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E-POSTER ABSTRACTS

Autonomic Function and Disorders

Cyclic Hypothermia, Morbidity, and Clobazam

Grant J. Turek, MD; Samir Karia, MD

Introduction: We report two patients with cyclic hypothermia on Clobazam leading to morbidity.

Case Report/Case History: Patient 1: 6 years, male with non-accidental trauma induced left spastic hemiparesis, intractable Lennox Gastaut syndrome hospitalized for infection triggered seizure cluster. Seizures of tonic stiffening, followed by left gaze with left > right arm jerking; 15-30 seconds each. Patient hypothermic 890 F, otherwise stable with no signs of infection. Broad spectrum antibiotic coverage until complete sepsis work-up was negative. Seizure regimen of Clobazam 2.3 mg/kg/day (level was 340 ng/mL, normal 30-300 ng/mL) Levetiracetam (100 mg/kg/day), Ketogenic diet. Repeat admission for fever triggered seizure clusters, when noted hypothermia of 930 F. Sepsis work up returned negative. Clobazam 1.9 mg/kg/day (level was 753 ng/mL), Keppra, and Ketogenic diet. Perampanel was initiated during this admission. Cyclic hypothermia pattern in association with loss of tone, decreased activity, somnolence requiring rewarming therapy resolved with lowered dose of clobazam 1.2 mg/kg/day Patient 2 : 11 years, female Aicardi syndrome, intractable epilepsy with spasms, focal seizures on stable regimen of Keppra, lacosamide, Perampanel , and Clobazam at 40 mg (1.2 mg/kg/day) hospitalized for pancreatitis. Patient's core temperature documented to be 860 F. Hypothermic with decreased activity, reduced tone, and somnolence. Patient treated with broad spectrum antibiotic till complete sepsis work up negative. Warm blankets elevated temperature to 960 F and improved exam. Clobazam metabolites level was 558 ng/ml. Cyclic hypothermia resolved with lowered dose of clobazam 20 mg daily.

Conclusion: Hypothermia is a unique side effect of Clobazam. Complex pediatric neurologic disorders with symptomatic generalized epilepsy on stable clobazam regimen are at risk of developing cyclic hypothermia during acute illness; likely from increased sensitivity of thermoregulatory centers to clobazam.

Basic Neurophysiology

Rethinking the Seizure Generation and Termination Mechanisms Underlying the Diverse Onset and Offset Ictal Patterns: A Computational Approach

Leila Abrishami Shokooh; Denahin H. Toffa; Philippe Pouliot; Frédéric Lesage; Dang Nguyen

Introduction: Several different seizure onset and offset patterns can be identified on intracranial EEG (iEEG) recordings. Whether these patterns reflect different underlying physiological mechanisms remains to be understood.

Methods: IcEEG recordings of 95 seizures used for analyses were obtained from 21 epileptic patients being investigated for epilepsy surgery. EEG patterns at seizure onset and termination were identified. Considering dynamic interactions between excitatory and inhibitory populations, we constructed a mathematical model that simulated some of the commonly observed patterns of seizure onset and termination. By identifying the range of parameters corresponding to each specific pattern, we investigated the underlying mechanisms for the generation of the various patterns and placed the modeling results in the context of physiological mechanisms.

Results: We identified 9 seizure onset patterns (Low Voltage Fast Activity (LVFA), preictal spikes followed by LVFA, LVFA superimposed on a slow wave, rhythmic Spike/PolySpike and Wave (rSW/rPSW) followed by LVFA, High Amplitude Fast Activity (HAFA), delta rhythmic activity, rhythmic theta/alpha activity, rSW/rPSW, delta brush) and 7 termination patterns (rSW/rPSW, HAFA, rhythmic theta/alpha, rhythmic spikes, rSW/rPSW with Burst Attenuation (BA), rhythmic spikes with BA, delta brush). By activating and modifying mechanisms such as depolarization block, shunting inhibition and GABAergic modulation, our model reproduced three different onset patterns (LVFA, HAFA, rSW/rPSW) and two different termination patterns (BA, rhythmic spikes).

Conclusion: Our model pointed toward more complicated scenarios for seizure generation than simple excessive excitation and insufficient inhibition. Specifically, our results revealed that seizure onset and termination patterns arise from different underlying mechanisms like the alteration of GABAergic signaling due to persistent inhibitory activity.

Rolandic vs. Association Cortex: Intracranial EEG Study of Connectivity and Entropy

Giridhar Kalamangalam, PhD; Mircea Chelaru

Introduction: A fundamental feature of the EEG is its qualitative difference over different head locations. How is this variation related to cortical neurobiology? We used intracranial EEG (iEEG) from human epilepsy patients to explore the resting state functional connectivity of the lateral frontal cortex as a player in determining its resting state dynamics. We asked whether primary and association brain areas were distinguishable in 'EEG space'.

Methods: We studied subdural iEEG recordings from the lateral frontal lobe in seven (N=7) human epilepsy patient subjects. Functional connectivity between a pair of electrodes was computed as the Pearson correlation of their respective quadrature amplitudes. Electrode connectivity (EC) was computed as the average of its functional connectivity with all the other electrodes in the grid. Electrode sample entropy (ESE) was computed from the Hilbert amplitude time-series of that electrode as –ln (A/B), where A was the number of vector pairs having $|xm+1(i) - xm+1(j)| < r$ and B the number of template vector pairs having $|xm(i) - xm(j)| < r$, with $m = 2$ and $r = 0.2$. Mean electrode connectivity (mEC) and mean electrode sample entropy (mESE) were obtained by time-averaging all the ECs and ESEs corresponding to that electrode.

Results: In general, mEC and mESE were in inverse proportion to each other. Extreme values of mEC and mESE occurred over the Rolandic region and were part of a more general rostro-caudal gradient in the parameters.

Conclusion: Brain networks influence brain dynamics. mESE over a given brain location is (inversely) related to that location's mEC to other brain regions. Over the lateral frontal lobe, these metrics demonstrate a rostro-caudal topography that distinguish primary sensorimotor from frontal association cortex. These results are consistent with current notions regarding the structural and functional parcellation of the human frontal lobe.

Unsupervised Classification and Sparse Representation of Neural Spikes Using Dictionary Learning

Ahmed Dallal, PhD; Safaa Eldeeb, MSc

Introduction: Spike sorting is necessary for many neuroscience applications. However, most of the existing methods require human intervention. This research proposes sparse representation and classification of neural spikes using unsupervised dictionary learning. Spikes are decomposed as a unique sparse combination of the dictionary basis vectors, which leads to efficient sorting performance.

Methods: The dictionary atoms were estimated using unlabeled training spikes. Test samples were projected on the learned dictionary to get a sparse code for each spike. The classification was done using the sparse coefficients and the reconstruction error. For high discrimination, the dictionary is structured as sub-dictionaries; each corresponds to a different spiking pattern. An optimization problem was solved to ensure that (i) the sub-dictionaries minimize the interclass variance while maximizing the intraclass variance, and (ii) the coding coefficients are sparse and minimize the reconstruction error. For testing, each spike was coded over each sub-dictionary and the reconstruction errors were computed. For each class, the summation of the reconstruction errors and the difference between the sparse code and that class average were computed. A testing spike was assigned to the class with the least error. The algorithm was tested on four simulated datasets. Approximately 15% of each class data was used to train the dictionary.

Results: Spikes reconstruction mean-squared error is 4.01, which endorses the learned dictionary's reconstruction power. The classification accuracy was computed at different noise levels and is 93% ±4%. This is comparable to the state-of-the-art algorithms.

Conclusion: The proposed method is used for spike sorting as well as data compression. The results suggest that sparse coding of spikes is feasible without significant loss. This representation enabled an unsupervised, fast, and accurate classification of neural spikes. It also enables the estimation of missing data points or clipped signals.

Alternating Hemiparesis in the Context of Hemolytic Uremic Syndrome (HUS) and COVID-19 Positivity

Hugh Simpson, MBBS, PhD; Erica Johnson, MD; Jeffrey Britton, MD ; Sherri Braksick, MD

Introduction: Hemiparesis has been reported in hemolytic uremic syndrome (HUS). We present detailed electrophysiological and clinical findings in a case of alternating hemiparesis corresponding to alternating focal delta slowing on prolonged EEG monitoring in a case of HUS with COVID-19 positivity.

Case Report/Case History: A 24-year-old woman with a history only of focal segmental glomerulosclerosis was admitted with bloody diarrhea, acute kidney injury, and focal seizures; initially presumed due to Shiga toxin mediated (typical) hemolytic uremic syndrome (HUS). Her first neurologic examination revealed a stuporous state, with midline gaze, no adventitious movements, equal and round pupils, and some spontaneous movements of the lower limbs. After admission, the patient tested positive for COVID-19. The patient was placed on prolonged EEG monitoring to exclude ongoing electrographic seizures, which revealed diffuse 0.5-3 Hz polymorphic delta slowing. Over the first several hours of the recording, a marked asymmetry developed, with focal higher amplitude slowing developing in the right hemispheric region, at which time, a left hemiparesis was observed. The patient underwent CT head and CTA head/neck which was normal. The EEG was then discontinued. The patient remained stable for 24 hours, then experienced another seizure, and a right hemiparesis was now observed. Prolonged EEG monitoring was restarted and showed asymmetric slowing involving the left hemispheric derivations. MRI brain was performed and was normal. The patient subsequently recovered over several days with no residual neurologic abnormalities.

Conclusion: Alternating focal slowing with a correlating reversible alternating hemiparesis may occur in HUS. The role of COVID-19 in the pathogenesis of this patient's presentation is not clear, but given the vascular affinity of this virus and the unusual neurologic presentation, a role cannot be discounted.

Boosting Cortical Inhibition with Theta Burst TMS in a Case of Super-Refractory Status Epilepticus

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Introduction: We present a case of Super-refractory status epilepticus (SRSE) successfully managed by a combined pharmacological and transcranial magnetic stimulation (TMS) approach

Case Report/Case History: A 63-year-old female with fever and slurred speech was admitted to the ICU, where she presented her first-ever focal unaware seizure evolving to a GTCS. Her brain MRI and CSF were unremarkable. On the next day, she developed an acute episode of tachycardia, facial hyperemia, unresponsiveness, and upper limb tonic contraction. Continuous video-EEG monitoring revealed bilateral rhythmic F-T sharp wave activity - IV diazepam and later phenytoin 20 mg/kg was given without clinical and EEG improvement. Upon phenobarbital load, a sustained burst-suppression pattern could be obtained. Meanwhile, the CSF culture was negative for bacteria and fungi as well as for HSV-1/2/6 DNA. After 24h, a fluctuating LRDA pattern emerged, prompting propofol infusion (3 mg/kg/h) with a burst-suppression pattern maintained for 24h. Due to incipient signs of propofol infusion syndrome, ketamine (3 mg/kg/h) for the next 48h was given. After failing attempts of ketamine weaning, decision for a theta burst TMS paradigm (bursts of 6 pulses at 50Hz, repeated at 5Hz, ITI 0.2 sec, 200 bursts in total) delivered over the vertex was taken. Under TMS, diffuse delta slowing and background reactivity could be observed. Over the next days of anesthetic wean and TMS modulation, patient's EEG and clinical status slowly improved. Subsequent CSF work-up for anti-VGKC/-NMDAR/-Hu/-Yo/-Ri antibodies was negative, which, however, doesn't definitively rule out the diagnosis of autoimmune encephalitis in this case. After 3 months she was discharged on anti-seizure medication.

Conclusion: Employing non-invasive neurostimulation techniques in SRSE might translate into earlier suppression of seizure activity. Our case illustrates that a favorable outcome in SRSE might be attained in selected patients by synergistic effects of pharmacological and TMS modulation.

Lateralized Rhythmic Delta Activity in Hyperperfusion Post Right M2 Segment Stent Placement

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Introduction: Discuss clinical dilemma with cerebral hyperperfusion syndrome versus seizure with electroencephalogram (EEG) findings of Lateralized rhythmic delta activity (LRDA).

Case Report/Case History: 50-year-old man was admitted with right-side weakness, facial droop and expressive aphasia outside time window for IV tPA. Conventional angiogram showed symptomatic severe atherosclerotic stenosis in the inferior division (mid M2 dominant trunk) and distal large angiographic perfusion deficit. An Enterprise stent was placed in inferior division with improvement in the residual luminal stenosis and reversal of prolonged angiographic mean transit time. Post intervention, expressive aphasia continued, with some improvement in right hemiparesis. Repeat CTA was negative for stent reocclusion. SBPs were maintained 120 to 140 mm of Hg. EEG showed frequent Left hemisphere LRDA. Given LRDA and clinical context, a lorazepam and levetiracetam trial administered which alleviated the rhythmicity on EEG with minimal clinical response. A repeat angiogram showed patent stent with mild stenosis and no flow limitation. MRI showed deep white matter small embolic infarcts in the left hemisphere and MR perfusion with increase in blood flow and blood volume in the left hemisphere.

Conclusion: LRDA and Lateralized periodic discharges (LPDs) can be predictive of seizures in critically ill. Treating them is a topic of debate. This case report highlights importance of clinical correlation with rhythmic EEG patterns and how few EEG patterns may be seen in both seizures and vascular phenomena. Given LRDA is more commonly seen due to lesions localized to cortical / juxtacortical regions, the deep location of ischemic infarcts would not fully account for this finding. Seizures versus hyperperfusion therefore are more plausible differentials. More studies are required to investigate LRDA as a possible marker of hyperperfusion among other vascular processes.

AED Treatment Simulations in Subarachnoid Hemorrhage-Designing the Optimal RCT

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Introduction: Anti-epileptic drugs (AEDs) are frequently prescribed in aneurysmal subarachnoid hemorrhage patients with Ictal-interictal continuum (IIC) patterns on EEG. Investigating AED effectiveness is confounded by the clinical complexity of these patients, and dynamic nature of IIC patterns. We sought to determine the impact of AED pharmacodynamics, choice of outcome measure, and treatment timing on the sample size needed for randomized clinical trials (RCT).

Methods: We quantified IIC burden and time courses for 50 subarachnoid hemorrhage patients. For patients treated with AEDs, Pharmacokinetic/Pharmacodynamic modeling was used to remove the estimated treatment effect on IIC burden. “Drug free” IIC burden time courses were used to generate RCT simulations comparing AED to placebo. AED efficacy was defined using published literature on status epilepticus. Outcome measures were total IIC burden and post-treatment IIC burden over 72 hrs. We repeated RCT simulations for increasing treatment delays. Sample size was calculated for each RCT.

Results: For RCTs with total IIC burden as the primary outcome, increasing treatment delay (in hours) increased the sample size by a median fold of 2.72(IQR:1.99-3.87). For RCTs with post-treatment 72 hr IIC burden as the primary outcome, treatment delay increased the sample size by a median fold of 1.108(IQR:1.105-1.11). When comparing RCTs with primary outcome of total IIC burden, to RCTs with primary outcome of post-treatment 72-hr IIC burden, the sample size increased a median fold of 6.22(IQR:1.93-37.92) with increasing treatment delay. Increasing treatment delays resulted in smaller effect sizes across all simulations.

Conclusion: Delays in AED administration and choice of outcome measures significantly impact sample size. Carefully defining inclusion/exclusion criteria, enrollment windows, and outcome measures, can increase the success of RCTs investigating treatment of IIC patterns.

Analysis of EEG Patterns and Clinical Findings in Cardiac Arrest Patients; Their Response to Treatment and Usefulness for Prognostication

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Introduction: The discovery of accurate prognostication measures for patients with cardiac arrest may assist in the avoidance of futile care and providing families with realistic expectations. Previously literature has emphasized that a multimodal approach may yield higher accuracy than previously evaluated single modality approaches. Therefore, we evaluated the prognostic utility of combined EEG findings and clinical characteristics among patients with cardiac arrest.

Methods: Adults hospitalized with in- or out-of-hospital cardiac or respiratory arrest were identified that had prospectively collected EEG data. Additional clinical and radiographic findings were evaluated retrospectively including outcomes which were measured by the Cerebral Performance Categories (CPC) scale. The association between clinical and EEG findings with outcomes were evaluated using the independent-samples T test.

Results: A total of 225 patients were identified who were monitored on EEG for a mean duration of 40.2 hours. Approximately one-third of patients had good outcomes (CPC score of 1 or 2), 63.6% died. Absent posterior dominant rhythm (PDR) and a generalized slow background on EEG were associated with significantly better outcomes. Myoclonic jerks, generalized periodic discharges (GPDs), seizures (13.8% of patients), burst suppression and continuous suppression were associated with significantly worse outcomes. When clinical variables were combined, the differences between patients with or without the combined findings were significantly increased. For instance, patients with a PDR or a generalized slow background, but without myoclonus or GPDs had a mean CPC of 1.9 compared to 4.7 in those with the opposite findings ($p < 0.001$, 99% CI = 2.0-3.5).

Conclusion: Readily obtained clinical and EEG data when used in combination, may assist with prognostication for patients with cardiac arrest.

Frontotemporal Electroencephalography to Guide Sedation in Novel Coronavirus Disease 2019 Related Acute Respiratory Distress Syndrome

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Introduction: Patients admitted with novel coronavirus disease 2019 (COVID-19) are often critically ill and require mechanical ventilation, prolonged sedation and neuromuscular blockade for treatment of acute respiratory distress syndrome. However, guiding sedation depth in COVID-19 patients and minimizing sedative overuse may be associated with shorter time on mechanical ventilation, shorter stays in the intensive care unit, and potentially decreased mortality. Here we studied whether limited frontotemporal electroencephalogram (EEG) can guide sedation changes in COVID-19 patients receiving neuromuscular blocking agent.

Methods: 98 days of continuous frontotemporal EEG from 11 consecutive patients was evaluated daily by an epileptologist to recommend reduction or maintenance of the sedative level. We evaluated the need to increase sedation in the 6 hours following this recommendation. Post-hoc analysis of the quantitative EEG was correlated with the level of sedation using a machine learning algorithm.

Results: Eleven patients were studied for a total of ninety-eight sedation days. EEG was consistent with excessive sedation on 57 (58%) and adequate sedation on 41 days (42%). Recommendations were followed by the team on 59% (N=58; 19 to reduce and 39 to keep the sedation level). In the 6 hours following reduction in sedation, increases of sedation were needed in 7 (12%). Automatized classification of EEG sedation levels reached 80% (±17%) accuracy.

