 18 athyreosis and 15 with sublingual nodule.

EEG, BAEP and PEVC were performed. The condition at birth, hypothyroidism type, treatment start and hormone levels were obtained.

Results: EEG. Delta activity >70%, amplitude of 51.06  $\mu$ V, lower voltage in the left hemisphere.

VEP. Binocular visual cortical responses were statistically different associated with hypothyroidism type: athyreosis vs. sublingual nodule ( $p < 0.05$ ). The athyreosis children had the longest visual responses.

ABEP. The latency of waves and interwave intervals were abnormal delayed in children with athyreosis ( $p < 0.05$ ).

Conclusions: There influence of the type of HC on the functional expression of children. The neurophysiological profiles show functional processes altered, indicators of the commitment of SNC.

### S30

#### **Continuous Theta burst stimulation (cTBS) applied to the dorsolateral prefrontal cortex modulates late somatosensory evoked potentials (SEP) in normal subjects.**

*Robert J. Varipapa, MD*

**Background:** Transcranial magnetic stimulation (TMS) is a well-studied and widely employed method for non-invasive stimulation and study of the human brain. The motor cortex is the most prominent of these areas likely due to the ability definitively measure cortical excitability with the motor evoked potential. Due to the lack of an overt physiologic measurement, TMS has been poorly studied in other brain regions. The TMS theta burst protocol developed by Huang et al. has been shown to induce transient physiologic changes in the motor cortex. Specifically, the continuous theta burst protocol was demonstrated to diminish MEPs when applied to the motor cortex. Previous research has demonstrated that individuals with a lesion to the DLPFC present with altered SEPs.

**Objective:** Here we apply the TMS protocol of cTBS to the dorsal lateral prefrontal cortex of normal subjects. We expect that the application of cTBS to the DLPFC will produce transient SEP changes consistent with persons with a lesion in the same area.

**Methods:** Normal subjects aged 18 to 65 were recruited from the Roanoke Valley. Baseline SEPs were elicited via stimulation of the median nerve and recorded via a 64 electrode EEG. cTBS was then be applied to the subjects contralateral DLPFC. SEPs were then measured at 7 and 14 minutes post stimulation.

**Results:** Group and individual subject data was analyzed. ANOVA failed to show any significant change between pre cTBS and post cTBS SEPs consistent with a real brain lesion in the DLPFC.

**Conclusion:** The application of cTBS to the DLPFC failed to elicit a significant change in SEPs consistent with a lesion in this area. This result suggests that cTBS does not sufficiently generate an area of suppression in the DLPFC capable of altering SEPs as observed in persons with a real lesion in this brain area.

### S31

#### **Evaluation of Idiopathic Sudden Sensorineural Hearing Loss with Brain Stem Auditory EP and ECOG**

*Syed S. Habib, MD*

**Objective:** Idiopathic sudden sensorineural hearing loss (ISSNHL) is a frightening symptom that often prompts an urgent visit to physicians. The present project aimed to study brain stem auditory evoked potential (BSAEP) and electrocochleographic (ECOG) findings in patients presenting with Idiopathic sudden sensorineural hearing loss.

**Methods:** This Observational Study was conducted in the Department of Clinical Physiology at KAUH, King Saud University Riyadh, KSA. We studied 23 cases with Idiopathic sudden sensorineural hearing loss (ISSNHL). The diagnosis of ISSNHL was made on the basis of sudden nonfluctuating hearing loss, etiology that remained unknown after clinical, laboratory and imaging studies, severity of the hearing loss averaging at least 30 dB HL for three subsequent one octave steps in frequency and blank otological history in an otherwise healthy individual. We performed BSAEP & ECOG in these cases according to standard protocols.

**Results:** Left Ear was affected in 9 (39.1%) patients, Right Ear in 13 (56.5%) and was bilateral in 1 (4.3%). Both Wave I and Wave V were significantly prolonged in affected ear compared to unaffected ears ( $p=0.0031$ ), while in interpeak latency I-V latency was significantly higher in affected ears versus unaffected ears ( $p=0.0544$ ). Six patients (26.1 %) had type II diabetes mellitus, five cases (21.7%) had hypertension and 5 cases (21.7%) had dyslipidemia. ECOG revealed absence of Summation Potential (SP) and Action Potential (AP) response even at 95 dB in 17 out of 23 cases (73.9%). In 31.8 % cases, unaffected ear had mild while 31.8% had high hearing threshold in the unaffected ear.

**Conclusion:** BSAEP and ECOG provide useful diagnostic information in patients with ISSNHL in addition to radiological and other investigations. It could also provide a guide for future cochlear implants in these patients especially when it is bilateral.