Conclusion: Visual inspection of a limited frontotemporal EEG was a safe method to assist with sedation depth guidance. In a secondary analysis, our data supported that this determination may be automated using quantitative EEG analysis. Our results support the use of frontotemporal EEG for guiding sedation in patients with COVID-19.

Improving Neonatal EEG Reports in Hypoxic Ischemic Encephalopathy

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Introduction: Neonatal hypoxic ischemic encephalopathy (HIE) is one of the major causes of morbidity and mortality in neonates, accounting for approximately 23% of neonatal deaths and causing neurodevelopmental disability in an additional 25% of children. Conventional and amplitude integrated EEG are used in neonates and background severity in the first 6-24 hours of birth can help predict outcome in HIE. However, a widely accepted classification system of neonatal EEGs in the setting of HIE, with standardized definitions of amplitude, voltage, and other characteristics, across institutions is needed. Such a standardized system may provide clinicians with useful interpretation of the EEG and aide in predicting prognosis.

Methods: Neonatal EEG reports were retrospectively reviewed at Duke University from July 2020 until October 2020. EEGs performed for the indication of HIE were included. EEG reports were reviewed to see if they commented on voltage, amplitude, variability, continuity, symmetry, reactivity, and sleep. EEG conclusions were examined for descriptions of background severity.

Results: A total of 41 neonatal EEG reports were reviewed. There were 9 neonatal EEG reports that were performed for the indication of HIE. Of these reports, 22-33% had comments on amplitude, voltage, reactivity, continuity, symmetry, and sleep. Seven (77%) of these EEGs were abnormal. Of the abnormal reports, only 28% discussed background severity, both of which reported a mildly abnormal background for age. The remaining 71% had no mention of background severity.

Conclusion: Out of the reports reviewed, there were inconsistent descriptions on background characteristics. There was no mention of background severity in the majority of the abnormal reports. With implementation of a grading system in our institution, we hope to improve EEG reports and interpretation, as EEG data is clinically relevant in predicting neurodevelopmental prognosis in neonatal HIE.

Incidence of Electrographic Seizures in Patients with COVID-19

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Introduction: Coronavirus disease 2019 (COVID-19) has been associated with a number of neurological disorders, but the incidence of seizures among COVID-19 positive hospitalized patients has been shown to be fairly low. This study adds to the literature by reporting the electroencephalography (EEG) data for COVID-19 patients in a multi-hospital urban medical center.

Methods: This retrospective case series assessed the incidence of electrographic seizures (ES) in patients hospitalized with COVID-19 who underwent continuous video electroencephalography monitoring (cvEEG) between March 1st, 2020 and June 30th, 2020 at four hospitals in New York City that are part of a major academic medical center. Patients were included who were at least 18 years old, had a positive SARS-CoV-2 nasopharyngeal Real-Time Reverse Transcriptase PCR swab, and were connected to cvEEG during their hospitalization for longer than 1 hour.

Results: Seventy-nine patients met study inclusion criteria, the majority (81%) of whom were critically ill. Six (8%) of the 79 patients had ES, and three of these six patients also had non-convulsive status epilepticus (NCSE). Three of the patients with ES had a prior history of seizures, while two other patients with ES suffered potentially epileptogenic acute brain injuries. Acute hyperkinetic movements were the most common reason for cvEEG in patients with ES (84%). None of the patients undergoing cvEEG for persistent coma (29% of all patients) had ES. Focal slowing (67% vs 10%), sporadic interictal epileptiform discharges (EDs; 33% vs 6%), and periodic/rhythmic EDs (67% vs 1%) were proportionally more frequent among patients with electrographic seizures than those without these seizures.

Conclusion: The incidence of ES and NCSE in COVID-19 patients is low. Prior history of seizures and acute brain injury increase the risk of ES and NCSE. None of the patients that underwent cvEEG for persistent impairment of conscious or coma had ES.

Progression of Electroencephalography (EEG) Changes During Prolonged Cardiopulmonary Resuscitation (CPR) After In-hospital Cardiac Arrest

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Introduction: Cardiac arrest (CA) induced brain injury is assumed at ~10 min of anoxia/ischemia. Thus, detecting ischemia during CPR is critical to optimize brain resuscitation and reduce injury. Regional cerebral oxygenation (rSO2) by cerebral oximetry reflects brain oxygen delivery/uptake, but may overlook ischemic cellular dysfunction over time. Combining EEG and rSO2 to measure the impact of ischemia on cortical function may be more robust. We hypothesized that a range of EEG activity occurs over CPR not predicted by rSO2 alone.

Methods: Prospective in-hospital CA study at 8 UK/US sites from 2015-2020. Consecutive CAs were enrolled (08:00-18:00) and EEG images captured (1/sec) during standard 3-5 sec pulse check pauses (to limit motion artifact) using a portable 4-lead EEG (SedLine, Masimo). EEG was interpreted by 2 neurophysiologists. Simultaneous rSO2 was taken by cerebral oximeter (Equanox, Nonin).

Results: 85 subjects were recruited with EEG images, of which 50 had combined EEG/rSO2. Mean age was 68 ±17, 73% were male and CPR duration was 37 ±25 min. 851 EEG images were captured and 55% interpretable. 9 rhythms were observed until ~90 minutes of CPR: voltage attenuation/suppression (47%), delta (22%), theta (12%), alpha (6%), epileptiform (5%), burst suppression (5%), rhythmic delta activity (2%), generalized periodic discharges (< 1%) and beta (< 1%). There was no association between rhythm and rSO2. Logistic regression between number of EEG states observed and CPR outcome controlling for CPR duration showed decreased probability of return of spontaneous circulation with each additional EEG state (odds ratio=0.25; p=0.012).

Conclusion: Despite the assumption of irreversible brain damage after 10 min of anoxia, near-normal EEG activity occurs even 60 min into CA, which is not reflected by rSO2. In addition, EEG instability during CPR may be related to poor outcome.

Deep Brain and Cortical Stimulation

Cluster of Atypical Seizures Triggered by Cortical Stimulation

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Introduction: Electrical cortical stimulation (ECS) to induce seizure may help to delineate the epileptogenic zone in patients undergoing invasive presurgical evaluation with stereo-EEG (SEEG) for pharmacoresistant focal epilepsy, but this procedure has not been standardized across centers. We report a patient who had a cluster of atypical seizures triggered by ECS off antiseizure medications (ASM) in the beginning of SEEG evaluation.

Case Report/Case History: The patient had intractable seizures characterized by abdominal aura followed by confusion with ictal speech, and rare generalized convulsions preceded by left face tonic grimace. The scalp ictal EEG was localized to the right frontotemporal region, MRI showed cortical thickening in the left temporal, parietal and frontal lobes, PET noted right temporal hypometabolism, ictal SPECT showed symmetric perfusion, neuropsychology noted left hemisphere deficit, and language was left dominant per fMRI. Given discordance of preoperative evaluation results, SEEG was recommended to localize the epileptogenic zone(s). A single typical spontaneous seizure was recorded on day 11 and localized to the right hippocampus, but ECS performed off ASM on SEEG day 6 triggered a 9-hour cluster of atypical subclinical seizures by stimulation of the left hippocampus (50 Hz, 1 mA). The patient was deemed to have independent bitemporal epilepsy, and responsive neurostimulator (RNS) leads were placed to both hippocampi; but seizures starting from the right hippocampus only were captured during 4.5 years of RNS recording.

Conclusion: Our report demonstrates that a potentially curative nondominant temporal lobe resection was postponed due to the long cluster of atypical ECS-induced seizures in the contralateral hippocampus captured during SEEG; but, these contralateral seizures have not been recorded during 4.5 years since RNS was placed. This case highlights the drawbacks of ECS before capturing habitual seizures while off ASM.

An Extraoperative Functional Atlas Based on Electrocortical Stimulation Mapping

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Introduction: Direct electrocortical stimulation mapping (ESM) is the gold standard in defining eloquent cortex, but has been most systematically documented intraoperatively. Intraoperative identification of eloquent cortex is time-limited, can be hampered by after discharges, and the ability to test beyond craniotomy borders is limited. Extraoperative ESM, the standard of care in multi-stage epilepsy surgeries, gives us insight through data acquired over an extended time period and multiple sites. Despite this, systematic mapping on normalized coordinates of behavioral responses obtained extraoperatively has not been done.

Methods: Bedside ESM was performed on 100 subjects who underwent clinically-indicated continuous intracranial EEG monitoring for seizure localization. For each subject eloquent cortex was identified using ESM (width 500 us, frequency 50 Hz, max duration 5 seconds, maximal 12 mA). Stimulation-elicited positive and negative findings were recorded and localized to MRI brain coordinates within subject gyral anatomy, then transformed to standard MNI coordinates.

Results: Speech Arrest was found in the IFG, pre and postcentral gyri, and throughout the Superior Temporal Gyri (STG; caudal, medial, and rostral). Comprehension was observed in the Supramarginal Gyri and Mesial Temporal Gyri (MTG; caudal, medial, rostral). Anomia, while more broadly distributed, showed a clear predilection for the rostral STG and MTG, greater than medial and caudal. Intraoperative literature identified anomia broadly in the regions surrounding the caudal STG; however, we localized it more to the rostral STG and MTG using more data points, including more posterior structures to a lesser extent.

Conclusion: We report the first practical atlas for definition of eloquent cortex based on extraoperative ESM in normalized MNI space and within subject gyral anatomy. The results provide a bedside rather than intraoperative based approach which will help guide clinicians in preoperative planning of eloquent cortex resection.

Analysis of Brief Potentially Ictal Rhythmic Discharges (BIRDs) and Seizures in Epilepsy Patients with Responsive Neurostimulation Undergoing Scalp Electroencephalography

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Introduction: The relationship between duration of detected RNS events and scalp EEG seizures is unknown. We sought to determine if brain-responsive neurostimulation (RNS)-detected events had to reach a certain duration in order to evolve into a seizure and to determine if the frequency and duration of events detected by the RNS could serve as marker of clinical seizure activity.

Methods: Retrospective study of epilepsy patients with RNS device who underwent video EEG (vEEG) monitoring in our epilepsy monitoring unit. Patient Data Monitoring System (PDMS) was queried to analyze ECOG library tracings to quantify the number of stored long-term episodes during the scalp vEEG monitoring period. The RNS detected events were then compared to scalp vEEG recorded seizures and BIRDs. Mann-Whitney test was used to assess group differences in numeric variables.

Results: 11 patients with a mean age of 35.53 years (range: 18-59) were identified. There was a greater number of long episodes captured in the RNS ECOG library when compared to scalp EEG detected seizures (mean 10.44 vs. 1.81, $p = 0.01$) during the admission period (mean 2.75 days, range: 1-5). When comparing the events seen in both the ECOG library and scalp EEG to the events seen in the ECOG library only, we found that the former had a longer duration (mean 27.4s vs. 13.2s, $p < 0.0001$) and a higher number of delivered treatments (mean 4.5 vs. 3.1, $p = 0.02$). Events in the ECOG library lasting more than five seconds did not differ from the number of seizures seen in scalp EEG ($P>0.05$).

Conclusion: RNS detected events lasting longer than 5 seconds had good correlation with scalp-vEEG detected clinical (scalp EEG negative) or electroclinical seizures. This study suggests longer (> 5 seconds) lasting RNS events could be used as a biomarker to determine individual patient's seizure frequency, and to monitor seizure frequency over time.

Effect of Claustral Stimulation on Attention in a Patient with Medication-resistant Epilepsy

Niyatee Samudra, MD; Brian Mathur, MD; William Nobis, MD, PhD

Introduction: The claustrum is a subcortical structure, situated between the insula and striatum. Its function has not been elucidated, but it has the highest connectivity of any brain area per regional volume. It may be involved in salience and attention, with implications for impaired awareness in focal seizures. Direct electrical stimulation studies have not tested the claustrum's role in attention.

Methods: We investigated the effect of claustral stimulation on performance of an attention task (the auditory consonant trigram task) in a patient with left-language-lateralized, drug-resistant focal epilepsy admitted for stereo-electroencephalographic (sEEG) evaluation. Participants are asked to recall a sequence of three consonants after delays of varying lengths, with or without a numeric distractor series (performance of serial 3s). This patient had right-lateralized insular-opercular depth electrodes, and the mesial contacts of one of the depths was in the claustrum when CT was co-registered to pre-operative MRI. Standard high-frequency bipolar stimulation parameters were utilized. Low currents (1 and 2.5 mA) were applied to the contacts in the right claustrum while the task was being performed. Control stimulation was applied in the left anterior cingulate.

Results: The participant made fewer errors with stimulation in the left anterior cingulate than in the right claustrum (2 errors at 1 mA as compared to 7; 4 errors at 2.5 mA as compared to 11). Errors occurred more frequently in those trials of greater difficulty (longer recall delay).

Conclusion: In one patient with drug-resistant focal epilepsy with sEEG electrodes placed, claustral stimulation on the non-language-dominant side resulted in more attention errors than stimulation in a control region. Further steps will include enrollment of more participants and assessment of task performance at different currents to establish statistical significance.

Functional Mapping of Language with High Gamma Electrocorticography

Jennifer Shum, MD; Patricia C Dugan, MD; Daniel Friedman, MD; Werner Doyle, MD; Orrin Devinsky, MD; Adeen Flinker, PhD

Introduction: Electrical stimulation mapping (ESM) is the current gold standard for identifying eloquent language cortex which should be spared during epilepsy surgery. However, there are many limitations to this technique, particularly the risk of seizures. ESM can also be time-consuming, requires excellent patient cooperation, and is not always well-tolerated by patients. High gamma electrocorticography (hgECoG) has been studied as another modality for pre-surgical language mapping as compared to ESM. HgECoG activity has been previously established as a robust marker of local cortical activity, making it an ideal candidate for functional mapping. However, existing studies comparing hgECoG to ESM have mixed results with highly variable sensitivities and specificities. It remains unclear what combination of hgECoG signal processing parameters and language tasks, as well as their spatial relationship, are most predictive of ESM results.

Methods: To overcome these limitations we utilize a battery of five language tasks and a statistical learning approach. Our language tasks capture multiple modalities of language processing and production and mirror the clinical paradigms employed during ESM. The tasks involved visual naming, visual word reading, auditory word repetition, auditory naming, and auditory sentence completion. Our statistical learning approach tests multiple supervised machine learning algorithms to predict which brain regions will be identified by ESM, and is based on hgECoG features during the five language tasks and normalized electrode spatial information.

Results: Using data from 11 subjects, the best model was a logistic regression algorithm which performed with a 10 fold cross validated AUC of 0.77 and had a specificity of 0.91 and sensitivity of 0.41 at its optimal operating point.

Conclusion: Our model shows that high gamma ECoG is a clinically useful tool to complement stimulation based language mapping.

Transcranial Magnetic Stimulation (TMS) Is Safe in Pediatric Clinical Populations

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Introduction: The safety of TMS has been previously evaluated in healthy and clinical adult populations. We sought to fill the gap in the safety of TMS functional mapping in a clinical, pediatric cohort.

Methods: We reviewed 502 TMS studies (2012-2020) in patients with epilepsy or brain tumor between the ages of 0.16-64 years (78% < 18yr) for adverse events. Motor mapping (MM) was attempted in all while language mapping (LM) was attempted in 302 patients.

Results: Pain at stimulation site was the most common adverse effect (~50% LM, ~10% MM). Reducing stimulation intensity usually alleviated pain and allowed for the completion of MM in all, while LM was discontinued in 10 patients (3.3%) due to persistent pain. Only 28 patients (6%) had seizures during or after TMS with semiology consistent with their typical presentation. Two patients who had generalized tonic-clonic seizures required administration of rescue medications. Twenty of 28 patients completed mapping during the same session. Additionally, 4 patients with epilepsia partialis continua completed successful studies with no adverse effects.

Conclusion: Pain at stimulation site was successfully managed by reducing stimulation intensity and mapping could be completed in the majority of the patients. Nearly of 94% patients with epilepsy or brain tumor were successfully mapped without experiencing a seizure during TMS. Moreover, the seizure events during/following TMS most likely are not directly attributable to the procedure since all patients had refractory epilepsy with a history of weekly seizure frequency. We show that in this large predominantly pediatric cohort with refractory epilepsy and brain tumor, TMS functional mapping is safe. We recommend the development of a standard protocol for recording adverse side effects for TMS patients for a more complete characterization of adverse effects and to further improve the safety profile of clinical TMS.

Altered Electrical Network Connectivity (ENC) During Epileptiform Discharges (IED) in Autism Spectrum Disorder (ASD), Symptom Response to Antiepileptics (AE). Report of Four Cases

Montserrat G. Gerez, MD, PhD; Armando Tello,MD

Introduction: ASD refers to conditions with variable degrees of social communication deficits and repetitive behaviors, different associated symptoms, comorbidities, and outcomes, most likely reflecting complex interactions among several etiological factors. Epidemiological confluence with epilepsy suggests shared mechanisms, also supported by the high IED ´prevalence in non-epileptic ASD patients and, by response of autistic symptoms to AE in epileptics. The time course of ASD symptoms cannot be explained by ictal discharges, yet, IED cause long-lasting disruptions in network dynamics. ENC can address this possibility because the time resolution allows segregation of segments containing IED and comparison with visually normal segments (VNS).

Case Report/Case History: Four HF-ASD adults (DSM-5) with frequent IED in the awake EEG, clinical history complemented with core symptoms and global functioning scales. For each subject, z-scored effective connectivities (zENC) of mirror-neuron, executive, default-mode, language and autism-related networks were calculated independently and compared between the IED and VNS. Significant alterations were associated with IED in all subjects, network differences related to predominant symptoms and improved significantly after six months with AE.

Conclusion: Findings from these four cases suggest that frequent IED alter the connectivity of particular networks, contributing to ASD symptoms that respond to AE. They also support the usefulness of EEG and ENC analysis in treatment selection for ASD. These conclusions cannot be endorsed to other ASD until replicated on larger, relatively homogeneous samples. In the meantime, patients may benefit from a personalized-medicine approach and judicious use of information from single cases.

Automated Seizure Detection with Epilog Sensors

Mark J. Lehmkuhle, PhD; Mitchell A. Frankel, PhD; Jay Jeschke, MA; Daniel Friedman, MD

Introduction: The standard for seizure tracking at home is the self-reported seizure diary. Many people living with epilepsy don't know when they have had a seizure as over half of all seizures have been shown to be missed. An easy-to-use long-term EEG recording system that continuously monitors seizures during everyday use could profoundly improve management and personalized treatment of epilepsy. Epitel is creating a home seizure monitoring system that pairs their Epilog, wearable EEG sensors, with novel seizure detection algorithms.

Methods: A training EEG dataset of 347 seizures was created outside of this study by placing Epilog sensors alongside wired EEG in the epilepsy monitoring units at three centers. A simple machine learning algorithm was trained on the electrographic portion of these seizures. 15 patients were enrolled at NYU previously diagnosed with epilepsy to wear Epilog for 3 weeks and keep a seizure diary. 10 patients wore Epilog for an average of 19 days. The Epilog EEG was then run through the algorithm where the output was 206 event markers plus 33 self-reported seizures. Finally, the EEG with event markers were reviewed by the epileptologist to detect seizures.

Results: A total of 32 events were marked by the epileptologist as electrographic seizures. Of these, only 2 events were reported in seizure diaries, detected by the algorithm, and confirmed by epileptologist review. 10 events were reported in diaries and detected by the algorithm but not marked as seizures by the epileptologist. 21 events were reported in diaries but not marked as seizures by the algorithm or epileptologist.

Conclusion: Epilog sensors successfully record EEG for weeks at home. An automated seizure detection algorithm reduced weeks of EEG to discrete events that an epileptologist was able to use to detect seizures. Over 90% more seizures were detected by the algorithm and confirmed by epileptologist review that were absent in self-reported seizure diaries.

EEG Current Density Reconstruction Models Provide More Reasonable SEEG Targets

John S. Ebersole, MD; Joseph Camerone, REEGT

Introduction: A major limiting factor in the use of SEEG is the determination of the most likely epileptogenic cortex for implantation. If a structural abnormality is absent, reliance on functional data, in particular EEG, is often necessary. However, visual inspection of EEG traces is seldom sufficiently localizing, and use of the most common EEG source model, the equivalent current dipole, is not optimal. Dipoles are an unrealistic point-like model, and they tend to be deep to the actual source. A model that is constrained to cortex and realistic extent would be far better for SEEG targeting.

Methods: EEG spikes and seizure rhythms, recorded with a minimum of 25 channels, including sub-temporal electrodes bilaterally, were averaged and modeled by single moving dipoles and an s-Loreta current density reconstruction (CDR) model constrained to cortex, cortical surface orientation, and to a selected extent using Curry 8 software (Compumedics Neuroscan). Sample discharges from 16 patients, including those from all cortical lobes, were analyzed.

Results: In nearly all cases (15/16), dipole models of spike and/or seizure potentials localized to white matter deep to overlying cortex. Interpretation of the likely source typically required projection of the dipole orientation to the cortical surface. In contrast, CDR models in over 80% (13/16) of cases defined an extent of cortex that was clinically reasonable in location and size. Interpretation of likely source cortex and selection of SEEG targets was straight-forward.

Conclusion: Source models of EEG spike or seizure potentials provide targets for SEEG, particularly in surgical candidates without brain structural abnormalities. Commonly used moving dipole models tend to be deep to cortex and require clinical interpretation. Cortically-constrained extended source models, such as s-Loreta, provide a better and more realistic SEEG target area.

Strong Macroperiodic Ocsillations in Critically Ill Children Are Correlated with Worse Clinical Outcomes

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Introduction: We identified a novel pattern of slow, periodic waxing and waning in the EEG power spectrogram, termed Macroperiodic Oscillations (MOs), in a retrospective cohort of very young critically ill patients; we aimed to quantify this phenomenon to correlate it with clinical outcomes.

Methods: 53 patients with long term (>12 hr) EEG monitoring were identified in intensive care units (ICUs) at St. Louis Children's Hospital between September 2016 and May 2019. We used a bilevel spectral analysis to identify MOs as a minutes-long modulation of 5-15Hz activity. We developed an index to quantify the strength and spatial homogeneity of this signal, validated against pairwise surrogate noise data (n=53) and normal controls (n=5). To quantify fluctuations in hemodynamic autoregulation, we compared spectral content of EEG with and without MOs (623 vs. 972 min, respectively) using multi-taper spectral analysis of intracranial pressure and heart rate data from one patient with physiological monitoring.

Results: MOs were identified as a 0.003-0.012Hz oscillation in the 5-15Hz power from EEG; their spatial manifestation was heterogenous. MOs index values were significantly higher for patient data than for surrogate noise data. Patients with strong and spatially widespread MOs had worse outcomes as measured by the Pediatric Cerebral Performance Coefficient. Intracranial pressure and heart rate data displayed peaked spectral content at 6-8mHz during MOs, matching the frequency range at which MOs were identified in that patient.

Conclusion: Our innovative approach quantified MOs, a novel minutes-long modulatory EEG phenomenon, and strong MOs index scores correlated with poor clinical outcomes in a cohort of critically ill young children. Further study is needed to elucidate the mechanism of its initiation, propagation, and termination, and to identify factors contributing to spatiotemporal heterogeneity.

EEG

A Curious Case of Intractable Yawning

Naraharisetty Anita Rau, MD ; Juan P Solano Romero, MD ; Saman Zafar, MD ; Anishee Undavia, MD Aparna Prabhu, MD

Introduction: We present a case of seizures manifesting as intractable yawning in a patient who developed pneumocephalus after epidural steroid injection, and how bedside Lorazepam clarified the diagnosis.

Case Report/Case History: A 42-year-old female with bipolar disorder, generalized anxiety disorder, and chronic neuropathic pain presented with altered mentation. As per husband, she was intermittently unresponsive following epidural steroid injection for musculoskeletal pain 3 days earlier. Admission urine drug screen was positive for amphetamines, cannabis and opiates. CT and MRI showed air in bilateral frontal horns and left lateral ventricle. Patient was awake and intermittently responsive, but was disoriented. She was repetitively yawning, several times per minute, without awareness. EEG background showed diffuse theta slowing. Yawning episodes were associated with bursts of rhythmic 4-5 Hz delta slowing. This pattern was observed for ~90 minutes. IV Lorazepam was then administered. This led to emergence of posterior dominant rhythm of 9 Hz. There was a dramatic change in patient- she stopped yawning, was amnestic of prior events, and was oriented and conversational. The EEG change, along with clinical response, confirmed the ictal nature of the episodes. She was started on Lacosamide. She remained symptom free with no altered mentation or yawning. Imaging confirmed resolution of pneumocephalus.

Conclusion: This case is interesting for the unusual seizure semiology of repetitive yawning, as well as etiology: pneumocephalus as a complication of epidural steroid injection. It also highlights the clinical importance of bedside observation of the effect of IV Lorazepam on suspected seizures. As per the Salzburg criteria, one way of diagnosing non-convulsive seizures is demonstration of EEG and clinical improvement with the administration of IV antiseizure medication. The remarkable improvement with Lorazepam clarified the diagnosis of an otherwise bizarre and challenging case.

Abnormal Involuntary Movements Unmasked by Brainstem Release Phenomenon

Kshama Ojha, MD; Mohammed Ilyas, MD ; Julie Gianakon, MD

Introduction: Burst-suppression is characterized by bursts of high-voltage activity alternating with near suppression of electroencephalographic (EEG) activity and is usually associated with a poor outcome especially in the setting of anoxic brain injury. Various abnormal movements, like spontaneous eye-opening, nystagmoid movements, oro-facial movements, myoclonus, and limb movements, have been associated with the EEG bursts, but abnormal movements exclusively between EEG bursts are very rarely reported. Reeves at al in 1997 described the pathophysiology for these interburst movements, as brainstem release phenomena. In this case report, we attempt to describe a similar phenomenon that allows the release of brainstem circuits during these abnormal movements to occur at a time of widespread, profound EEG suppression.

Case Report/Case History: A 15-month-old female with a medical history of spinal muscular atrophy presented with refractory myoclonic status post cardiorespiratory arrest. Her seizures were refractory to initial treatment, and so was started on a Pentobarbital drip to achieve burst suppression. During therapeutic burst suppression, she developed rhythmic bilateral upper extremity internal rotation movements (Video with simultaneous EEG), only during the suppression phase, with cessation in the burst phase, lasting 2-10 seconds. These abnormal movements did not respond to abortive medications. Neurological examination revealed a comatose patient with spasticity. Brain MRI showed global ischemic injury.

Conclusion: These abnormal, rhythmic, and stereotypical movements that occurred exclusively during periods of profound cortical suppression were likely due to the brainstem release phenomenon that occurs in cases of extensive injury to the cerebral cortex with relative preservation of the brainstem and should not be misinterpreted as seizures.

Brainstem-related EEG Phenomena in COVID 19: A Case Report

Lesly R. Araque Colmenare; Olga Fedirchyk; Raquel Fernandez Tajuelo; Ignacio Regidor; Guillermo Martín Palomeque

Introduction: Recently, there has been described an alpha coma electroencephalographic (EEG) pattern associated to critically ill SARS-CoV2 infected patients who remain in coma after sedation withdrawal. This pattern as well as spindle coma seems to be part of the "brainstem-related EEG phenomena", that could be explain as a sign of brainstem damage directly cause by the virus, thrombosis or immumediated local dysfunction.

Case Report/Case History: A 75 year-old man, diagnoses of COVID-19, without neurological comorbidities, is admitted to the intensive care unit (ICU) for respiratory failure and hemodynamic instability. He requires a prolonged respiratory support due to respiratory sepsis. On day +31 of ICU admission, sedative medication is withdrawal, 48 hours after, he remains comatose. A EEG was made with subcutaneous needle electrodes according to the international 10-20 system in a reduced montage. It had a low voltage, theta range background activity, with intermittent, low prevalence, anterior predominance, paroxistic bursts of 14-15 Hz rhythmic sinusoidal morphology activity, 1 second long, similar to sleep spindles. Background activity was reactive to noxious stimuli. A second EEG was made, at day +41. It had slowed background activity, normal voltage, reactive to stimulus. No "spindle-like" bursts was observed. The patient remains on the ICU with improvment of his neurological status.

Conclusion: Alpha coma is a EEG pattern associated with poor prognosis. Recently it has been described in COVID 19 related encephalopathy. Spindle coma is another "brainstem-related EEG phenomena" associated to a better prognosis. We would like highlight the EEG pattern correct identification and reactivity in patients with Covid-19 related encephalopathy, and to coined the term "brainstem-related EEG phenomena" to describe this patterns avoiding the use of alpha/spindle coma in critical ill COVID-19 patients, due to the poor prognosis related to such terms.

Coexistence of Focal and Idiopathic Generalized Epilepsy: A Case Report

Navnika Gupta, MD; Arun Swaminathan, MD

Introduction: The presence of coexisting focal and idiopathic generalized epilepsy (IGE) is rare, and its etiopathogenesis unknown. We report a case of well-controlled IGE and medically refractory temporal lobe epilepsy.

Case Report/Case History: A 26-year-old woman presented to the University of Nebraska Medical Center Epilepsy Clinic for evaluation of seizures. Her spells started at the age of 18 when she had an event of confusion and loss of orientation. Thereafter, she had episodes of metallic taste without seizures until the age of 26 when she had a generalized seizure preceded by an aura of abnormal taste. She was diagnosed with focal seizures based on semiology and empiric oxcarbazepine (OXC) started. Her seizure frequency worsened with OXC. Later, electroencephalogram (EEG) showed interictal generalized spike-and-wave (GSW) complexes and left frontotemporal epileptiform discharges. Brain magnetic resonance imaging was normal. Based on the EEG, OXC was switched to levetiracetam (LEV). On follow-up visit, she mentioned having myoclonic-like jerks as a teenager. She continued to have seizures on LEV for which topiramate and clobazam were added but, she continued to have seizures. Continuous video EEG monitoring was done, and she had four clinical seizures with left temporal onset. Additionally, there were interictal left frontotemporal epileptiform and GSW discharges. On follow-up clinic visit, pre-surgical evaluation for medically refractory left temporal epilepsy was initiated.

Conclusion: This case highlights the importance of using anti-epileptic medications with a broad spectrum in patients with coexisting focal and idiopathic generalized epilepsy as medications like oxcarbazepine can worsen seizures. It also emphasizes the importance of considering surgery for the treatment of medically refractory focal epilepsy even with coexisting IGE.

Deep Brain Stimulator-induced Artifacts Mimicking Ictal EEG Patterns

Sydney V. Palka, MD; Carlos Villamizar Rosales, MD ; Meghan A. PICCININ, DO; Joshua Smith, DO; Maria Baldwin, MD; Anne Van Cott, MD; James Castellano, MD

Introduction: Conventionally, deep brain stimulator (DBS) devices are known to cause an intermittent high-frequency artifact on EEG. We present two cases of mental status alteration concerning for status epilepticus with DBS-induced EEG artifact mimicking an ictal pattern.

Case Report/Case History: Case #1 A 67-year old man with a history of Parkinson's disease with bilateral subthalamic DBS (Boston Scientific, Vercise) was admitted with a 5mm right temporal subdural hematoma and was placed on phenytoin for seizure prophylaxis. A stat EEG obtained during an episode of altered mentation and asynchronous myoclonic jerking of all extremities revealed continuous, bifrontal-predominant 4.5 Hz rhythmic activity. He was treated for presumed status epilepticus with intravenous lorazepam, levetiracetam and fosphenytoin with cessation of myoclonus but without electrographic improvement. Due to suspicion of artifact related to the DBS, his DBS was turned off with abrupt termination of the 4.5 Hz rhythmic activity. Case #2 A 72-year old man with Parkinson's disease with bilateral subthalamic DBS (Medtronic, Percept PC) was admitted for loss of consciousness, altered mental status and a small right subdural hematoma. EEG revealed continuous rhythmic activity at 4 Hz with maximal amplitude over the right frontal region, without evolution and no clinical correlate. After 14 minutes of recording, the DBS was turned off with prompt cessation of the 4 Hz rhythmic activity.

Conclusion: The constant evolution and increasing complexity of implantable electronic devices presents a new challenge when interpreting EEG. These two cases represent a previously undescribed electrographic artifact of DBS that mimics an ictal pattern. Recognition of this novel artifact will minimize misinterpretation and potential overtreatment in the acute setting.

EEG Changes During Left- and Right-sided Weakness in a Patient with Sporadic Hemiplegic Migraine

Magdalena Bosak; Kamil Wężyk; Iwona Mazurkiewicz; Izabela Domitrz

Introduction: EEG is not a standard examination for diagnosis of migraine. Nevertheless, it is useful for making a differential diagnosis with seizures. Different types of electroencephalographic abnormalities have been reported during hemiplegic migraine attacks.

Case Report/Case History: A 24 year-old man was referred to hospital with multiple episodes of impaired responsiveness and right arm weakness since the age 15 years. He was initially diagnosed with epilepsy and treated with carbamazepine 800/d without improvement. Medical history revealed episodes of numbness and paresis starting in the right hand and gradually spreading up into the arm and face, accompanied with aphasia and drowsiness. Symptoms lasted 40 to 90 minute and were followed by a severe, throbbing left-sided headache with photo- and phonophobia, nausea and vomiting. These symptoms resolved completely between attakcs. To the date of first evaluation the patient had experienced 11 stereotypic episodes. MRI and angioMRI performed between episodes were normal. Scalp EEG obtained during his stereotypic attack revealed slowing over the left hemisphere, follow-up EEG was normal . Hemipelgic migraine was diagnosed and carbamazepine was withdrawn. Four years later he experienced the episode of the paresis of the left arm and hemiface followed by a right-sided headache. EEG performer during that episode showed slowing over the right hemisphere which resolved within one week.

Conclusion: To the best of our knowledge, this is a first report of EEG taken during left- and right-sided hemiplegic episodes. We documented that an EEG pattern of unilateral slowing, contralateral to the affected body side, characterizes acute episodes with complete resolution of abnormalities in an asymptomatic state. Slowing during the acute episode may reflect depression of cortical reactivity or vasoconstriction and normal follow-up EEG the resolution of cortical changes.

Electroclinical Changes in a Case of Anti GABA-B-receptor Encephalitis with Gelastic Seizures as Initial and Predominant Manifestation

Joyce E. Villarreal-Bohsain; Montserrat G. Gerez, MD, PhD ; Guillermo Vargas-Lopez; Carlos Acosta-Monroy

Introduction: Anti-GABA-B receptor encephalitis, uncommon autoimmune encephalitis caused by antibodies to GABA-B receptor.In this case, with Gelastic seizures an uncommon type of seizures.

Case Report/Case History: 15-year-old male, admitted in Hospital Español of México,02,27,2020, due to involuntary,uncontrollable and unmotivated laughter.VEEG,generalized low-voltage βrhythmic activity, intermixed paroxysms of θ polymorphic waves,in left FT region.03,02,2020,VEEG with slowdown background activity,burst suppression pattern with 40:60ratio,hypersynchronous burst of δ and δ brush-like activity, paroxysms of sharp waves and FT spike-slow wave complexes.03,11,2020 VEEG,with generalized low voltage,little reactivity.No paroxysms or focal dysfunction were observed.CSF with antibodies against GABA b receptor.Seizure control and decreased epileptiform activity were achieved after the triple antiepileptic scheme, intravenous IG,steroids and Mycophenolate.Discharged after 17-days with diagnosis of autoimmune encephalitis due to anti-GABA-B receptor antibodies.04, 30, 2020, re-admitted with epileptic status and diagnosis of relapsed.VEEG,with clonic focal onset seizures, altered state of consciousness and gelastic crisis that correlate with spike-wave complexes, over the left posterior temporal region, propagation to the contralateral region. Managed with Methylprednisolone, plasmapheresis and Rituximab.

Conclusion: We describe the first patient on literature to develop a gelastic seizure as a symptom of autoimmune encephalitis due to anti-GABA-B receptor and describe his electrical evolution, with EEG abnormal in 90% showing generalized or local predominant Temporal slow-wave and low amplitude activity in 90% and temporal epileptiform discharges in 50%.It's important to continue research and report, to understand and assess this relative new pathology, and its atypical presentations.

Electroencephalographic Findings in a Patient with Prolonged Todd's Paralysis

Kamil Wężyk; Iwona Mazurkiewicz; Magdalena Bosak; Wojciech Turaj

Introduction: Transient limb paralysis following focal epileptic seizure (Todd's paralysis) is a classical post-epileptic lateralizing sign, involving hemiparesis contralateral to the epileptogenic focus. It is reversible and lasts from several minutes to several hours. We report the case of unusually long Todd's paralysis. The emphasis is put on evolution of EEG findings which may help to understand the nature of this abnormality.