### S32

#### **Lateral Femoral Cutaneous Nerve Somatosensory Evoked Potentials in Meralgia Paresthetica in Sri Lanka**

*Vajira S. Weerasinghe, MD; Nimal Senanayake, MD*

Lateral femoral cutaneous nerve (LFCN) entrapment at the inguinal canal is referred to as meralgia paresthetica (MP). Previous studies have reported recording of nerve conduction along this nerve which is practically a difficult procedure to perform. Somatosensory evoked potentials (SSEP) have been reported. But the results of those studies have not been consistent. In a group of patients with numbness of lateral aspect of the thigh, somatosensory evoked potentials were recorded from the lateral femoral cutaneous nerve to assess whether there is any evidence of compression of the nerve at the inguinal canal.

**Materials and Methods:** This was an observational descriptive study conducted at the Teaching Hospital, Peradeniya, Sri Lanka. Cutaneous site on the upper lateral thigh region innervated by the lateral femoral cutaneous nerve was stimulated using standard stimulating electrodes and the SSEP were recorded at Cz-Fz electrode positions using a Natus electromyographic machine.

**Results:** There were 68 patients with an age range of 19-81 yrs. Right side was affected in 51%. P38 wave was absent in 11 pts while it was delayed in 31 patients (4.5 to 20.1 ms delay). A significant amplitude difference was found in 11 patients. There was no latency or amplitude difference in 15 patients. According to these results in 53 patients (78%), SEP was able to detect a compression while in 15 patients (22%) a compression could not be detected.

**Conclusions:** This study shows that in clinically suspected meralgia paresthetica, somatosensory evoked potential recording is a relatively useful technique to detect a compression of the lateral femoral cutaneous nerve at the inguinal canal.

### S33

#### **Cross-Modal-Plasticity: study with Evoked Potential**

*Lidia Charroo Ruiz, MD*

This research focuses on Cross-Modal-Plasticity in deaf and deaf-blind children candidates for Cochlear Implants (CI) through the evaluation of the maps topography of the Visual-flash (VEP) and Somatosensory-of median (SSEP-N20) and tibial (SSEP-P40) nerves-Evoked Potentials. In deaf children (n=14) and deaf-blind children (n=12) topographic maps SSEP-N20 showed expansion of activation. Cortical areas: temporal in deaf and temporal-occipital in deafblind children were activated. These regions under normal physiological conditions processed information auditory and visual but no somatosensory. SSEP-P40 no showed changed with localized in the central-parietal mid-line (area of somesthetic representation of foot). Maps topographic of the VEP no showed changes. The expansion of the cortical response of the SSEP-N20 to the left temporal region in deaf and deafblind children was interpreted as evidence of Cross-Modal-Plasticity, although in deaf children the over-representation of SSEP-N20 was less extensive that in deafblind children. These results are pointing neuroplastic changes that occur as result of the loss input of the sensory information during the critical period of neurodevelopment, as well as, the effect that may have the use of the hands for communication in these children, with consequent implications of the Cross-Modal-Plasticity to the optimal use of the CI after implantation.

### S34

#### **Synergistic Effect of Theanine and Caffeine on Visual Reaction Time, Evoked Potentials and Cognitive Event Related Potentials**

*Vajira S. Weerasinghe, MD; Chanaka Kahathuduwa, MD; Tissa Amarakoon, MD; Tharaka Dassanayake, MD*

Theanine and caffeine have shown improvements in behavioral cognitive studies 1-3. We examined the neurophysiologic effects of theanine and caffeine on perception, cognitive processing and expression. In a double-blind, five-way cross-over trial, we administered 200 mg theanine (T), 160 mg caffeine (C), a combination of T and C (TC), 10 g Ceylon black tea (Tea) and distilled water (placebo) prepared as 150 ml solutions on five separate days to 20 healthy males with an age range 18-28 years. We recorded recognition visual reaction time (RVRT) before and 55 minutes after each administration and visual evoked potentials (P100), motor evoked potentials<sup>4</sup> (MEP) and auditory P300 event-related potentials<sup>4-5</sup> (oddball paradigm) within 30-55 minutes after each administration. We calculated cognitive processing time<sup>4</sup> (CPT) using RVRT, P100 and MEP.

RVRT and CPT improved with T (22.4 ms), C (21.6 ms) and TC (38.4 ms) ( $p < 0.05$ ). A substance-time interaction was seen in CPT ( $p = 0.048$ ). T and C increased P300 amplitudes compared to placebo ( $p = 0.001$ ). TC further increased P300 amplitude to a level greater than both T and C ( $p < 0.05$ ). P100, MEP and P300 latency did not differ across substances. Thus, theanine and caffeine seem to improve speed and neural resource allocation in cognitive tasks synergistically.

### S35

#### **Pseudo-random Pairs in Functional Brain Networks Using fMRI-based Adjacency Matrices.**

*Ioannis P. Pappas, MD*

Clustering of the brain network in a neurological context consists mainly of identifying clusters of nodes that as totalities behave independently and exhibit a uniform behavior within their body. The subsystem segregation model considers the existence of dense, and highly functional subgraphs. In this paper we extend this framework by identifying areas of the brain that form pseudo-random pairs regardless of their topological position; these pairs are  $\epsilon$ -close to being completely random in terms of their edge density. From a probabilistic point of view, a node in any of these clusters has a probability proportional to  $\epsilon$  to be connected with an arbitrary node of any other cluster. A bit of information can travel between these with a strictly defined probability and, potentially, following a specific pattern. The theoretical framework behind these pseudo-random measures can establish facts about the existence of patterns in the brain network (such as triangles) that can populate, at least "prima facie", non-segregated areas. Eventually, quantifying pseudo-random behavior can reveal functional deviations in patients with abnormal connectivity such as Alzheimer patients where it has been showed that there is a transition from the normal small-world networks to highly random networks. Quantifying such deviations can be replaced by comparing the pseudo-random interpolations between the clusters of the two graphs and arguing probabilistically about the information exchanged between different parts of the brain. Our method consists of two parts: Firstly, we construct the adjacency matrix of the fMRI data based on the linear correlation of the time series of each voxel. Secondly, we apply a modified version of Szemerédi's algorithm that produces  $\epsilon$ -regular partitions of the aforementioned graph.

### S36

#### **Fully Automatic Head Modelling for EEG Source Imaging**

*Gerhard Gritsch, MD; Franz Fürbass, MD; Manfred Hartmann, MD; Hannes Perko, MD; Tilmann Kluge, MD*

EEG source imaging can provide clinically relevant localization results especially if individual head models are used. We developed and evaluated a fully automatic procedure for head model extraction. A high resolution T1 weighted structural MRI including the entire head is used to automatically determine the scalp surface, the electrode positions and source space points which are defined as a regular distributed subset of the grey matter voxels of the cerebrum. Based on this information a Lead Field Matrix is calculated automatically using SMAC [1]. The head modelling procedure was evaluated using 14 MRIs. We visually assessed the position of the source space points and the electrodes. To show source localization accuracy, we compared localization results using the calculated head models with localization results using complex BEM head models [2] and clinical findings. The evaluation shows that our method is capable of automatically determining the electrode positions and the source space points with high accuracy. Localization of ictal and interictal events using automatically derived head models showed equivalent results compared to localization with BEM head models.

[1] L. Spinelli et al, "Electromagnetic inverse solutions in anatomically constrained spherical head models". [2] Z. A. Acar et al, "Neuroelectromagnetic forward head modeling toolbox".

### S37

#### **Utilization of SSEPs Collision Test for Spinal Cord Stimulator Lead Placement**

*Ning Zhong, MD; Justin Cheongsiatmoy, MD; Pedro Coutin-Churchman, MD; Nader Pouratian, MD; Marc R. Nuwer, MD, FACNS*

**Background** Spinal cord stimulation is a procedure involving direct epidural electrical stimulation to the dorsal column of the spinal cord. Utilization of spinal cord stimulators (SCS) has become an evidence-based treatment for various chronic pain disorders. Optimization of SCS lead placement and appropriate stimulation of the dorsal column are required for optimal pain control. By strategically inducing collision of antidromic impulses from the SCS with orthodromic impulses evoked by peripheral nerve stimulation, we can optimize SCS placement by intraoperative monitoring somatosensory evoked potentials (SSEPs). **Patients & Methods** Three patients with different pain presentation and pathology were studied. Both median and posterior tibial SSEPs monitoring were established after induction of anesthesia, SSEPs were collected continuously throughout the procedure. Collision tests were achieved by stimulating the dorsal column while recording both subcortical and cortical SSEPs. **Results** Baseline median and posterior tibial SSEPs were within normal limits in all three patients. Continuous SSEP monitoring was reproducible and stable during the procedures. Positive collision was observed in all three cases. A significant unilateral reduction (50% or greater) or abolishment of SSEP cortical responses was interpreted as lateralized placements of the stimulating electrodes during the collision test. A reduction or abolishment of bilateral SSEP amplitudes was indicative of midline or near-midline placement. The stimulating lead placement was further confirmed via peri-operative imaging. During post-operative follow-up, all patients had notable pain relief. Table 1 summarizes the patient data. **Conclusions** SSEP collision testing is an effective and safe method for determining the position and lateralization of SCS lead placement. Successful SSEPs collision may help to improve pain control outcomes.

### S38

#### **Dexmedetomidine in Spine Surgeries- A Friend or Foe?**

*Sharika Rajan, MD; Diana Braver, MD; Mirela V. Simon, MD, FACNS; Dinesh Nair, MD*

**Introduction:** In this study, we report our experience on the effects of Dexmedetomidine on motor and somatosensory evoked potentials (MEPs and SSEPs) during intraoperative neuromonitoring (IOM) for scoliosis surgery.