Case Report/Case History: A 46-year-old woman was admitted to hospital because of the sudden loss of consciousness, generalized convulsions and head and eyeball deviation to the left followed by right-sided weakness. Brain MRI and angio-MRI, studies of CSF, ultrasound of carotid and vertebral arteries and CT of the head did not reveal any significant abnormalities. EEG performed at the day of admission showed abundant delta waves registered from frontal, temporal and parietal regions of the left hemisphere. Right-sided leads registered normal and spatially heterogeneous posterior dominant rhythm of alpha activity. On day 3, patient's clinical status improved. She was conscious and well-oriented; paralysis of the right limbs disappeared. EEG performed on day 6, showed abundant theta and alpha waves in left temporal region. During follow-up visit, 6 weeks after the onset of symptoms EEG revealed normalization of the bioelectrical activity over the left hemisphere.

Conclusion: Intermittent rhythmic delta activity in the hemisphere contralateral to the side of the hemiparesis was described in a large group of patients with Todd's paralysis. We were not able to find any report of evolution of EEG abnormalities during Todd's paralysis and after its resolution.It is worthy to note that the recovery of EEG abnormalities lasted much longer than the hemiparesis itself. It may suggest that the subclinical electrophysiological derangements remain longer than the obvious clinical manifestation.

Neurostimulation EEG Artifacts: VNS, RNS, and DBS

Fabio Nascimento, MD; Jay Gavvala, MD

Introduction: Overinterpretation of EEG findings has been reported as the most common reason for EEG misinterpretation by a group of expert electroencephalographers. Pitfalls to EEG interpretation encompass a large group of findings including artifacts. Within the realm of artifacts, we highlight those generated by mechanical devices such as vagus nerve stimulator (VNS), responsive neurostimulator (RNS), and deep brain stimulator (DBS). We aim to demonstrate and characterize artifacts generated by neurostimulation devices (VNS, RNS, and DBS) by showing several illustrative examples.

Case Report/Case History: We report three patients who underwent implantation of VNS, RNS, and DBS, respectively. VNS (figure 1) and RNS (figure 2) artifacts display an electrical interference-like "spiky" morphology with a distribution that is incompatible with a cerebral source and frequencies that mirror stimulation settings. DBS artifact (figure 2) features diffuse electrical interference with a relatively monomorphic appearance and its frequency can vary depending on intermittent versus continuous neurostimulation – indicated for epilepsy and movement disorders, respectively.

Conclusion: Accurately recognizing artifacts in electroencephalogram (EEG) is necessary to prevent EEG misinterpretation and epilepsy misdiagnosis. EEG artifacts generated by neurostimulation devices can be identified based on their unique spatial and frequency properties.

Tracking the Course of Delayed Posthypoxic Leukoencephalopathy with MRI and EEG: Did Steroid Therapy Improve the Outcome?

David Chachkhiani, MD; Anil K. Chimakurthy, MD; Cheryl Goyne, MD; Edward C. Mader, Jr., MD

Introduction: Delayed posthypoxic leukoencephalopathy (DPHL) is characterized by initial recovery from hypoxic brain injury, clinical stability over 2 to 5 weeks, and subsequent neurological deterioration due to emergence of white matter disease. The most commonly reported cause of hypoxic brain insult in DPHL is opioid overdose and carbon monoxide poisoning.

Case Report/Case History: A 46-year-old man with history of substance abuse and post-traumatic epilepsy suffered respiratory failure and hypotension due to opiate overdose. Brain MRI showed watershed infarcts and EEG showed diffuse theta-delta activity consistent with global hypoperfusion. He recovered fully and was discharged with intact cognitive function. Four weeks later, he lapsed into delirium and was admitted again. MRI showed extensive white matter disease and EEG showed diffuse polymorphic delta activity. Toxicology was negative and other causes of white matter disease were excluded. DPHL was diagnosed based on these findings and on the history of cerebral hypoxia-ischemia. Neurological status declined towards akinetic mutism prompting treatment with methylprednisolone 1g IV q24h for 5 days. Responsiveness improved but he still had psychomotor retardation on the day of discharge. Three months later, neurological exam was normal except for hyperreflexia. MRI showed near-complete resolution of white matter abnormalities, and EEG showed irregular delta waves anteriorly and normal alpha rhythm posteriorly.

Conclusion: Most patients who recover from DPHL continue to have neurological symptoms, such as impaired attention or executive function, parkinsonism, and signs of corticospinal tract injury. Our patient achieved near-complete recovery despite evidence of extensive demyelination on MRI and EEG. It is possible that steroid therapy spared our patient the severe sequelae of DPHL.

An Interictal EEG Grading Scale for Children with Infantile Spasms – the 2021 BASED Score

John R. Mytinger, MD; Jorge Vidaurre, MD; Melissa Moore-Clingenpeel, MA, MAS; Dara VF Albert, DO

Introduction: To develop an improved interictal electroencephalogram (EEG) grading scale for children with infantile spasms founded on elements with adequate inter-rater reliability (IRR) to justify its use for clinical and research purposes.

Methods: Three blinded reviewers assessed five-minute sleep epochs in 54 EEGs from 36 children (18 consecutive normal, 18 consecutive infantile spasms [pre- and post-treatment]) using a longitudinal bipolar montage. We determined the IRR of background amplitude, epileptiform discharges, multifocal spikes (MFS, including < or >/= 50%), grouped MFS, paroxysmal voltage attenuations, and symmetry of sleep spindles. This data was used to create the 2021 BASED (Burden of AmplitudeS and Epileptiform Discharges) score.

Results: All included elements had moderate to near perfect IRR. Among controls, >/= 200 μv background waves occurred commonly in bilateral posterior temporal (T3-T5, T4-T6) and midline (Fz-Cz, Cz-Pz) channels; high amplitude background waves were most frequent within midline channels. Excluding midline and occipital channels, we designated abnormal high amplitude background waves as >/= 200 μv for most channels, but >/= 300 μv for posterior temporal channels. Channels that included occipital and midline electrodes were excluded because of normal common high amplitude background waves. The IRR was moderate to near perfect for < or >/= 50% MFS, paroxysmal voltage attenuations, grouped MFS and symmetric sleep spindles. Paroxysmal voltage attenuations, grouped MFS, and >/= 50% MFS all significantly distinguished pre- from post-treatment studies whereas symmetric sleep spindles did not (the latter excluded from the 2021 BASED score). When the 2021 BASED score was applied to the 13 children with infantile spasms achieving clinical remission, 11 met criteria for electroclinical remission.

Conclusion: Our scoring method includes elements with high levels of IRR supporting the use of this interictal EEG background assessment tool for children with infantile spasms.

COVID-19 Continuous EEG Series in Peak Pandemic Months

Candace Schaefer, MD, MS; Bhavan Shah, MD, MPH; Pegah Afra, MD, FACNS

Introduction: COVID-19 is a novel infection caused by the SARS-CoV-2 virus. While neurologic symptoms and sequelae have become more apparent, electroencephalogram (EEG) findings remain poorly defined.

Methods: Continuous video EEG monitoring (cEEG) tracings were retrospectively reviewed for all COVID-19 positive patients at Weill Cornell Medical Center-NYPH connected between February 10 and June 10, 2020. Each patient was represented in the data only once unless cEEG was reconnected more than 7 days after last disconnection, in which event a unique case entry was made for the same patient (n=11). If there was significant change in the EEG over time, the best achieved background frequency was considered. 2012 ACNS standardized ICU EEG terminology was used.

Results: Sixty-five COVID-19 patients on cEEG were identified. The most common indication was abnormal mental status. 97.4% had generalized background slowing (GBS); diffuse slowing in the remaining 2.6% was intermittent. There was significant change in background frequencies in 17.1% (improvement in 14.5%, sustained worsening in 2.6%). Burst suppression was seen in 10.5% during portions of recording. Focal or multifocal interictal epileptiform discharges were seen in 17.1% and 10.5%, respectively. Periodic discharges (PDs) were present in 43%, most commonly in the form of generalized PDs with triphasic morphology (GPD-TM), followed by lateralized PDs (LPDs). Seizures were recorded in 9.2%, including 5.2% in focal status epilepticus.

Conclusion: The predominant cEEG finding in COVID-19 patients was GBS followed by GPD-TM, consistent with diffuse encephalopathy of non-specific etiology followed by metabolic encephalopathy. LPDs, suggestive of some degree of cortical injury, were the third most common finding. The majority of patients with seizures were in focal status epilepticus, suggesting active epileptogenicity. Data (demographics, cEEG indications, EEG abnormalities) to be presented in table format.

Electroencephalographic Changes in Sporadic Creutzfeldt–Jakob Disease – a Single-center Study

Magdalena Bosak; Kamil Wężyk; Iwona Mazurkiewicz

Introduction: Creutzfeldt–Jakob disease (CJD) is a progressive and uniformly fatal transmissible spongiform encephalopathy. EEG is an integral part of the diagnostic process in patients with CJD. We aimed to describe EEG changes in patients with sporadic CJD.

Methods: We retrospectively analysed EEG data of 18 patients (11 females) with sCJD admitted to our hospital between 2006 and 2020. sCJD was diagnosed according to Updated clinical diagnostic criteria for sporadic Creutzfeldt-Jakob disease (Zerr et al. Brain 2009).

Results: The mean age of patients with probable (14 - 77,7%; in one patient RTQuIC performed - positive) and definite (4 - 22,3%) sCJD was 60,1 years (34-80). Time interval (mean) between onset of disease to admission was 4,6 months (range: 1-12). We performed 1 to 6 recordings in each patient. EEG abnormalities were present in all subjects. Progressive slowing of background activity was recorded in 18 patients. Periodic sharp wave complexes (PSWCs) were found in the first EEG in 9 (50%) patients. If PSWCs were not present EEG was performed every 5-7 days. Finally, PSWCs were recorded in 15 (83,3%) patients.

Conclusion: EEG abnormalities were present in all patients and typical periodic sharp wave complexes in the vast majority of patients. Early diagnosis of probable CJD is crucial for preventing disease transmission. EEG is relatively inexpensive and readily available diagnostic test and still remains a valuable biomarker in patients with suspicion of CJD.

Etiology and Prognostic Significance of Ictal EEG Patterns in Patients with Nonconvulsive Seizures

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Introduction: We aimed to study the ictal EEG patterns in patients with non-convulsive seizures (NCS) and their relationship with underlying etiology and patient's outcome.

Methods: We conducted a retrospective review of EEG's studies and ictal EEG findings of NCS were categorized in three patterns: focal or generalized epileptiform discharges (EDs) at frequencies higher than 2.5 Hz (pattern 1); EDs at frequencies of 2.5 Hz or lower or rhythmic activity higher than 0.5 Hz with spatiotemporal evolution (pattern 2); and EDs with 2.5 Hz or lower with subtle clinical correlate during the ictal EEG or clinical and EEG improvement after trial of IV antiseizure drugs (pattern 3). Patients with anoxic brain injury were excluded from the study. Association of ictal EEG pattern with underlying etiology and their impact on in-hospital mortality was measured.

Results: Of 487 patients included in the study, a total of 57 (12%) patients had NCS recorded on cEEG monitoring. A SOFA (Sequential Organ Failure Assessment) score of 7.23 ($p=0.0007$) in patients with acute medical illness, presence of IEDs ($p <0.0001$) and LPD ($p<0.0001$) on cEEG were associated with NCS. The Pattern 2 was most commonly seen ictal EEG findings in patients with NCS (70%, n=40/57), followed by pattern 3 (15%, n=9/57) and pattern 1(14%, n=8/57). In patients with acute brain injury, ictal pattern 2 (67%, n=27/40) was commonly seen, whereas pattern 1 (62% n=5/8) was seen in patients with acute medical illness. No significant difference was found between ictal EEG patterns with underlying etiologies ($p=0.27$) or with in hospital mortality ($p=0.5$).

Conclusion: Spatiotemporal evolution of ED at lower frequency was most commonly recorded ictal EEG pattern in our cohort. A further prospective study could add more clinical value to evaluate etiologic correlate of the various ictal EEG pattern and their effect on the patient's outcome.

Long-term Follow-up of EEG in Unverricht-Lundborg Disease

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Introduction: Unverricht-Lundborg disease (ULD) is the most prevalent form of progressive myoclonic epilepsy. The aim of the study was to describe the EEG characteristics of patients with ULD and their changes during the long-term follow-up.

Methods: We retrospectively evaluated the EEG features of 7 patients with genetically confirmed ULD.

Results: We included 2 females and 5 males with the mean age 36,2±6,5 years, the mean age at onset 8.9 years and the lenght of follow-up 1-18 years. Thirty-one EEGs were performed in 7 patients. 27 (87%) EEGs were performed during treatment with borad spectrum antiepileptic drugs. The average background rhythm was 8.1 Hz and was normal in one patients and mildly slowed in 6. The frequency of background activity remained stable over time. Spike/polyspike and wave discharges (SWD) were found in all patients in at least one recording and in 22 EEGs (70,1%). Photosensitivity was found in all patients and in 15 recordings (48,3%). Myoclonic jerks were recorded in all subjects, most of the jerks were not time-locked to epileptiform discharges. In all patients jerks were provoked by photostimulation. In 2 patients SWD and myoclonic jerks were aggravated by contraindicated drugs (phenytoin and carbamazepine) and their frequency diminished after treatment change. Despite the increased frequency and severity of myoclonic jerks the frequency of SWD tended to diminish with time.

Conclusion: The most common EEG abnormalities in patients with ULD include background slowing and spike and wave discharges. The average background rhythm remains stable over time; epileptiform discharges tend to diminish with time.

Measuring Real-Time Medication Effects from Electroencephalography

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Introduction: Evaluating the effects of anti-seizure medication in patients with epilepsy remains a slow, challenging and manual process. We hypothesize that nonlinear analysis can discover an EEG-based digital biomarker to measure medication effects and/or changes in epileptogenicity to provide real-time, objective information that guides clinical decision making.

Methods: This study conducts nonlinear signal processing on EEGs collected from 67 patients in the Long-Term Monitoring Unit at Boston Children's Hospital between July 2016 and June 2017. Two 30-second EEG excerpts are selected from each patient pre- and post- medication weaning. To analyze these EEGs, we conduct recurrence quantification analysis, a method of nonlinear time series analysis based on a graphical projection of the phase space trajectory of a dynamical system, and enables the functional dynamics of the brain to be evaluated.

Results: Anti-seizure medication effects were measurable by nonlinear analysis on EEGs. Moreover, the size of the medication effect correlated with a patient's seizure frequency, seizure localization, and clinical response to medication. Patients with a moderate number of expected seizures per day showed a larger medication effect on the brain than patients with rare or frequent seizures. Patients on four or more medications showed the largest effect size. The seizure onset zone of the brain responded differently to medication than the rest of the brain. Patients with a clinically-determined lack of response to medication had distinctly different brain electrodynamics compared to patients who did have a response to medication. All of these measured medication effects correlate with the inferred level of epileptogenicity in a patient's brain.

Conclusion: Multifrequency nonlinear EEG analysis shows promise for identifying digital biomarkers to measure medication effects and evaluate response to treatment in patients with epilepsy.

Skull Permeating HFO Is Demonstrated by Schredinger Equasion

Hisanori Hasegawa, MD

Introduction: Dense array EEG (dEEG) recordings over scalp are available by several vendors. They utilize 128 channels high-impedance system easily applicable without using collodion. They are recorded in referential montage. Such dEEG has higher spacial resolution by denser scalp electrodes distribution and better temporal resolution by DC amplification. Single electrode high frequency range (40 to 120 Hz) rhythmic electrographic discharge pattern are seen in dEEG. Unlike ECog, such findings may not be regarded as actual neurophysiological phenomena in scalp recording traditionally because of the distance and bone resistance, and has been believed that HFO activity may not be recorded on scalp. Recently scalp-permeating gamma/HFO are recognized by comparison with scalp and intracranial recordings. Alternative mechanism than electrical conductance should be considered. The intension of the presentation is novel approach using Schlesinger's wave equation to elucidate skull permeation of HFO.

Methods: Schlesinger wave equation is prepared as a theoretical platform to elucidate skull permeability of HFO by tunnel effect. dEEG recordings were done by either 128 channels using EGI system. Using records demonstrating single electrode rhythmic HFO phenomena. By solving non-time-dependent Schlesinger equation, the ratio of wave amplitudes attenuation was calculated which is independent from frequency. The amplitude quickly dwindles by the thickness of the skull bone barrier.

Results: dEEG recordings which demonstrate single electrode electrographic patterns follows decremental pattern predicted by the Schlesinger equation. The limitation of the highest recordable frequency was reasonably up to 150 Hz attributed to the low pass effect of the skull and sculp tissue.

Conclusion: Scalp permeating single electrode electrographic activity identified in dEEG recording is explained by mathematical model by Schlesinger equation. Therefore, single lead electrographic rhythmic HFO is most likely non-artifact.

EMG/NCV Testing

Diaphragm Impairment in Patients Admitted for Severe COVID-19

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Introduction: Ventilation disorders could develop in patients with COVID-19, not only associated with pneumonia but also with the diaphragmatic function. Our main objective is to study the changes in the diaphragm that occur in patients with moderate and severe COVID-19.

Methods: Patients admitted with the diagnosis of viral pneumonia and positive PCR for SARS-CoV-2 were recruited, differentiating two groups according to the severity of the respiratory symptoms. The cases group consisted of 9 inpatients with moderate-severe dyspnea, pain with diaphragmatic origin or hiccup. The control group consisted of 10 inpatients who suffered from mild dyspnea. Both neurophysiological (phrenic nerve electroneurogram) and radiological (diaphragmatic ultrasound) tests were performed in these patients.

Results: We highlight the differences in the amplitude of motor evoked potentials, being 25.92%(SEM:7,22) in the group of cases, and 19.81%(SEM:5,27) in the control group(p=0,711). Concerning the ultrasound variables, in the group of cases, the right diaphragm thickness mean was 46.67%(SEM:8,86) and the left diaphragm thickness mean was 57.89%(SEM:15,36); the right expiratory fraction mean was 0.53(SEM:0,11), and the left expiratory fraction mean was 0.58(SEM:0,15). However, in the control group, the right diaphragm thickness mean was 62.15%(SEM:5,58) (p=0,432) and the left diaphragm thickness mean was 73.34%(SEM:6,74) (p=0,730); the right expiratory fraction mean was 0.59(SEM:0,05) (p=0,674), and the left expiratory fraction mean was 0.73(SEM:=0,07) (p=0,195).