**Method:** Between 2010 and 2014 we identified 102 patients who underwent scoliosis surgery with IOM. Six of them received Dexmedetomidine at an infusion rate ranging from 0.2-1.0 mcg/kg/hr. Twelve age and sex-matched scoliosis patients, who did not receive Dexmedetomidine, was used as control.

**Results:** In 5/6 patients, MEPs amplitude on average decreased by 67% of baseline in the upper and 21% in the lower limbs, approximately three hours after starting Dexmedetomidine (Figure 1). Final MEPs recorded at maximal stimulation intensity, continued to remain suppressed, despite discontinuing Dexmedetomidine. In 1/6 patients, surgery lasted only 2h 45 min and the stimulus intensity to elicit MEPs changed from 85mA (baseline) to 180mA (end of surgery). SSEPs remained stable in all. Among control subjects, MEPs remained stable and at conclusion of surgery, stimulus intensity on average increased only 13.86% over baseline.

**Conclusion:** Our data does not support the use of Dexmedetomidine in surgeries requiring continuous monitoring of MEPs. More data needs to be analyzed to determine the dose-dependent effects of Dexmedetomidine on MEPs and SSEPs.

### S39

#### **Accidental Spinal Cord Contusions During Spine Deformity Surgeries**

*María del Mar Moreno, MD; Lidia Cabanes, MD; Gema de Blas, MD; Miguel Anton, MD; Vicente Garcia, MD; Jesus Burgos, MD*

**Introduction:** Accidental spinal cord contusions are a rare event in the surgical correction of spinal deformities. We present a study in a large series of patients which underwent these surgeries with the aim of establish the clinical and neurophysiologic pattern of this complication, that to our knowledge is not yet well described in the literature.

**Methods:** Multicenter (5 centers), observational, retrospective (2008-2013) study. A total of 691 patients presenting complex spinal deformities who underwent posterior instrumented surgical correction were studied. Intraoperative neurophysiologic monitoring of spinal cord function was performed with motor (MEPs) and somatosensory (SSEPs) evoked potentials.

Results: 23 out of 691 patients (3%) suffered a spinal cord trauma, which become evident by a high blood pressure peak, as well as a neurophysiologic event that followed a constant sequential pattern. Ipsilateral MEPs were lost in the first place. Following that, contralateral MEPs were lost, and finally, SSEPs dropped. In the 19 cases (83%) with MEPs lost and preserved SSEPs, MEPs recovered during surgery. 4 (20%) of these patients presented a transient post-operative paresis (3-7days) with complete recovery, and the rest were asymptomatic. In the four cases (17%) which presented complete loss of MEPs and significant changes in the SSEPs, the evoked potentials did not recover during the surgery, and the four patients presented some degree of post-operative paraparesis. Three of them were completely recovered after 3, 4 and 12 months respectively, whereas one patient presented only a partial recovery. Conclusion: Intraoperative accidental spinal cord contusions which produce a selective MEPs loss with intraoperative recovery have an excellent prognosis. When the contusions also produce changes on the SSEPs, they have a worst outcome, and produce transient neurological sequelae.

## **S40**

### **Proximal Weakness During Cervical Spine Surgery**

*Parastou Shilian, MD; Bong Su Kang, MD; Justin Cho, MD; Andres A. Gonzalez, MD*

Introduction: Unilateral deltoid and/or biceps weakness is one of the complications of cervical spine surgery. It is reported to be more frequent for posterior(8.6-18.4%) than anterior approaches(1.6-12.1%). Etiology is thought to be a C5 root injury, however, the exact mechanism has not been established.

Materials and Methods: A retrospective chart review was performed of patients that had intraoperative monitoring at Keck Hospital of USC, January 2010 and June 2012. 243 patients had cervical spine surgery, four of which developed postoperative biceps and/or deltoid weakness.

Results: The incidence of upper extremity postoperative proximal weakness was 1.64%(4/243), 1.23%(2/162) for anterior and 2.46%(2/81) for posterior approaches. In three cases, intraoperative neurophysiological monitoring did not detect any changes in SEP and MEP, however, EMG discharges were reported but not necessarily logged. In one case, there was a transient decrease amplitude in left hand and left lower extremity MEP. Of our four patients, one had deltoid, another had deltoid/triceps, and two had deltoid/biceps weakness. Patients developed weakness 1 to 2 days after surgery with recovery was seen within 1-5 months, although one was lost to follow up.

Discussion: This study shows that the use of monitoring is associated with lower incidences of proximal arm weakness in cervical procedures than reported. The variety of clinical presentations suggest different mechanisms of injury: C5 nerve root traction, brachial plexus injury, segmental spinal cord injury, and reperfusion injury. By understanding the mechanism, intraoperative monitoring could be tailored to detect such injuries and improve surgical outcomes. Segmental cord injury and axillary nerve compression may be better detected by MEP in the deltoid and biceps, while traction to the C5 root could be best detected using EMG. Further study is needed to better understand the mechanism of injury.

## **S41**

### **Hemorrhagic Complications with Subdermal Needle Electrodes in Intraoperative Neurophysiologic Monitoring (IONM) of Endovascular Procedures**

*Eric Jones, MD; S Charles Cho, MD; Scheherazade Le, MD; Leslie Lee, MD; Viet Nguyen, MD; Jaime R. Lopez, MD, FACNS*

IONM presents many unique challenges but is usually not associated with significant complications. Nonetheless, complications from IONM have been reported, amongst others, tongue bites and seizures from transcranial and cortical electrical stimulation, respectively. However, excessive and prolonged hemorrhage from routine subdermal needle placement has not been reported. We present a case series of 5 patients where the planned postoperative medical management caused unexpected, excessive needle-site hemorrhage, impacting postoperative care. All cases occurred during endovascular treatment of cerebrovascular disorders where high-dose combination antiplatelet agents were used. Neuromonitoring using somatosensory and motor evoked potentials (EPs), and EEG was

performed in all patients, using standard subdermal needle electrodes. Discussion with the treating neuroradiologist and chart review identified a correlation between high dose anti-platelet treatment and post-procedure needle-site hemorrhagic complication. No short or long-term neurologic deficits or prolonged sequelae from bleeding were identified. Hemorrhagic short-term complications included subcutaneous hematomas, discomfort and patient concern. Treatment included prolonged manual pressure to bleeding sites and pressure head bandage. These short-term complications led us to change our IONM protocol, using only surface electrodes in high risk patients on planned high-dose anti-platelet therapy. We have eliminated post-procedure hemorrhagic complications while successfully recording EEG and EPs since the change.

## **S42**

### **Pulse-train Stimulation Technique for Implantation of Thoracic Pedicle Screws: Preliminary Results of a Brazilian Monitoring Group**

*Paulo A. Kimaid, MD; Rafael De Castro, MD; Charles Nascimento, MD; Rodrigo N. Cardoso, MD; Rinaldo Claudino, MD; Marcondes Franca, MD*

**Purpose:** The effectiveness of detecting mal-positioning of pedicle screws varies widely in the literature. Recently, a new technique of intraoperative neuromonitoring with high accuracy in preventing medial mal-positioning of thoracic pedicle screws was published. We present our preliminary results using the proposed technique in 20 cases of idiopathic scoliosis.

**Methods:** Patients were submitted to posterior arthrodesis and scoliosis correction under total intravenous anesthesia and intraoperative neuromonitoring with our standard protocol updated with the new multi-train stimulation technique (MTST). MTST consists of a repetitive train of pulses applied with a ball-tip probe in the track and in the implanted pedicle screw. Warn criteria were thresholds below 15mA for track and 30mA for screw evoking a muscle response in lower limb muscles. We analyzed the warn criteria, the surgeon decision and the outcome of the patient.

**Results:** From 315 tracks/screws tested, threshold was below the lower limit in 22, especially for T9 (6) and T8 (4) pedicle screws. In 9 cases (45%) the warn criteria was not achieved. The time expended to perform the MTST was between 3-5 seconds for each level. When warned, it was checked with radioscopy and surgeon feedback. Screws were repositioned successfully in 19 cases and due to their persistent lower thresholds, three screws were removed definitely. All patients awoke with no new deficits.

**Conclusion:** Despite the small number of cases the technique showed a good relation with medial mal-positioning of the probe or screw. It was not time consuming and the surgeons felt confident with the warn criteria, reducing the x-ray exposition. In our opinion the technique should be considered as a standard of care for the implantation of thoracic pedicle screws.

## **S43**

### **Motor Evoked Potential Double Train Stimulation: Optimal Number of Pulses Per Train**

*Emily B. Kale, BS, CNIM Jose Devesa, MD; Aatif M. Husain, MD, FACNS*

**Introduction:** Double train stimulation for motor evoked potentials (MEP) consists of one train of testing stimuli and one train of facilitating stimuli. The optimal number of pulses per train has not been determined. We wanted to determine the optimal combination of pulse trains that produces the highest MEP amplitude.

**Methods:** Double train stimulation was attempted in 10 patients. Stimulation trains of 4 + 4 stimuli, 2 + 7 and 7 + 2 stimuli were attempted. The MEP response from the right foot muscles was used to determine the amplitude. Additionally, the MEP amplitude obtained with a single train of 7 stimuli was compared to the double trains.

**Results:** Trains with 2+7 pulses resulted in higher amplitudes than trains with 7 + 2 and 4 + 4 pulses. Single trains of 7 pulses resulted in amplitudes comparable to 7+2 double trains and amplitudes lower than 2+7 double trains.