Conclusion: More severe COVID-19 patients showed more differences in amplitude between both sides on the phrenic nerve electroneurogram and lesser bilateral diaphragm contractility on ultrasound examination. These findings suggest an important role for diaphragm impairment in patients with severe COVID-19.

Electrodiagnostic Testing for Carpal Tunnel Syndrome When Routine Median Sensory and Thenar Motor Responses Are Absent

Abbie Ornelas, MD; Benn Smith, MD

Introduction: The cardinal symptoms of carpal tunnel syndrome (CTS) include pain and paresthesia in the affected hand(s). The median/second lumbrical nerve (2ndL) appears to be relatively preserved in severe CTS, with previous small studies suggesting its value in electromyography (EMG) to localize a median neuropathy to the wrist segment when both the initial routine sensory and thenar motor responses are absent.

Methods: This is a retrospective analysis of 207 hands in 182 patients with electrophysiologically markedly severe CTS (absent median sensory and thenar motor responses) who underwent stimulation of both the median/2ndL and ulnar/second dorsal interosseous (2ndDI) motor nerves. A median/2ndL nerve distal latency of greater than 0.4 milliseconds (ms) when compared to the ulnar/2ndDI nerve confirmed the diagnosis of a median neuropathy at the wrist. The presence or absence of hand pain was also recorded if these data were available.

Results: Some 82.6 % of median nerves (171/207) in 182 patients with electrophysiologically markedly severe CTS had preservation of the median/2ndL motor nerve response. The mean distal latency difference between median/2ndL and ulnar/2ndDI was 4.35 ms (range 0.5-12.9 ms). Of the 97 patients with data available, 81.0% (85/105) of the hands had 0/10 pain on a standard visual analog scale (VAS).

Conclusion: This is a large study exploring the utility of the distal latency difference between median and ulnar nerves when recording over the 2ndL and 2ndDI to localize median neuropathy to the wrist in severe CTS when both routine initial sensory and thenar motor responses are absent. In addition, contrary to what might be expected, most patients with electrophysiologically markedly severe CTS had no pain.

Neuromuscular Diseases in Patients Affected by COVID-19

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Introduction: The coronavirus SARS CoV-2 (COVID-19) has an affinity for neural tissue, causing neuromuscular problems after onset the respiratory symptoms in affected patients.

Methods: We analyze the characteristics of 19 patients with suspicion of neuropathy admitted by COVID-19 infection in "La Princesa" Hospital between March and May 2020. We performed nerve conduction and concentric needle electromyography in all patients.

Results: We performed neurophysiological tests in 19 patients (3 females (15%), 16 males (85%)) The mean age was 65±3.04 years (39–82). Two patients had an acute inflammatory demyelinating polyneuropathy (AIDP), as Guillain-Barré Syndrome; one of them affected with Miller Fisher Syndrome also. Their needle EMG showed spontaneous activity, without MUP abnormalities. Twelve patients showed critical illness myopathy and polyneuropathy (CIMP). From the latter group, seven patients presented with axonal motor-sensitive polyneuropathy, and five patients presented with demyelinating and axonal motor-sensitive polyneuropathy. Their needle EMG showed spontaneous activity, without or with very mild MUP abnormalities. Five patients suffered from peripheral neuropathy, three of them with axonal peroneal neuropathy, the other two with brachial plexopathy and femoral neuropathy, respectively. Their needle EMG showed abundant spontaneous activity, without or with very mild MUP abnormalities.

Conclusion: We need to consider the neuromuscular injuries caused by COVID-19 infection. Neurophysiological tests are essential for the diagnosis of these patients to improve their clinical management.

A Case of GRIN 2 a Mutation with ECSWS and Variable Phenotypical Expression

Cimy Jacob, MD; Ewa Way, MD

Introduction: Alterations of the N-methyl-D-aspartate receptor (NMDAR) subunit GluN2A, encoded by GRIN2A, have been associated with a spectrum of neurodevelopmental disorders with prominent speech-related features, and epilepsy. We report a case of Deletion in Exon 11 of GRIN2A causing Epileptic encephalopathy and CSWS with no aphasia or speech regression

Case Report/Case History: Patient is a 5-year-old female born premature at 27 weeks diagnosed with partial epilepsy from the age of 3 years who was initially on Trileptal with partial response . There was history of bronchopulmonary dysplasia and feeding issues after birth and patient was maintained on GTT feeds till one year of age .Semiology was mainly starring spells with head and gaze deviation , at times progressing into generalized convulsions. Neurological exam was benign with no major delays , speech problems or verbal agnosia . MRI brain showed a small pineal cyst . Initial EEG showed slower background for age with faster frequencies . Prolonged monitoring showed multifocal spike wave discharges with left sided predominance and features of background slowing and disorganization depicting a picture of epileptic encephalopathy and continuous spike wave pattern seen during slow wave sleep (CSWS). Her epilepsy genetic evaluation revealed heterogenous mutation of GRIN2A ,which is associated with a spectrum of autosomal dominant conditions concerning for speech related issues and epilepsy, ranging from Landau-Kleffner syndrome to mild disability with conversational speech. Patient was started on Clobazam with good clinical response.

Conclusion: The phenotypic spectrum of GRIN2A mutation ranged from normal or near-normal development with mild epilepsy and speech delay/apraxia to severe developmental and epileptic encephalopathy, often within the epilepsy-aphasia spectrum. This case has a variable phenotypical expression of the mutation , with genetics and EEG findings being congruent.

Left-Right Brain Mystery

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Introduction: Focal cortical brain lesions have ictal semiology based on the epileptogenic network involved. Secondary epileptogensis may explain interictal and ictal electrophysiological findings remote from the anatomic lesion. We report a case of malignant brain tumor presenting as seizures arising from the contralateral homologous cortex with complete resolution of seizures after tumor resection.

Case Report/Case History: A 3-year-old right-handed girl presented with several months of daily seizures characterized by right facial twitching, behavioral arrest and drooling, 2-3 times a day lasting 15-30 seconds. Neurological examination was normal. Routine EEG at outside facility was normal. Initiation of levetiracetam led to significant seizure reduction. MRI brain showed a well circumscribed 19 mm by 18 mm, nonenhancing T2-hyperintense lesion in the right perirolandic region. Patient underwent continuous EEG monitoring which recorded stereotypical focal seizures all of left central onset with frequent interictal epileptiform discharges over the left central region and rarely over the right central region. Patient underwent gross total resection with pathology showing anaplastic astrocytoma (IDH-wild type, WHO grade 3). She completed proton radiation treatment with repeat brain MRI showing no tumor recurrence at 6 months. She remained seizure free, and levetiracetam was tapered. At 18 months after resection, patient remained seizure free. Repeat EEG showed no epileptiform discharges.

Conclusion: Contralateral-maximum epileptiform discharges and seizure onset can be a manifestation of reversible secondary epileptogensis. “Mirror focus” can result from interactions between the primary lesion and interhemispheric connections to the contralateral homologous cortex. Surgical resection of the primary anatomic lesion can lead to an excellent seizure outcome.

New Onset Refractory Focal Status Epilepticus as Initial Presentation of Coronavirus Disease 2019

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Introduction: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has demonstrated an ability to affect multiple organ systems beyond acute respiratory distress syndrome. Acute symptomatic seizures have been described and cortical irritation from blood-brain barrier breakdown. To our knowledge, there are no previously reported cases describing refractory focal motor status epilepticus as the initial presentation to SARS-CoV-2 infection in a patient without a history of prior seizures.

Case Report/Case History: A 45-year-old Native American man presented to a rural emergency department for evaluation of 2-day duration of involuntary, rhythmic movements of the left hand. Computed tomography head demonstrated remote left lenticulostriate perforator infarct but no acute intracranial abnormalities. SARS-CoV-2 RdRp gene nasal swab testing was positive for Covid-19. Involuntary, rhythmic movements continued despite treatment of hyperglycemia and use of two antiseizure medications, midazolam and levetiracetam. Patient transferred for higher level care and his focal status epilepticus resolved after fosphenytoin initiation . Electroencephalogram (EEG) showed moderate generalized slowing and rhythmic sharply contoured theta activity of 4 Hertz, poorly localized but seen maximally in the paracentral head regions. After seizure control, the patient subsequently developed fever and relative hypoxia, classic manifestations of Covid-19.

Conclusion: New onset focal status epilepticus is more often associated with structural changes such as stroke or epilepsy. EEG did not demonstrate obvious seizure focus, but in the case of small seizure foci, scalp EEG can be unremarkable as would be expected in this case. To our knowledge, this is the first known case in the United States of a patient with Covid-19 presenting with the initial symptom of focal status epilepticus.

Non-Convulsive Status Epilepticus in a 28-year-old Pregnant Woman

Iwona Mazurkiewicz Kamil Wężyk; Magdalena Bosak

Introduction: Status epilepticus during pregnancy is a rare condition which may lead to fatal maternal and fetal complications. There is a limited amount of such cases which makes it difficult to plan effective, evidence-based treatment. Here we report the case of 28-year-old pregnant woman who was treated due to non-convulsive status epilepticus.

Case Report/Case History: Patient one was a 28 year-old primigravida on 20th week of her gestation with a history of focal epilepsy. She was treated with gabapentin and she was seizure-free for 3 years. The dose of the drug was reduced before pregnancy. She was admitted with impaired awareness and bizarre movements of upper limbs. In a neurological examination she was: alert, attentive most of the time, but periodically distractible, illogically answering the questions, presenting alternating movements of the right and left upper limbs, hyperventilating, swallowing saliva, blinking, periodically making eye contact. No paresis, no pathological symptoms were found. Video-EEG revealed repetitive epileptiform discharges localized in the right temporal region. 1 mg IV clonazepam was administered followed by 750 mg phenytoin infusion. Magnetic resonance imaging revealed mild swelling of the right hippocampus. The patient was still unresponsive. Phenytoin serum level was above therapeutic range: 29,4 μg/ml. EEG showed background slowing without epileptiform discharges. IV phenytoin infusion was stopped and the patient was given levetiracetam 500mg BID and recovered within 24 hours. She remained seizure- free until the end of pregnancy and delivered a healthy daughter by cesarean section.

Conclusion: Management of status epilepticus in pregnancy is influenced by etiology of status epilepticus and duration of pregnancy. Non-convulsive status epilepticus may have been related to changes in gabapentin pharmacokinetics during pregnancy. EEG plays a central role in the diagnosis of non-convulsive status epilepticus.

Progression of ATP1A3 Related Epilepsy from Focal to Generalized Epilepsy with ESES: Novel Observations

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Introduction: Alternating hemiplegia of childhood (AHC) has been associated with epilepsy (focal or generalized; not both in same patient) in approximately 50% of patients. We report a case of AHC that began as focal epilepsy with recurrent episodes of status epilepticus, but later progressed to generalized epilepsy with electrical status epilepticus in sleep (ESES).

Case Report/Case History: 10 y.o. left-handed girl developed right focal motor seizures on day 1 of life. She developed recurrent hemiplegic and dystonic spells at age 1 y., and AHC was diagnosed and confirmed by D801N ATP1A3 mutation. EEG at 4 y.o. showed left focal seizures with secondary generalization, and right interictal epileptiform discharges. She had episodes of status epilepticus (30min-2hr each) at 3, 4, and 5 y.o. without loss of milestones. MRI was normal post episodes. Seizures remained resistant despite multiple AED's, VNS, and ketogenic diet. She continued to have AHC spells. At 10 y.o., she developed new subacute neurologic regression over 6 mo. including language deterioration, cognitive decline, loss of fine motor skills, worsened gait, dysarthria. AHC manifestations remained unchanged. EEG demonstrated generalized 4Hz spike/slow wave discharges while awake, and ESES with two distinct patterns in sleep. Pattern 1: generalized spike/wave discharges during the first half of the night. Pattern 2: generalized predominantly bifrontal repetitive spikes in early morning. Daily atonic and staring spells were not associated with EEG change and deemed AHC events. MRI/MR Spectroscopy demonstrated interval cerebral/cerebellar atrophy and depressed NAA peaks, which were previously normal.

Conclusion: This is the first case to our knowledge of ATP1A3 mutation with the following unique features: 1) Progression from refractory focal to generalized epilepsy 2) ESES with developmental regression accompanied by neuronal loss and MR spectroscopy changes

Recurrent Infantile Spasms in a Male Infant with De-novo GABARA1 Gene Mutation

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Introduction: A treatment goal for infantile spasms (IS) is the resolution of clinical spasms and hypsarrhythmia. We present a case where IS and hypsarrhythmia resolved with ACTH treatment, though returned as asymmetric IS with modified hypsarrhythmia and remained refractory to pharmacologic treatment.

Case Report/Case History: A healthy term male, the product of normal pregnancy and delivery, with no dysmorphism or neurocutaneous markers presented at 3 months with focal seizures with loss of awareness, myoclonic seizures and infantile spasms. Development regressed with spasm onset. EEG showed hypsarrhythmia. Clinical spasms responded to ACTH. Steroid tapper lead to spasm recurrence which was easily controlled by increasing ACTH. Topiramate, Vigabatrin, and Pyridoxine were ineffective. His brain MRI was normal. A De novo GABRA1 mutation c.799C>T (p.Leu267Phe) was identified. At 8 months, hypsarrhythmia resolved with successful ACTH wean. EEG showed slow background with left temporal sharps. He showed slow developmental progress. At 11 months, clinical spasms returned. EEG showed modified hypsarrhythmia. IS manifested as asymmetric right extremities spasms with right eyebrow elevation. Concurrent EEG findings of left hemisphere lateralized high amplitude slow waves preceded by sharp with maximum negativity at T5 region. Incomplete response to maximum treatment with Clobazam, Vigabatrin, Zonisamide and ACTH. Slow developmental progress was uninterrupted from recurrence of infantile spasms. Ketogenic diet initiated at 18 months of age and he became seizure free.

Conclusion: Our patient with de-novo GABARA1 mutation who initially presented with symmetric flexor spasms, hypsarrhythmia, and developmental regression was easily controlled with high dose of ACTH. However, recurrent asymmetric Infantile spasms with modified hypsarrhythmia showed incomplete response to pharmacologic treatment with impact on development.

Responsive Neurostimulation for Super-Refractory Status Epilepticus

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Introduction: No clear evidence-based treatment paradigm currently exists for refractory and super-refractory status epilepticus (SRSE), which can result in significant mortality and morbidity in survivors. While affected patients are treated with antiepileptic drugs (AEDs) and anesthetics, neurosurgical neuromodulation techniques can also be considered. We present a novel case in which responsive neurostimulation (RNS) was used to effectively treat a patient with SRSE.

Case Report/Case History: The patient is a 22-year-old woman who initially presented with left visual field distortions and severe headache, which developed into left arm myoclonic jerking, left eye deviation, and left head version with intermittent impairment of awareness, associated with electrographic seizures in the right posterior region. She was initially treated with multiple AEDs without adequate electrographic or clinical response and ultimately required burst suppression. MRI and PET demonstrated only seizure sequelae, without a clear lesion. CSF and serum autoimmune, paraneoplastic, metabolic, toxicologic, and infectious studies were unremarkable. Due to concern for autoimmune etiology, she was treated with immunomodulatory therapy without improvement. She also did not improve after transcranial magnetic stimulation. With the lack of a clear lesion, she underwent invasive EEG monitoring with subdural strips and depth electrodes to localize the most active regions. She subsequently had an RNS device implanted to deliver regional therapy and had significant reduction in detected and clinical events after stimulation was initiated.

Conclusion: This case shows how regional therapy provided by RNS can be effective in treating SRSE through neuromodulation of seizure networks. While existing literature has reported on the use of deep brain stimulation and vagal nerve stimulation, there is only one other report where RNS has been used, though with unclear efficacy.

Seizure Denial: A Case Report of Acute Anosognosia for Focal Onset Seizures with Impaired Awareness

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Introduction: Loss of awareness during a seizure and denial of seizure occurrence are two separate issues. A reduced level of consciousness during a seizure or the onset of seizure in sleep may result in loss of awareness of the seizure. An alteration in the content of consciousness, such as language, visuospatial attention, and body image, may also result in a failure to recognize seizures. It has also been hypothesized that ictal recruitment of right parietal lobe circuitry can lead to "seizure anosognosia."

Case Report/Case History: The patient is a 37-year-old female with a 5-year history of tonic-clonic seizures. Most of her seizures were provoked by emotional distress raising concerns for a psychogenic mechanism. During video-EEG monitoring, three seizures with right temporal onset were captured. The third seizure progressed to a generalized tonic-clonic seizure (GTCS). The patient knew she had a GTCS but denied experiencing the first two seizures, even though she was awake and alert on video during the onset of the seizures. She also managed to press the alarm button at the onset of the first seizure and she was seen searching for the button at the onset of the second seizure.

Conclusion: Ictal spread resulting in right parietal lobe dysfunction is the most likely reason the patient failed to recognize her first and second seizures. Researchers have demonstrated that patients do not report as many as 50% of their seizures during long-term EEG monitoring, although not all studies distinguished between unawareness (e.g. seizure onset and offset during sleep) and lack of recognition post-ictally. Further research is needed to investigate the mechanisms underlying these two issues of seizure awareness. Automated sensing methods may improve detection regardless of level of awareness, which will facilitate this distinction.

The "Shrill" of Anterior Insular Epilepsy

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Introduction: Insular epilepsy has been underreported but over the past decade there has been an increased fascination with insular epilepsy. Insular epilepsy is often misreported as either temporal, parietal, or frontal lobe epilepsy based on semiology and EEG findings. We present a unique case of pure anterior insular epilepsy treated with resective surgery including full clinical work-up.