**Conclusions:** A shorter initial priming train and a longer train for testing improved MEP responses. This can result in lower stimulation intensity and less patient movement due to MEP testing during surgery.

## **S44**

### **Unexpected Neurophysiological Changes during Intracranial Revascularization Procedure**

*Holly G. MacCallum, MD; Parastou Shilian, DO; Andres A. Gonzalez, MD*

Background: Cerebral hyperperfusion syndrome (CHS) is an uncommon complication of intracranial revascularization procedures. If untreated, CHS can result in devastating events including cerebral edema, seizures, and intracranial hemorrhage, and therefore must be promptly recognized.

Clinical presentation: 37 year old woman presented with a two month history of weakness and numbness on the right more than left upper extremity. MRI showed bilateral watershed infarcts. Cerebral angiogram demonstrated bilateral supraclinoid ICA stenoses consistent with Moya Moya disease. Patient underwent a high flow extracranial to MCA bypass. Intraoperative monitoring included SEPs and MEPs. Following anastomosis, significant amplitude reduction was seen in the bilateral hand MEPs. Blood pressures had remained in the normal range during the intraoperative and postoperative periods. Postoperatively, patient had worsening bilateral arm weakness, blurry vision and headache. CT perfusion revealed increased rCBF suggesting hyperemia in the brainstem and bilateral occipital lobes. Esmolol drip was started, and within thirty minutes, patient's symptoms resolved.

Discussion: Bilateral changes are often dismissed as they are not thought to be anatomical or in the corresponding vascular distribution at risk. Commonly, hyperemia occurs at the site of bypass, however, in our case, hyperemia additionally affected the posterior circulation. Due to the patient's bilateral ICA stenoses, the posterior circulation was providing collateral flow. We postulate at the time of anastomosis, a change in blood flow dynamics resulted in hyperemia. Hyperemia is an uncommon complication that needs to be in the differential when changes occur in evoked potentials in order to prevent catastrophic complications.

## **S45**

### **Spinal Cord Tolerance to Antero-posterior and Lateral Compression: Experimental Study**

*Lidia Cabanes, MD; Gema de Blas, MD; María del Mar Moreno, MD; Carlos Correa, MD; Miguel Anton, MD; Carlos Barrios, MD; Jesus Burgos, MD; Jaime R. Lopez, MD, FACNS*

Summary: The aim of this study is to establish, by means of neurophysiologic monitoring, the tolerance of the spinal cord to compression (antero-posterior and lateral), and to describe the sequence of changes in the neurophysiologic parameters.

Methods: Spinal cord was exposed through a large laminectomy in 13 experimental animals (domestic pigs) with mean weight of 35 kg. Dural sac (T7-T11) was exposed. The dural sac and spinal cord widths were measured at the level where the compression was going to be performed. Progressive compression of the spinal cord was performed with a precise compression device with a pair of parallel blades that were set up antero-posteriorly or to both sides of the spinal cord between T8 and T9 roots, and then sequentially approximated 0.25 mm every 2 minutes to cause a progressive cord compression. Epidural catheters were placed cranial and caudal to the compression level, and spinal cord to spinal cord evoked potential (EP), D-wave recordings and somatosensory epidural evoked potential (SSEP) were obtained for each approach of the sticks.

Results: Mean width of the dural sac was 7.5 mm. For progressive compression, increasing latency and decreasing amplitude of the evoked potentials were observed after a mean displacement of the sticks of  $1.5 \pm 1$  mm for the motor EP,  $1.5 \pm 0.7$  mm for the cord to cord EP, and  $2.5 \pm 1.3$  for the SSEP when provoking an antero-posterior compression; and  $2.9 \pm 1.1$  mm for the motor EP,  $2.7 \pm 1$  mm for the cord to cord EP, and  $4.1 \pm 1.3$  for the SSEP when performing the lateral compression.

Conclusion. The spinal cord is more sensitive to antero-posterior compression than to lateral compression. In both cases, cord to cord EP and D-wave are the first neurophysiologic parameters to detect the injury, whereas the SSEPs are less sensitive to compression. D-wave and cord to cord EP are equally accurate for the detection of spinal cord damage.



## S46

### **Balloon Test Occlusion with IONM & Exams for Surgical Planning**

*Viet Nguyen, MD; David Morales, MD; S Charles Cho, MD; Leslie Lee, MD; Scheherazade Le, MD; Jaime R. Lopez, MD, FACNS*  
Surgical treatment of head and neck tumors, vascular lesions, and traumatic injuries sometimes involves the sacrifice or permanent occlusion of an artery to the brain. Balloon test occlusions (BTOs) performed with intraoperative neurophysiologic monitoring (IONM) before sacrifice can help determine if there will be enough collateral blood flow to avoid cerebral infarction. We investigated whether combining neurophysiology awake physical examinations could improve the efficacy of BTOs. Seventy-three BTO procedures between 2005 and 2013 were examined. Fifty-five patients underwent awake physical exams and neurophysiologic testing. Eighteen patients under general anesthesia underwent neurophysiologic testing only. IONM changes during the BTO were identified, as well as immediate postoperative deficits related to the final procedure. One patient demonstrated IONM changes during the BTO and had postoperative deficits; 15 demonstrated changes but had no postoperative deficits; 49 neither demonstrated changes nor had postoperative deficits; and 8 did not demonstrate changes but did have postoperative deficits. False negative outcomes were significantly lower ( $p=0.0042$ ) when performed with physical examinations. IONM with BTOs can help decrease the risk of neurologic deficits from arterial sacrifice for vascular lesions and tumors. Adding physical exams to neurophysiologic testing decreases false negatives compared to neurophysiologic testing alone.

## S47

### **Safety of Transcranial Electrical Motor Evoked Potential in Patients with Epilepsy**

*Vikas Singh, MD; Joshua Mergos, MD; Simon Glynn, MD; Brian Bush, MD; Ramesh Kushwaha, MD; Daniela N. Minecan, MD*  
Background: Transcranial electrical motor evoked potentials (Tce-MEP) are used during intracranial and spine procedures to reduce the risk for intraoperative injury. Prior history of epilepsy or seizures is widely considered to be a relative contraindication for Tce-MEP. There has been no published study to date evaluating the risk of seizures in patients with epilepsy undergoing Tce-MEP.  
Aim: To evaluate the incidence of clinical and electrographic seizures provoked by Tce-MEP in patients with epilepsy.  
Methods: We identified patients monitored using Tce-MEP from June 2010 to June 2014 ( $n=5580$ ) who had epilepsy or seizures listed as a diagnosis. Patients with  $<2$  seizures or without documentation were excluded. We also excluded patients presenting with acute symptomatic seizures leading to the surgical procedure. EEG was formally interpreted in intracranial cases; in all other cases EEG interpretation was limited to depth of anesthesia. Tce-MEP parameters were optimized (3-6 pulses, 100-500V, fixed pulse width of 50 $\mu$ s, inter-stimulus interval of 1.0-2.0ms). Electrodes were placed anterior to C3 and C4.  
Results: Tce-MEPs were performed on 36 patients (range 6 months-73 years) with a definite history of antecedent seizures and epilepsy. 81% of patients had symptomatic focal epilepsy, and 47% of patients were medically refractory. The majority of patients had had generalized convulsions. 92% of patients were using antiepileptic drugs (AEDs) and almost 50% on multiple AEDs at the time of surgery. No intraoperative clinical or electrographic seizures were recorded in these patients. The majority of procedures did not use total intravenous anesthesia and included a halogenated agent.  
Conclusion: Tce-MEP may be safely performed in patients with seizures and epilepsy, including patients with medically refractory epilepsy. We advocate routine use of Tce-MEPs in this patient population.

## S48

### **Diffuse Optical Monitoring of Spinal Cord Blood Flow and Oxygenation**

*Angela Kogler, MD; Thomas Floyd, MD*

Introduction: Spinal cord ischemia can occur as a result of spinal trauma and spine and vascular surgery, often leading to paralysis or paresis. Somatosensory and motor evoked potentials are an indirect measure of spinal cord integrity. We have developed a prototype optical monitor, based on the principles of Diffuse Correlation Spectroscopy (DCS) and Diffuse Optical Spectroscopy (DOS), and hypothesized that this device would be capable of continuously monitoring changes in spinal cord blood flow and oxygenation

concentration. This portable monitor could potentially be used intraoperatively and in the critical care units to immediately detect loss of blood flow to the spinal cord and to monitor the effects of interventions aimed at ameliorating ischemia.

**Materials and Methods:** We tested the efficacy of the device in 28 adult Dorsett sheep models by recording the response of spinal cord blood flow and oxygenation to pharmacological interventions and aortic occlusion. Temporal resolution in detecting ischemia after aortic occlusion was compared between the optical monitor and evoked potentials.

**Results and Discussion:** The monitor immediately detected increased blood flow ( $+51\pm 11\%$ ) and oxygenation in response to hypertension and decreased flow ( $-39\pm 11\%$ ) and oxygenation due to hypotension. Aortic occlusion resulted in an immediate fall in spinal cord blood flow and oxygenation. Upon aortic occlusion, the optical device detected a decrease in blood flow by 50% in 3 min whereas evoked potentials took 5 min - 22 min to notice a drop in signal.

**Conclusions:** Optical monitoring of spinal cord blood flow and oxygenation is feasible and the results of initial testing are promising. This monitoring tool potentially represents an important step forward, offering a new level of accuracy and immediacy in detecting spinal cord ischemia intraoperatively, and in the neurocritical care setting.