Case Report/Case History: An 18-year-old right handed female with no seizure risk factors and medically refractory epilepsy presented for an epilepsy surgery evaluation. Onset of seizures at age 13 initially as a non descript feeling awakening her at night followed by "siren-like" vocalization. Pre-surgical work-up including multiple scalp EEG epilepsy monitoring unit admissions were negative. MEG showed a dipole to the right frontal region. As seizure semiology and some of her evaluation lateralized to the right hemisphere she underwent an extensive icEEG study with grid, cortical strips and depth electrodes of the right hemisphere. During her icEEG monitoring, interictal discharges were exclusively seen in two electrode contacts of the anterior insular depth with seizures arising from those two contacts and spreading locally within the anterior insular depth only. Cortical stimulation mapping revealed autonomic and thermal sensory symptom. She underwent resective surgery of the anterior insula with surgical approach via the triangularis and pathology revealed focal cortical dysplasia Type 2b. Post-surgically the patient has remained seizure-free on her medications without neurologic sequelae from surgery.

Conclusion: The case we present is a perfect example of how insular epilepsy can falsely localize to other regions of the brain. In our literature search we did not find any mention of ictal vocalization with pure insular epilepsy in the literature or motor manifestations of the anterior insula, so this is the first unique anterior insula case to illustrate these semiologic features.

Characterizing the Driving Dilemma Among Patients with Nonepileptic Events: A Single-Center Prospective Cohort Study

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Introduction: Driving is a critical topic to counsel among patients with epileptic seizures (ES) and nonepileptic events (NEE), with significant legal and public health implications. This prospective cohort study examines the frequency of ES and NEE in a single institution's epilepsy monitoring unit and assesses driving-related issues between each group.

Methods: Adult patients from the Mayo Clinic Arizona Epilepsy Monitoring Unit (EMU) were given comprehensive driving history surveys . Descriptive analysis and statistics were used to summarize differences between patients with ES and NEE. Differences between patients with ES and NEE were determined by Pearson chi-square.

Results: Nearly half (n=75/163) of all patients admitted to the EMU were diagnosed with NEE. Although the NEE group had a statistically significant higher frequency of events (p=0.01), 87.7% of these patients reported compliance with the driving law recommendations, suggesting a trend that patients who have been counseled regarding fitness-to-drive are likely to follow the recommendation. One-third of patients with NEE reported an event while operating a motor vehicle and 8% (n=2/25) resulted in a motor vehicle collision (MVC) severe enough to require hospitalization. In contrast to those with ES, 25% of patients reported a typical event while driving and 25% (n=2/8) of those resulted in a collision requiring hospitalization. The incidence of habitual events while driving is higher in the NEE population (n=25) when compared to those with ES (n=8).

Conclusion: Although patients with ES have less frequent episodes, they have more severe driving-related injuries. In contrast, patients with NEE have more frequent episodes, but are less likely to be involved in MVCs resulting in severe bodily injury. This study reinforces the need for diligent driving counseling to help prevent driving-related injuries in patients with NEE and ES.

Circadian and Multiday Cycles of Brain Excitability and Cardiac Activity

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Introduction: Chronic brain recordings show that for many people seizure timing is not random, but rather seizure risk is modulated over circadian and multiday cycles. Autonomic cardiac regulation may link long term cycles of brain excitability to rhythms of cardiac activity. Here we use chronic brain and heart recordings to characterize circadian and multiday cycles in interictal epileptiform discharges (IED) and heart rate (HR). We assess for phase locking of seizures relative to these cycles.

Methods: Six patients with drug resistant epilepsy had chronic brain recordings with the NeuroPace RNS® System and heart monitoring with the Empatica E4 wristband. The continuous wavelet transform derived IED and HR cycles from hourly averaged IED counts (clinician-defined RNS detectors) and HR (E4, Blood Volume Pulse). Seizures were identified from RNS iEEG (epileptologist confirmed). Significant cycle periods were defined as peaks in the power spectral density (PSD) of IED and HR cycles above the 95th percentile of the white noise PSD. Circular statistics assessed seizure phase locking to IED and HR cycles.

Results: All subjects had circadian and multiday cycles of IED and HR. Three had correspondence between multiday IED and HR cycle periods. Three subjects had adequate iEEG seizures to assess seizure phase locking to IED and HR cycles. Of these subjects, all had seizure phase locking to circadian IED and HR cycles, and multiday IED cycles. Two of three had seizure phase locking to multiday HR cycles. All findings are significant, $p<0.05$.

Conclusion: Circadian and multiday cycles of IED and HR are common in patients with epilepsy. There was comodulation of IED and HR cycles in half of our subjects. Seizure risk was informed by IED and HR cycles, with seizures occurring at preferred phases of these cycles of brain excitability and cardiac activity. This work advances efforts for seizure risk forecasting and chronotherapy with wearable devices.

Electro-clinical Profile and Management of Patients with Epilepsia Partialis Continua Undergoing Continuous EEG Monitoring

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Introduction: Epilepsia partialis continua (EPC) is rare focal status epilepticus, seen in the setting of different etiologies. There is lack of data on electrographic correlates of EPC and its management in the continuous EEG (cEEG) era. Our study tries to address this knowledge gap.

Methods: After IRB approval, we used our prospectively maintained cEEG database to identify patients between 01/01/2009 to 10/31/2020 who were diagnosed with EPC. We reviewed electronic medical records (EMR) to extract demographical, clinical, neuroimaging information along with data on anti-seizure medication (ASMs) and prognosis of EPC. Descriptive statistical analysis was performed in this study.

Results: We identified 30 patients (56.6% women), with average age of 56 (±17) years. Thirteen (43.3%) had epilepsy history, including 11 with acquired symptomatic epilepsy secondary to ischemic stroke (n = 7), hemorrhage (ICH) (n = 2) and neoplasm (n = 2). The underlying etiology in 17 (56.6%) patients where EPC was an acute symptomatic seizure was ischemic stroke (n = 9), neoplasm (n = 4), and 1 each with ICH, HSV encephalitis, PRES and CJD. EPC was noted in hands (13;43.3%), face (13;43.3%), foot (2; 6.6%), face plus arm, and head (1 each;3.3%). EPC lacked clear ictal EEG correlate in 8 (26.7%) patients. The rest had localizable seizure pattern, including lateralized periodic discharges (LPDs) in 18 (60%) patients. A mean of 3.7 (±1; median 4) ASMs were used. IV anesthetics were used in 11 (36.6%) patients; specifically for EPC control in 8 (26.6%) patients. EPC were controlled in 10 (33.3%) patients before discharge. Two (6.7%) patients died, and rest were discharged on a mean of 2.8 (±1.3; median 3) ASMs.

Conclusion: Ischemic stroke was the most common cause of EPC in our cohort, typically involving hand, and face. A quarter of patients did not have clear EEG correlate and a majority had concomitant LPDs. Despite high ASM burden, EPC could only be controlled in one-third of patients.

Epilepsy Due to Mild TBI in Children Confers a Favorable Outcome

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Introduction: Post-traumatic epilepsy (PTE) is a common cause of morbidity in children after a traumatic brain injury (TBI), and occurs in 10-20% of children following severe TBI.1, 2 Most previous studies on PTE have focused on children with severe TBI. The present study analyzes the therapeutic outcome of children with epilepsy due to mild TBI.

Methods: We retrospectively studied 321 children with TBI at a tertiary pediatric referral center during a 10-year period. Patients were categorized into mild, moderate, or severe TBI based on clinical data. Mild TBI was defined as loss of consciousness (LOC) or amnesia < 30 minutes, moderate TBI as LOC or amnesia between 30 minutes -1 day, and severe TBI as LOC or amnesia > 1 day, subdural hemorrhage, or contusion. Multiple clinical variables collected incldued post-TBI EEGs/prolonged video-EEGs at different time points. Statistical analysis was applied to different data sets.

Results: Forty-seven children were diagnosed with PTE: 8 children (17%) due to mild TBI, 39 children (83%) due to severe TBI (Table 1). No subject met the criteria for moderate TBI. For the 8 children with mild TBI, who all had an accidental trauma (non-inflicted), median follow-up period was 25 months. No relevant previous medical history was present for 6 patients (80%), and two patients' (20%) relevant previous medical histories were unknown (Table 2). Six (75%) of the 8 patients had normal routine EEG(s). Compared to the 39 patients with severe TBI 3, 31 (79%) of whom had abnormal EEGs, mild TBI patients were more likely to have normal EEGs, p=0.005 (table 3). In patients with mild TBI, no patient had both abnormal EEG/VEEG and HCT and no one was on more than one AED, p<0.005 (table 4). Five patients (63%) had a seizure <24 hours post-TBI, while the remaining 3 had seizures after the first week of injury.

Conclusion: Children with epilepsy due to mild TBI, loss of consciousness or amnesia < 30 minutes, are more likely to have normal EEG, and confer a favorable outcome of being on 0-1 AED.

Functional and Pathological Networks for Epilepsy Surgery

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Introduction: Localization of pathological neural activity is a major issue in treatment of epilepsy. Focal and generalized epileptogenic syndromes may involve multiple pathological or even functional networks, which could be identified by a joint procedure including electrocorticographic (ECoG) high gamma activity (HGA) mapping, electrophysiology (cortico-cortical evoked potential or CCEP) and tractography.

Methods: 14 patients with intractable epilepsy underwent subdural grid implantation. Functional areas and pathological foci were localized by ECoG mapping and further electrically stimulated to reveal connected cortex locations in CCEPs. Fiber tracts connecting the CCEP locations were obtained with diffusion-weighted imaging (DWI). Fibers of pathological CCEP networks were disconnected during while CCEPs were monitored under general anesthesia. An example in Figure 1 shows the entry point for operation in blue (corpus callosum) (A) and the CCEPs on the left hemisphere (frontal lobe F) while stimulating a focus on the right hemisphere (B). Then, when the corpus callosotomy approaches the splenium (C) the CCEPs diminished after resection (D).

Results: The CCEPs showed an early N1 (<40ms) and a late N2 (<150ms) component. Early components in pathological CCEPs appeared in 8/14 patients and varied between 25 and 35ms. They diminished after disconnection of the fibers in 7/8 patients. Surgical outcome in 13/14 patients with or without CCEPs who underwent network surgery was Engel score I. In one case, whose pathological CCEPs remained after resection, showed poorer outcome.

Conclusion: Epilepsy surgery extended by combined ECoG and CCEP is a new method to visualize pathological networks and hence, improve epilepsy treatment. The disappearance of early CCEP components indicates a good surgical outcome.

Response to Vigabatrin as First-line Treatment for Epileptic Spasms, Not Due to Tuberous Sclerosis Complex

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Introduction: Epileptic spasms (ES) is an age specific seizure type that occurs usually between (b/w) 3 to 8 months of age, associated with stasis or regression of developmental milestones. There are many causes of ES. Standard FDA approved therapies are adrenocorticotropic hormone (ACTH), oral corticosteroids (OCS), and vigabatrin (VGB). Literatures comparing ACTH, OCS, and VGB make different conclusions regarding best initial therapy and preferred dose. Studies report low VGB response rate for treatment (tx) of ES (not due to tuberous sclerosis complex (TSC)), ranging from 27% to 39.4%. 1,2,3,5 This retrospective study assessed the efficacy of VGB as first-line tx for ES (not due to TSC) at a tertiary referral center.

Methods: We performed a single-center, retrospective analysis of newly diagnosed cases of ES b/w Jan 2014 and June 2020. All patients underwent a comprehensive evaluation. All patients were followed by a child neurologist or an epileptologist. Duration of follow-up was up to 1 year. Various clinical variables were collected. Monitoring of vision was conducted by a pediatric ophthalmologist. Resolution of ES with or without hypsarrhythmia was defined as sustained absence for 3 months after tx initiation. Children were considered early responders or late responders.

Results: Thirty-one patients were treated with VGB. Sixteen (52%) of the infants were early or late responders. All remained in remission at 12 months. Of the responders, 87.5% demonstrated no worsening of development per neurologist's serial assessments. All 31 infants experienced no VF deficits related to VGB. Three out of seven patients who are currently taking VGB had cortical vision impairment (CVI) but showed no signs of retinal toxicity. Amongst the patients who responded to VGB, 90% of the patients responded at a dose of 150-160mg/kg/day. The non-responder and relapse groups consisted of 48%.

Conclusion: VGB appears to be as effective as ACTH as first-line therapy for ES across various etiologies (other than TSC).

Responsive Neuro Stimulation (RNS) in Treatment of Pediatric Epilepsy

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Introduction: The RNS is a neuromodulation therapy for epilepsy with demonstrated efficacy in adult patients. However, there is a relative lack of literature describing the effectiveness of RNS in pediatric patients with intractable epilepsy. Here, we present long-term outcomes of a series of pediatric patients with medically refractory epilepsy treated with the RNS system in a comprehensive epilepsy center.

Methods: We performed a retrospective chart review of all patients who had RNS device implanted at Texas Children's Hospital between July 2016 and November 2020 and had at least one year of follow-up (N = 15). We assessed seizure frequency changes based on the caregiver's report at the last follow-up visit relative to the pre-implantation baseline.

Results: The mean age at RNS implantation was 16 years (range 9-20), with a mean duration of epilepsy of 11 years (range 5-21) at the time of implantation. Nine of 15 patients (60%) had undergone prior epilepsy surgery. RNS leads were placed in the frontal (50%), temporal (40%), and parietal regions (10%). At the last follow-up visit, three patients (20%) were seizure-free, nine patients (60%) had greater than 50% reduction in seizure frequency, two patients (13%) had less than 50% reduction in seizure frequency, and one patient (7%) had increased frequency of seizures compared to their baseline seizure burden.

Conclusion: RNS is a promising neuromodulation technology in treating children with medically refractory epilepsy, with a significant proportion of patients achieving seizure freedom. Further studies with larger cohorts are needed to evaluate factors contributing to better outcomes in pediatric patients receiving treatment with RNS.

Severity of Peri-ictal Respiratory Dysfunction with Epilepsy Duration and Patient Age at Epilepsy Onset

Kiran Kanth, MD; Katherine Park, MD; Masud Seyal, MD

Introduction: Respiratory dysfunction preceding death is fundamental in sudden unexpected death in epilepsy (SUDEP) pathophysiology. Hypoxia occurs with one-third of seizures. We investigated the possibility that the duration of epilepsy, or age at epilepsy onset, may impact the severity of seizure-associated respiratory dysfunction.

Methods: Patients with focal epilepsy undergoing video-EEG telemetry in the Epilepsy Monitoring Unit (EMU) were studied with synchronized recordings of nasal airflow, abdominal excursions, and digital pulse oximetry. Focal seizures with and without progression to bilateral tonic-clonic seizures and seizure duration were analyzed. Apnea was defined as cessation of nasal airflow or respiratory abdominal excursion signal for five seconds or longer. Oxygen desaturation nadir and duration of oxygen desaturation less than 90% were evaluated. Linear regression analysis was used to determine a relationship between age at epilepsy onset, duration of epilepsy, or age at EMU admission and the various measures of peri-ictal respiratory dysfunction.

Results: Data from 73 patients (37 female) showed a significant relationship ($p=0.012$) between age at epilepsy onset and duration of peri-ictal oxygen desaturation for focal seizures that did not progress to bilateral tonic-clonic seizures, with greater duration of peri-ictal oxygen desaturation in patients with older age at epilepsy onset. Seizure duration and various measures of peri-cital respiratory dysfunction were not associated with duration of epilepsy, age on EMU admission or age at epilepsy onset.

Conclusion: In animal models, recurrent hypoxic episodes induce long-term facilitation (LTF) of ventilatory function, however, LTF is less robust in older animals. Our findings suggest an intriguing possibility that LTF of ventilation may be protective when epilepsy starts at a younger age.

Stereo-EEG Localization of Midline Onset Seizures on Scalp EEG

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Introduction: The precise localization of midline onset seizures has not been well described using stereo-EEG (sEEG). This study described sEEG seizure localization, semiology, management and outcome of midline onset seizures on scalp EEG.

Methods: EEG reports from patients who underwent sEEG were reviewed to identify patients who had seizures onset involving midline electrodes (FZ, CZ, PZ, OZ). Charts were reviewed to determine clinical factors, seizure semiology graded into lobar segmentation, imaging and electrographic findings, sEEG plan, interventions, and outcome.

Results: Fourteen patients were identified (10 males, mean age of sEEG 27 years) out of 102 cases of undergoing sEEG from January 2015-September 2019. MRI was lesional in 10. Localization of seizure onset by sEEG was diverse: 6 frontal, 3 multifocal/diffuse, 2 insular, 2 cingulate, 1 mesial temporal. Seizure semiology categorized by lobar segmentation was concordant with sEEG localization in 6. Four underwent resective surgery: 2 frontal corticectomy, 1 frontal plus anterior insular corticectomy, and 1 anterior temporal lobectomy. Of the remaining, 9 underwent another procedure: 2 chronic subthreshold cortical stimulation, 2 deep brain stimulation (DBS), 1 responsive neurostimulation, 1 vagus nerve stimulator (VNS), 1 laser ablation, 1 posterior disconnection, and 1 corpus callosotomy (CC). Engel surgical outcome of I or II was obtained in 2 patients who underwent resections. VNS, DBS, CC, and laser ablation produced a favorable outcome in one patient. No clinical, presurgical, or surgical factors correlated with good outcome.

Conclusion: Localization of scalp midline onset seizures by sEEG shows diverse locations. Seizure semiology was similarly diverse and often discordant with sEEG onset, highlighting the complexity of epileptogenic networks. Despite this, a good outcome was achieved in half.

The Evolution of Epilepsy Surgery over Three Decades: A Comprehensive Retrospective Review of a Quaternary Pediatric Epilepsy Surgical Program

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Introduction: To analyze the trends in patient selection and surgical technique, the authors report a comprehensive overview of a high-volume quaternary epilepsy surgery program at Nicklaus (Miami) Children's Hospital.

Methods: Consecutive records of surgical epilepsy cases were retrospectively reviewed over a 30-year period, and divided into early (1989-2003) and late (2004-2018) eras. Patient demographic, clinical, radiographic and surgical information, in addition to 2-year outcomes, were collected and statistically analyzed.

Results: A total of 1127 independent records were included in the final analysis. They consisted of 55% males and included 453 and 674 cases in the early and late eras, respectively. The age of seizure onset was 3.0 and 4.5 years in the early and late eras ($p=0.027$), while the age at surgery was 8.7 and 10.3 years in the early and late eras ($p<0.0001$), respectively. On MRI, the majority of cases were lesional (63.0 %), followed by non-lesional (20%), broad malformation (8.4%) and cerebral insult (8%). The use of advanced imaging techniques, including functional MRI, PET and SPECT, has increased over the years. The late era witnessed fewer hemispherectomies ($p=0.004$) and fewer multi-lobar resections ($p<0.001$). Additionally, there has been a gradual reduction of two-stage implantation cases ($p<0.001$) and use of cortical stimulation mapping ($p<0.001$), likely due to the evolution of pre-operative functional MRI, DTI, and TMS use. The volume of palliative surgical procedures as a conglomerate of corpus callosotomy and neuromodulation, were stable over the years ($p=0.66$). Two-year seizure freedom was captured in 912 patients and remained stable at 54% over the eras ($p=0.60$).