## **S49**

### **IONM of Cranial Nerves Using EMG Hookwire Electrodes**

*Santiago Avilav, Jaime R. Lopez, MD, FACNS; S Charles Cho, MD; Leslie Lee, MD; Scheherazade Le, MD; Viet Nguyen, MD*

Electromyography (EMG) can be used in intraoperative neurophysiologic monitoring (IONM) to monitor cranial nerves at risk during brainstem or cavernous sinus surgical procedures. The safety and clinical utility of EMG monitoring of cranial nerves III, IV, VI, and IX, which requires special hookwire electrodes, are not well studied. We hypothesize that cranial nerve EMG monitoring using hookwire electrodes is safe and useful in minimizing new neurological deficits. 78 cases from 2012 to 2014 were retrospectively examined. Preoperative and postoperative neurological deficits were compared, IONM changes were noted, and clinical complications were analyzed using electronic medical records. Complications were defined as any deviation from the normal perioperative course. Complications due to IONM, and more specifically due to the hookwire electrodes, were juxtaposed to other operative complications. A total of 19 cases with perioperative complications were recorded. Of these, 2 (2.6%) had complications due to the IONM hookwire electrodes – both periorbital ecchymosis. 17 (20.5%) had complications of non-IONM etiology. Cranial nerve monitoring using hookwire electrodes proved to be safe, and its clinical utility outweighs the risk for harm. IONM complications accounted for only a small amount of perioperative complications.

## **S50**

### **Value of Stimulus-triggered EMG of Track vs Screw for the Detection of Lumbar Radiculopathy in Scoliosis Surgery.**

*Gema de Blas, MD; Lidia Cabanes, MD; María del Mar Moreno, MD; Guillermo Martin Palomeque, MD; Miguel Anton, MD; Vicente Garcia, MD; Jesus Burgos, MD*

**Question:** One of the complications in scoliosis surgery are radiculopathies due to pedicular screw malposition. Our aim is to analyze our cases of lumbar radiculopathies after scoliosis surgery, in which screw malposition was not detected by the usual neurophysiologic techniques.

**Methods:** We have studied 294 surgeries (6765 screws, 30% lumbar). Intraoperative monitoring (IOM) was performed with muscular MEPs after rTES, SEP and t-EMG of the screws. 8 patients presented lumbar radiculopathy after surgery, despite t-EMG values were normal, and screw malposition was confirmed by CT-scans. In the surgery to withdraw these screws, t-EMG was determined after stimulation of the depth and the middle part of the track.

**Results:** All of the malpositioned screws showed normal t-EMG thresholds after stimulating the screw. When stimulating the depth of the track, values were also normal, but stimulation in the middle of the track showed very low thresholds in most of the cases. All of the patients improved with the screws withdrawal.

Conclusion: Malpositioned lumbar screws are infrequent, but very symptomatic. t-EMG of the track improves the detection of these cases.

## S51

### **Intraoperative Vasoactive Treatment Reverses Loss of BAEP in MVD**

*Ning Zhong, MD; Rafael J. Lopez-Baquero, MD; Pedro Coutin-Churchman, MD; Marc R. Nuwer, MD, PhD, FACNS*

Background Postoperative sensorineural hearing loss (up to 20%) is a major co-morbidity in microvascular decompression (MVD) procedure when surgically treating the patient with hemifacial spasm, trigeminal or geniculate neuralgia. For MVD procedure, there has been no study of utilizing perioperative vasoactive treatment, which has been established for vestibular schwannoma surgery to prevent post-operative hearing loss. Patient & Method A 58-year-old female with left facial twitching was found to have a prominent PICA with possible left CN VII compression. The patient underwent left retrosigmoid craniotomy MVD, intraoperative brainstem auditory evoked potential (BAEP) were monitored. Results Baseline latencies and amplitudes for BAEP waves I, III and IV/V were seen bilaterally within normal limits. During left brainstem MVD, an over 40% prolongation in absolute latencies for waves III, IV/V; and a 75% reduction of wave V amplitude were observed on the left side. Such changes were not reversed after releasing the retractor. Nimodipine was added into the surgical field, which resulted in normalization of latencies and amplitudes for left BAEP waves. Post-operatively the patient did not have hearing loss. Conclusion We observed that focally applying calcium channel blocker nimodipine helped reverse the loss of BAEP. This may have helped to preserve the patient's hearing. Stretching the eighth nerve from cerebellar retraction is thought to be the most common mechanism of postoperative sensorineural hearing loss, and persistent loss of BAEP is an independent indicator of post-operative hearing loss. Our case suggested that microcirculation disturbance or vasospasm may also happen during MVD, which may be an additional pathophysiological factor for hearing loss in the patients undergoing vestibular schwannoma surgery. Local application of vasoactive treatment may be beneficial for hearing preservation in MVD.