Conclusion: The surgical volume has increased over the years, with an evolution towards extra-temporal cases and tailored more limited resections.

Epilepsy: Pathophysiology

Cardio-ventricular Repolarization Variability in Temporal Lobe Epilepsy

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Introduction: Chronic focal epilepsy may cause cardiac electrical instability in the absence of underlying heart disease (Surges et al., Epilepsia, 2010). T wave alternans (TWA), a beat to beat fluctuation in the T waveform of EKG, is considered an indicator of autonomic control on cardioventricular function (Libbus et al, 2016) and predictive marker of heightened cardiac risk when TWA is greater than 47 μV (Pang et al, Neurology 2019, 2011). TWA values in this range have been observed post-ictally following secondary generalized seizures (Strzelczyk et al, 2011). However, the effects of purely partial seizures, and the relation between seizure-related, and spontaneous, behavior of TWA has not been fully characterized. Here we studied partial seizures in a patient group with a diagnosis of temporal lobe epilepsy (TLE) within an Epilepsy Monitoring Unit (EMU) environment to characterize spontaneous and seizure related fluctuations in TWA.

Methods: EKG data were analyzed from six patients with TLE. Epochs of 3-minute duration separated by eight hours were selected from the multi-day EMU stay, in addition to 3-minute segments immediately before and after any seizures, 30 minutes before and after any seizures, and for entirety of all seizures regardless of their duration. TWA was calculated in successive segments with the modified moving average (MMA) method (Nearing & Verrier, 2002).

Results: High values of TWA are seen in the postictal period in two of the right-hemispheric patients and in all three left hemispheric patients (green arrows), in addition to several spontaneous (during baseline conditions of wakefulness and sleep) excursions to high values in all patients (red arrows), some greater than 47 μV.

Conclusion: Short-lived increases in TWA can be seen following partial seizures in temporal lobe epilepsy. Spontaneous, seizure-independent, increases in TWA also occur in patients with both right and left-sided TLE.

Circadian and Multiday Cycles of Seizure Risk in Canine Epilepsy

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Introduction: Chronic brain recordings in humans, dogs and mice have shown that for many people and animals with epilepsy, seizures risk is modulated over circadian and multiday cycles. To date, the periodic timing of seizures in dogs has not been evaluated relative to cycles of brain excitability, as measured by interictal epileptiform discharges (IED). Here we used chronic brain recordings to evaluate circadian and multiday IED cycles and assess for phase locking of seizures to these cycles.

Methods: Seven dogs with naturally occurring epilepsy had chronic full bandwidth iEEG with the investigational Medtronic Summit RC+S™ device or NeuroVista Seizure Advisory System. IED and seizures were identified using validated spike and seizure classifiers, with epileptologist review. The continuous wavelet transform was used to assess for daily and multiday IED cycles. Significant cycle periods were defined as peaks in the power spectral density (PSD) of IED cycles above the 95th percentile of white noise PSD. Circular statistics (Rayleigh and Omnibus tests) assessed seizure phase locking to IED cycles. Statistical significance was evaluated at level 0.05.

Results: All dogs had circadian and multiday cycles of IED. Four dogs had seizure phase locking to circadian IED cycles. Four dogs had around weekly IED cycles, with associated seizure phase locking. Five dogs had 14- to 20-day IED cycle periods, all with associated seizure phase locking. For multiday cycles, there was a group level seizure phase preference for the rising phase of IED cycles. There was no group level seizure phase preference for circadian IED cycles.

Conclusion: Seizure risk is influenced by circadian and multiday cycles of brain excitability in naturally occurring canine epilepsy. Canine epilepsy shares many features with human epilepsy, including cycles of seizure risk. Dogs with epilepsy may provide a model platform for the development of seizure risk forecasting and chronotherapy.

Monitoring of Chemical Labyrinthectomy in Ménierè Disease with Vestibular Evoked Myogenic Potentials

Esmeralda Rocío-Martín; Laura López-Viñas; Rybel Wix; Jesús Pastor

Introduction: Ménierè's disease (MD) is characterized by fluctuating hearing loss, tinnitus and vertigo. Some patients may develop disabling vertigo attacks, refractory to medical treatment. Intratympanic gentamicin (IG) produces a chemical labyrinthectomy, being an effective alternative to surgery. However, this therapy could cause hearing loss. The vestibular evoked myogenic potentials (VEMPs) provide information about the vestibular function and can be used to control IG therapy. This study aims to examine the usefulness of VEMPs for IG treatment.

Case Report/Case History: We studied a 56-year-old male with Meniere's disease in the left ear. The patient had disabling vertigo attacks refractory to medical treatment and intratympanic corticosteroids, within the first ten years of progress of this disease. By that, IG was administered in 2017, and we performed VEMPs before and after this therapy. We used the following stimulation parameters: 500 Hz tone burst at 105 dB nHL and 5 Hz rate, with 200 averaging responses. We set bandpass filters between 20 Hz-2 kHz. We studied latency n10 (oVEMP), p23 (cVEMP) and amplitude (A). VEMPs results in right ear (RE) and left ear (LE) was: VEMP (2012): cVEMP RE/LE [p13 (14.25/15.80 ms), A (80/80 µV)].Normal values. VEMP (2016): oVEMP RE/LE [n10 (9.05/10.75ms), A (2.06/1.05 µV)]; cVEMP RE/LE [p13 (14.6/15.80 ms); A (230/100µV)]. Left ear showed lower amplitude than right ear. VEMP (2018): oVEMP RE/LE [n10 (9.6/0 ms); A (4.1/0µV)]; cVEMP RE/LE [p13 (15.50/0ms); A (298/0µV)]. Absent of left responses demonstrate the effectiveness of IG therapy.

Conclusion: VEMPs have demonstrated their usefulness in MD, in their early stages to diagnosis and determining the efficacy of IG treatment as it allows us to assess whether complete ablation has been achieved to stop the treatment and avoid the hearing loss.

Visual Evoked Potentials for Early Diagnosis of Dysthyroid Optic Neuropathy

Esmeralda Rocío-Martín; Laura López-Viñas; Rybel Wix; Jesús Pastor

Introduction: Dysthyroid optic neuropathy (DON) is a severe manifestation of Grave's disease that can result in irreversible visual loss. Visual evoked potentials (VEP) provide information about the function of the optic nerve and can be useful in this disorder.

Case Report/Case History: A 42-year-old female was diagnosed with Grave´s disease when she was at 40 years old. She presented with an 11-month history of visual loss. Her physical examination showed reduced visual acuity, conjunctival hyperaemia and photophobia, so she was treated with 1gr/d methylprednisolone for five days, without improvement. Orbit CT scan did not show compression or elongation of the optic nerve, so we performed the VEP on April 2020. We used the Queen Square System placement and Full-field (FF) and Hemifields (HFs) monocular pattern stimulation. We set the bandpass filter at 1-100 Hz, and we recorded two responses (100-200 stimuli per response). We examined latency (N75, P100, N145) and amplitude (A) for both eyes (RE and LE). The results were: RE 25", FF: N75(90.8ms), P100(127ms), N145(161ms), A(11µV). RE 60", FF: N75(93.7ms), P100(130ms), N145(169ms), A(5.31µV). Both HFs showed increased latency without asymmetry. LE 25", FF: N75(76.8ms), P100(106ms), 145(143ms), A(15.9µV); LE60", FF: N75(79.7ms), P100 (107ms), N145(144 ms) A (15µV). Both HFs showed normal values without asymmetry. This data was compatible with right optic neuropathy, so surgeons decompressed the nerve. The patient showed an improvement of the visual acuity. After seven months, we assessed the patient with a new VEP to see her progression, and it showed normal values. RE 25", FF: N75(79.8ms), P100(106ms), N145(142ms), A(16.4µV). LE 25", FF: N75(78.8ms); P100(105ms); N145(145ms), A(16.4µV).

Conclusion: Our data shows the great usefulness of VEP in early diagnosis of dysthyroid optic neuropathy in this case, without optic nerve injury seen in Orbit CT scan.

Diagnostic Value of Vestibular Evoked Myogenic Potentials in Benign Paroxysmal Positional Vertigo

Laura López-Viñas; Esmeralda Rocío-Martín; Rybel Wix

Introduction: Vestibular evoked myogenic potentials (VEMPs) are useful to study the disturbances along with the transmission of information from otolithic organs. Benign paroxysmal positional vertigo (BPPV) characterizes by vertigos associated with cephalic movements, and VEMPs could be useful to detect this disturbance.

Methods: We recruited 36 patients, 18 of them had clinical criteria suggesting BPPV and another 18 patients had not any vestibular disturbance. Related to the applied stimulus, we used headphones with stimulus type 'burst' at a frequency of 500Hz (100dB NHL) and duration from 6 to 8 ms and a stimulus frequency of 5Hz. The pass filters were 20Hz-2kHz. We studied latency, amplitude and asymmetry ratio (AR) of cVEMPs (cervical VEMPs) and oVEMPs (ocular VEMPs).

Results: We could remark a pathological value of AR in patients affected with BPPV, reaching 22% (4 cases) in cVEMPs and 38% (7 cases) in oVEMPs. In the control group, we could not observe any pathological finding in the amplitude. Also, we point out an absence of response, being 11% (2 patients) in cVEMPs and 50% (9 patients) in oVEMPs in the cases group. In the control group, we observe the presence of all the recordings. Also, we note a difference in the mean latency of P13 response in the right ear (in case group: 16,31 ms; in the control group: 15,68 ms), but these differences were not statistically significant (p=0,416). In the remaining latencies, we do not observe differences between both groups.

Conclusion: The value of VEMP in the BPPV demonstrates the implication of the vestibular damage, mainly utricle damage. By this, it should not only perform the cVEMP in the daily routine, but also we should make oVEMP, allowing a better sensibility in the detection of these abnormalities.

Vestibular Evoked Myogenic Potentials in the Diagnosis of Vestibular Migraine

Esmeralda Rocío-Martín; Laura López-Viñas; Rybel Wix; Jesús Pastor

Introduction: Vestibular migraine (VM) is a disorder characterized by vestibular symptomatology and migraine and is one of the common causes of episodic vertigo and dizziness, although usually is underdiagnosed. The vestibular evoked myogenic potentials (VEMPs) provide information regarding the vestibular function and can be useful for diagnosis of VM. The study aims to examine VEMPs characteristics in patients with VM.

Methods: We included 15 patients diagnosed as VM (2 males, 13 females) and 14 patients as the control group (6 males,8 females), between 2015 and 2019. VEMPs were recorded from the ipsilateral sternocleidomastoid muscle (cervical, cVEMP) and periocular sites (ocular, oVEMP). We averaged 200 pulses at 500 Hz tone burst, 105 dB nHL intensity and 5 Hz rate. Bandwidth was set at 20 Hz-2 kHz, and the notch was on. Statistical analysis included paired Student t-test or Mann-Whitney U test using Sigmat Stat 3.5. We compared latencies n10 (oVEMP), and p23 (cVEMP), amplitude (A) and amplitude asymmetry ratio (AR) for VM and control group (CG). Data are shown as mean±SE.

Results: The mean age for VM was 50.9±3.2 and CG was 50.4±3.9 years. 13 patients showed low amplitude or no response (6 patients had oVEMP, 2 patients cVEMP and 5 patients [oVEMP+cVEMP] affected), 1 patient showed n10 increase latency and only 1 patient had normal values. Comparing both groups (VM/CG), we observed significant differences in oVEMP-A (2.3+0.4/5.2+0.4µV, $p = 0.001$) and oVEMP-AR ($40.3 \pm 11.7/7.2 \pm 1.5$, $p = 0.008$). No statistically significant differences were obtained in the remaining parameters (VM/CG): n10 (12.8±0.7/10.3±0.1ms); p13 (13.6±0.5/14.6±0.2ms); cVEMP-A (82.8+17.1/85.5+11.2µV); cVEMP-AR ($35.3 \pm 11.7/7.3 \pm 2$).

Conclusion: Our data suggest that in patients with VM, VEMPs are frequently affected and especially oVEMP (low amplitude or AR increased). This test had proven to be useful for diagnosis of VM.

Do Epilepsy Patients Have More Alzheimer's Disease-like FDG-PET Scans?

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Introduction: Both epilepsy and Alzheimer's Disease (AD) present with changes on cerebral fluorodeoxyglucose (FDG) PET imaging, and subclinical seizures with minimal surface EEG correlate may be common in AD. Prior work has examined AD classification and prediction using machine learning algorithms based on FDG-PET. This project explores whether epilepsy patients have similar PET findings as AD patients.

Methods: Chart review of epilepsy clinic patients with PET. Scans were preprocessed with SPM12 and evaluated by machine learning-based AD designation (MAD) algorithm using Support Vector Machines (Iterative Single Data Algorithm). MAD produces labels designating AD (MAD-positive) vs. non-AD (MAD-negative). Previous study suggests high sensitivity (0.84) and specificity (0.95) in classifying AD patients vs. healthy individuals (Katako et al., 2018; PMID: 30185806). When used for prediction of AD development from mild cognitive impairment, sensitivity was 0.875 and specificity was 0.6.

Results: 52 patients had PET. Mean age was 37.2 years (18-70) with 54% male. Most patients had focal epilepsy (37% temporal, 15% frontal, 11% parietal or occipital). Of 22 patients with neuropsychological testing, 16 had findings suggestive of cognitive deficits associated with epilepsy compared to premorbid state. PET in 5/16 patients was classified as MAD-positive. For the remaining 6 patients, all were classified as MAD-negative.

Conclusion: MAD designations on PET from epilepsy clinic patients seem to correlate with neuropsychological test results, with most patients having temporal lobe epilepsy. Future directions include adjusting for relatively young cohort age, analyzing cognitive subdomains (verbal, executive, memory), serial follow-up, and establishing better cutoffs for correlation of MAD designation with cognitive changes. This work promises to one day find a biomarker for AD-like pathology in epilepsy patients.

Adjuncting Linked Quadri-polar (LQP) and Preconditioning Stimulation Technique to Improve TCeMEPs During Spinal Tumor Resection. a Case Report

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Introduction: Double-train stimulation has been used in patients when conventional TES had not provided consistent responses. We have added a second facilitation technique, LQP stimulation, to improve the likelihood of obtaining robust MEP responses.

Case Report/Case History: A 61-year-old male presented with progressive sensory ataxia and lower limb weakness. Imaging findings showed an extramedullary intradural lesion (meningioma) with significant cord compression at the T4 level. The patient was admitted to undergo surgery under total intravenous anesthesia with no muscle relaxation. Multimodality IONM protocol included SSEP, MEP, S-EMG, TOF, and EEG. Single-Train (ST) and Double-Train (DT) MEP stimulation parameters were attempted with both bipolar (C1/C2 and M3/M4 derivations) and LQP (linked-C1/M3 plus C2/M4 derivations) TES stimulation. LQP-DT stimulation provided the most robust MEP responses. SSEPs were obtainable only in the upper limbs. Evidence pointed out after exposing the lesion to be an intramedullary intradural hypervascular tumor, with numerous supplying vessels, no dural attachment, exerting a significant mass effect. There was no available epidural recording electrode; thus, frequent MEPs eliciting was paramount. During resection, MEPs in the right lower limb had progressively decreased. Upon inspection, it was secondary to limb compression. MEP was resolved with prompt recovery after rearranging the pressure point pads at the right inguinal area. Almost total tumor resection was achieved. IONM remained stable through the end of the procedure. Post extubation neurological examination did not show any added neurological deficit.

Conclusion: Improving reliability in MEP responses while minimizing patient movement is one of the utmost IONM goals during spine surgery. The add-on of both facilitation techniques seems to be supportive in attaining this purpose.

Medullar Infarct During a Foramen Magnum Meningioma Resection

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Introduction: Surgery of meningioma located at the foramen magnum (FM) is associated with high postoperative morbidity mostly related to cranial nerve deficits. Although unusual, vascular complications are possible due to their close anatomical relation with the vertebral artery, which can be encapsulated by the tumor.

Case Report/Case History: A 75 y.o. man presented with progressive weakness of lower extremities. MRI showed a mass, compatible with meningioma, sitting at the left lateral aspect of the foramen magnum, surrounding the left vertebral artery and compressing the adjacent medulla and spinal cord. Surgery with intraoperative monitoring was consented. The posterior fossa was exposed by a cervico-occipital craniectomy. During the excision of the main part of the tumor, no changes on somatosensory or motor evoked potentials (SEP and MEP respectively) and corticobulbar MEP for lower cranial nerves, were observed. When mobilizing the deeper portion of the tumor away from the brainstem, a decrement limited to the MEP of the right upper extremity (RUE) was warned to the surgeon. Surgery was halted, resulting in RUE-MEP recovery to baselines. Resection proceed and again a selective and progressive increment of the threshold for eliciting RUE-MEP occurred until RUE-MEP was completely lost. MEP of right lower extremity and contralateral upper and lower extremities MEP were unchanged. Post-operatively the patient presented with plegia of the RUE with no other deficit. An MRI showed an acute infarct selectively located in the left ventral medulla and cerebellar tonsil, area irrigated by perforant branches of the anterior spinal and vertebral arteries and topographically correlated with the corticospinal tract.

Conclusion: We present the intraoperative monitoring events observed in a patient who developed an infarct in the left ventral medulla causing a selective lost of RUE-MEP, in order to highlight this unusual but devastating intraoperative complication.

Optimizing TCeMEP Stimulation for Intraoperative Neurophysiological Monitoring (IONM) in Pediatric Patients. a Case Report

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Introduction: In the pediatric population, owing to the immaturity of their CNS, higher levels of stimuli and longer stimulating-pulse-train might be required to elicit MEP responses. Priming techniques have been used in cases where single-train failed to produce responses. We are appending linked-quadripolar (LQP) stimulation to broader the chances of obtaining effective responses.

Case Report/Case History: A 5-year-old male patient was admitted for posterior spine scoliosis correction and resection of two hemivertebrae. Total intravenous anesthesia with no muscle relaxation was used during surgery. Multimodality IONM protocol included SSEP, MEP, S-EMG, TOF, and EEG. Single-Train (ST) and Double-Train (DT) MEP stimulation parameters had bipolar (C1/C2 and M3/M4 derivations) and quadripolar stimulation (linked-C1/M3 plus C2/M4 derivations). LQP-DT stimulation produced the best MEP responses. Immediately after the incision, there was a significant decrease in the patient's MEP in bilateral lower limbs. This event was due to propofol infusion increasing from 150 to 300mcg/kg/min. MEPs improved after decreasing the propofol to 150 mcg/kg/min. During the resection of T7 hemivertebrae, MEPs were lost bilaterally in leg and foot muscles. Mean-arterial-pressure (MAP) was at 48mmHg. The surgeon and anesthesiologist were immediately alerted with the immediate recovery of MEPs following the increase of MAP to 75mmHg. Through the correction procedure, there was again a drop in lower limb MEPs. MEP recovered after performing Time-Irrigation. The patient woke up with no neurological deficit. There were no significant changes in the patient's SSEPs during the surgery.

Conclusion: Achieving reliable MEP is paramount in pediatric patients in surgeries where IONM is required. We believe the adjunct of these two facilitation techniques might be applicable when obtaining MEP would be contrarily small or absent.

Protecting the Visual Pathways During Optic Nerve Surgery Using Intraoperative Visual Evoked Potentials (VEP)

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Introduction: This case report illustrates the benefit of utilizing Intraoperative Neurophysiological Monitoring (IONM) during the resection of an optic nerve lesion. A multimodality IONM utilized Electroretinogram (ERG), Visual Evoked Potentials (VEP), and Electroencephalography (EEG).

Case Report/Case History: A 47-year-old female presented with left intracranial meningioma and decreased vision in the right eye. An MRI showed a tumor attached to the left optic nerve and posteriorly displacing the optic nerve and chiasm to the right. After induction and patient positioning, LED goggles were placed and secured on both eyes for performing VEP. The VEP responses were absent at baseline due to the inhalational agent. After switching to Total Intravenous Anesthesia (TIVA), ERG responses were recorded bilaterally. Baseline ERG, VEP, and EEG recordings were obtained with good left VEP and absent right VEP responses. During tumor resection, there was a sudden decrease in left VEP responses. Retractors were immediately removed, responses came back to baseline within a few minutes. The tumor was resected without any loss of vision intraoperatively. The patient noticed an improvement in her right eye four days postoperatively. One month postoperatively, she continued to feel improvement

Conclusion: In this patient, IONM utilizing ERG and VEP helped prevent any further loss of vision and directed the surgeon intra-operatively. VEP can be abnormal in brain injuries, optic neuritis and neuropathy, tumors compressing the optic nerve, retrobulbar neuritis surgery. Postoperative visual loss is a devastating complication of brain surgery. During surgeries that put the visual pathway at risk of injury, continuous monitoring of the visual function is desirable. However, the intraoperative monitoring of the visual evoked potential (VEP) is not yet widely used.

Application of Machine Learning to Intraoperative Electroencephalographic Monitoring to Detect Ischemia in Carotid Endarterectomy Procedures

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Introduction: Intraoperative electroencephalographic (EEG) monitoring is increasingly used during carotid endarterectomy (CEA) procedures to detect cerebral ischemia and stroke. We investigated if application of machine learning to EEG can accurately detect intraoperative ischemia.

Methods: A multi-hospital database of 206 CEA procedures that were monitored with 8-channel EEG was used for machine learning to detect ischemia during the first 10 minutes after clamping of the internal carotid artery when the risk of ischemia is high. The EEG recordings were reviewed by a neurophysiologist trained in intraoperative monitoring who annotated the time periods in each recording that were indicative of ischemia. Three machine learning methods – logistic regression (LR), naïve Bayes (NB), and support vector machines (SVM) – were evaluated using 10-fold stratified cross-validation. Diagnostic performance was measured using area under the receiver operating characteristic curve (AUROC), sensitivity and specificity.

Results: During the 2,060 minutes of post-clamp EEG recordings in 206 CEA procedures, ischemia was observed for 78 minutes in 33 procedures (i.e., ischemia occurred 3.8% of the time in the first 10 minutes post-clamp). The AUROC values were 0.96 (CI 0.91, 0.98) for LR, 0.91 (CI 0.78, 0.98) for NB and 0.94 (CI 0.88, 0.98) for SVM. The sensitivities were 0.44 (CI 0.22, 0.68) for LR, 0.49 (CI 0.24, 0.72) for NB and 0.53 (CI 0.17, 0.89) for SVM. The specificities were 0.99 (CI 0.98, 0.99) for LR, 0.99 (CI 0.98, 0.99) for NB and 0.98 (CI 0.96, 0.99) for SVM. The three machine learning methods performed equally well with high AUROC values and specificities but lower sensitivities.

Conclusion: During CEA procedures, machine learning has the potential to detect intraoperative ischemia with EEG monitoring with high specificity. Further research is needed to improve sensitivity.

Cost Comparison of IntraOperative Neuromonitoring Performed by a Neurophysiology Team vs an Automated System in an L5-S1 Posterior Decompression and Fusion

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Introduction: Intraoperative Neurophysiological Monitoring (IONM) of high risk spine surgeries utilizes a standard set of techniques to help prevent injury. Today, there are multiple FDA-approved automated neuromonitoring systems for use in minimally invasive spine surgeries. These automated platforms commonly use electromyography (EMG) and/or somatosensory evoked potentials (SSEP). In this study, we compare the cost of using an in-house IONM team to that of an automated system for an L5-S1 posterior decompression and fusion.

Methods: We summated the cost of medical supplies, amortized equipment value, technologist's hourly cost, and professional fees through standardized methods for an L5-S1 posterior decompression and fusion. IONM included EMG and motor evoked potentials (MEP) of bilateral distal upper and lower extremities, and anal sphincter muscles with a set up and recording time of 4 hours. Physician cost was calculated based on 2019 Relative Value Units (RVU) released by Medicare Physician Fee Schedule from acquisition of baselines to discontinuation of neuromonitoring (3 hours). We then compared the final hospital remittance for use of the automated system selected by the surgeon (SafeOp by Alphatec) for monitoring of bilateral upper and lower extremity SSEPs and EMG which didn't include a certified technologist or supervising neurophysiologist.

Results: The comprehensive cost of IONM services provided by our IONM team was 65.5% lower than that of the automated neuromonitoring system based on our institution's calculations.

Conclusion: There are many variables in calculating costs, even when using the most conservative methods, our analysis shows that our IONM team, including certified technologist and Board-Certified neurophysiologist was almost 2/3 lower than using the automated system, which provides only hardware and no IONM expertise.

Electrophysiologic Isolation of Ulnar Nerve Fascicles Innervating Flexor Carpi Ulnaris in Oberlin Nerve Transfer Surgery

Felix Chang, MD; Scheherazade Le, MD; Leslie Lee, MD; Sungho Cho, MD; Viet Nguyen, MD; Thomas J. Wilson, MD; Jaime Lopez, MD

Introduction: Oberlin nerve transfer, which utilizes an ulnar nerve fascicle as the donor nerve and the biceps branch of the musculocutaneous nerve as the recipient, is commonly used to restore elbow flexion following upper brachial plexus injury. Selectively transferring a fascicle that only innervates flexor carpi ulnaris (FCU) may be beneficial for risk reduction, as partial loss of FCU function is functionally less significant than loss of ulnar-innervated hand intrinsic function. We describe the use of intraoperative neurophysiology to isolate fascicles only innervating the FCU.

Methods: Between 2018 and 2020, 10 cases of Oberlin nerve transfer were reviewed. Individual nerve fascicles were pulled away from surrounding ulnar fascicles and stimulated with a monopolar or tripolar hook stimulator. Intensity ranged from 0.04-0.50 mA, pulse duration (PD) from 100-250 μs, and frequency from 2.1-5.1 Hz. Compound muscle action potentials (CMAPs) were recorded from the FCU, abductor digiti minimi (ADM), first dorsal interosseus (FDI), and adductor pollicis (AP) muscles. CMAPs from stimulation in all recorded muscles were confirmed at other sites. Fascicles where FCU was isolated or that had minimal CMAPs from the ADM, FDI, and AP were selected for transfer by the surgeon.

Results: Patients (9 male and 1 female) ranged from 8 months to 79 years of age. All patients had at least upper trunk brachial plexus injuries. 90% of injuries were due to trauma. In 5 cases FCU CMAPs were isolated after single fascicle stimulation. Difference in PD ($p=0.15$) and frequency of stimulation ($p=0.18$) between cases with and without isolation was not significant.

Conclusion: With low stimulation intensities, it is possible to isolate ulnar nerve fascicles that only innervate FCU. This technique may help minimize risk associated with Oberlin nerve transfer, while maximizing the potential for functional recovery.

Intraoperative Lateral Rectus Electromyographic Recordings Optimized by Deep Intraorbital Needle Electrodes

Tatsuya Oishi; Matthew Hoffman, MD

Introduction: Electromyographic (EMG) monitoring from trigeminal or facial nerve-innervated muscles during skull base tumor resection surgeries is technically straightforward, while monitoring from extraocular muscles is comparatively challenging. To meet this demand, various EMG monitoring techniques for extraocular muscles have been pursued, most commonly via 10-13 mm subdermal needle electrode placed near their tendinous insertions. In this small intraoperative case series, we demonstrate the advantages and safety of longer insulated needle electrodes while recording lateral rectus EMG activity.

Methods: Insulated 25 mm and uninsulated 13 mm monopolar needle electrodes, aimed at lateral rectus muscle belly, were placed in parallel during skull base surgeries. Spontaneous and stimulation-induced lateral rectus EMG activities were examined. Postoperative complications were reviewed, together with additional patients who had at least one long needle in the lateral rectus.

Results: In 16 stimulation-induced recordings from 4 patients, the 25 mm electrodes resulted in 6- to 26-fold greater amplitude EMG waveforms than the 13 mm electrodes (range 248-2106 μV vs. 25-135 μV, $p<0.01$). Meanwhile, the 13 mm electrodes detected greater unwanted volume conduction upon facial nerve stimulation (range 47-401μV vs. 23-221 μV with 25 mm electrode; $p<0.01$), while also exceeding the EMG amplitude obtained from abducens nerve stimulation. No reported clinical or radiographic complications occurred in 17 patients following long needle placement.

Conclusion: By placing an insulated 25 mm needle electrode in the lateral rectus, robust and reliable EMG monitoring can be achieved with excellent discrimination between abducens and facial nerve stimulations. This technique overcomes major limitations of 10-13 mm needles, without any noted complications from needle placement.

Intraoperative Triggered Electromyography Recordings from the External Urethral Sphincter Muscles During Spine Surgeries

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Introduction: Bowel and bladder function are at risk during tumor resection and other surgeries of the conus, cauda equina, and nerve roots. This study demonstrates the ability to acquire triggered Electromyography (tEMG) from the external urethral sphincter (EUS) muscles by utilizing a urethral catheter with an electrode attached.

Methods: A retrospective analysis of neurophysiological monitoring data from two medical centers was performed. Seven intradural tumors and three tethered cord release surgeries were analyzed. The patients consisted of five females and five males with ages ranging from eight months to 67 years (median: 49y). Our neuromonitoring paradigm included upper and lower extremity Somatosensory Evoked Potentials (SSEPs). Transcranial Motor Evoked Potentials (TCeMEPs), Train of four (TOF), spontaneous (sEMG), and triggered Electromyography (tEMG) from the external anal sphincter (EAS), EUS muscles, and lower extremity muscles bilaterally. A catheter with a urethral electrode was used for recording sEMG, tEMG, and TCeMEPs from the skeletal muscles of the EUS.

Results: We successfully recorded tEMG responses from the EUS muscles in all patients (100%). Only one patient presented preoperatively with bladder incontinence, urgency, and frequency. Immediately in the postoperative phase, the patient's frequency and urgency improved, and the bladder function normalized within two weeks postoperatively.

Conclusion: In this study, we acquired tEMG in 100% of patients recorded from the EUS using a urethral catheter with electrodes built into it. TEMGs can be attempted in surgeries that put the function of the pelvic floor at risk. More study is needed to establish better statistical methods, modality efficacy, and understanding of intraoperative countermeasures that may be employed when an alert is encountered to prevent impending neurological sequelae.

Motor Evoked Potential (MEP) Facilitation via Double Train Transcranial Electric Stimulation (dt-TES)

Victoria Cannon, MD; Parastou Shilian, DO

Introduction: The objective of this study is to add to the limited body of literature regarding homonymous, dt-TES and its utility in increasing MEP amplitude. This study also looks at the two most commonly used train lengths, 4+4 (symmetric) and 2+7 (asymmetric), to assess for possible superiority of one versus the other in regard to increasing MEP amplitude. Our null hypothesis is that there is no difference between dt-TES and single train stimulation and that there is no difference between symmetric and asymmetric double train lengths.

Methods: We performed a retrospective case series analysis of 42 patients undergoing spinal surgery beginning 8/5/2020 and ending 10/15/2020. dt-TES was performed in patients with MEPs with amplitudes of less than 100 mV. An interstimulus interval (ISI) of 20 ms, pulse width (PW) of 50-75 μs, and intertrain (ITI) of 2.1 ms were used. Intensity used was that which produced a maximal amplitude response. Our independent variable was train length: symmetric (4+4) versus asymmetric (2+7). Our dependent variable was MEP response amplitude with dt-TES. Muscles MEPs analyzed were deltoid, hand, vastus lateralis, tibialis anterior, and foot muscles.

Results: Of the 42 patients, dt-TES produced increased amplitudes in 17 patients when compared to single train stimulation. In all of these 17 patients, an asymmetric train length of 2+7 consistently produced greater improvement in MEP amplitude when compared to symmetric train length of 4+4.

Conclusion: dt-TES improved MEP amplitude in some but not all patients with initial MEPs with amplitudes of less than 100 mV, and did so most consistently with the use of asymmetric (2+7) trains. In setting of the simplicity and brevity of this facilitation technique, it is reasonable to consider applying this method to attempt to improve MEP amplitudes in patients with MEP amplitudes of less than 100 mV.

Motor Evoked Potentials in Children: A Practical Approach in Brazilian Population

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Introduction: The lack of widespread use of transcranial electrical motor evoked potentials (tcMEP) in pediatric population is partially due to maturational issues, technical aspects or safety concerns. The aim of this study is to describe the methodology and reliability of tcMEP monitoring in children under ten years.

Methods: We reviewed patients under 10 years in whom spinal cord surgery and intraoperative neuromonitoring (IONM) has been made between January 2017 and October 2020, in São Paulo, Br. Total intravenous anesthesia was performed with propofol and remifentanil. Ketamine infusion was used as needed. tcMEP were evoked through corkscrew electrodes placed at FC3 and FC4 (International 10-10 system), with a train of 9 pulses, 75 µs of duration and 4.0 ms interstimulus interval. Supramaximal stimulation was routinely used. Potentials were recorded with subdermal needle electrodes placed bilaterally in iliopsoas, quadriceps femoris, tibialis anterior (TA), fibular longus, gastrocnemius, abductor hallucis (AH) and anal sphincter. TA and AH responses were mainly considered due to their maximal cortical representation. Bilateral abductor digiti minimi were also monitored as control.

Results: Eight patients where included. Age ranged between 0,6 and 8 years (media 4.1) at time of surgery. Diagnosis were spasticity (1), lumbosacral cyst (1), filum lipoma (3), spinal cord tumor (1), and myelomeningocele (2). Prior to surgery, tcMEP in TA and AH were obtained in 50% of the cases and remained stable trough the procedure. In those were no response was elicited, it appeared in 50% in AH and in 100% in TA at the end of surgery. Lower limb SSEP showed reliable responses in 7 patients. None of them showed significant changes.

Conclusion: We have shown than tcMEP constitutes are a safe and valuable technic for spinal cord and conus medullaris surgery during spinal cord surgery in the pediatric population.

Multimodality Intraoperative Neurophysiological Monitoring (IONM) During Shoulder Surgeries

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Introduction: The purpose of this study is to identify the advancing role of Intraoperative Neurophysiological Monitoring (IONM) in detecting and preventing nerve injuries during shoulder surgery procedures.

Methods: We performed a retrospective analysis of IONM data from ten shoulder procedures. The patients consisted of nine females and one male with ages ranging from 67 to 81 years (median: 74 years). IONM modalities utilized were bilateral Somatosensory Evoked Potentials (SSEP), Transcranial Motor Evoked Potentials (TCeMEP), ipsilateral Electromyogram (EMG) from upper extremity muscles, and Train of four (TOF) recordings.

Results: A decrease in signals was noted in three patients (30%). Only upper SSEP amplitude decreased in one patient; both upper extremity SSEP and TCeMEP decreased in two patients. Only one patient had poor baseline radial nerve SSEP that improved during the surgery. We performed spontaneous EMG (s-EMG) in all ten patients and successfully recorded triggered (t-EMG) in seven patients (71.4%). In one patient, SSEP and TCeMEP did not improve, and the patient woke up with deficits.

Conclusion: In this small series, we were able to identify real-time impending nerve injury. The use of IONM alerted and may have prevented intraoperative nerve injury in 30% of the patients in this series. In one patient, SSEP and TCeMEP did not recover even after the intervention due to severe blood loss. The patient woke up with sensory and motor deficits. The utilization of multimodality IONM can be helpful due to signal changes, therefore minimizing the frequency of nerve injury and deficits.

Outcomes and Patient Characteristics of Intraoperative Peripheral Somatosensory Evoked Potentials (SSEP) Changes

Felix Chang, MD; Viet Nguyen, MD; Sungho Cho, MD; Scheherazade Le, MD; Leslie Lee, MD; Jaime Lopez, MD

Introduction: Peripheral nerve injuries (PNI) occur in 0.03-0.14% of all surgeries, can cause significant patient morbidity, and are a common reason for anesthesia-related litigation. In addition to monitoring structures directly at-risk during surgery, intraoperative neurophysiologic monitoring (IONM) can also identify unexpected potential PNI by selective changes in the SSEPs. Here, we report the characteristics and outcomes of such cases.

Methods: Review of 1753 consecutive cases from 07/2019 to 08/2020 in a single institution's IONM database showed a total of 13 cases (0.74%) of peripheral SSEP changes. Cases were considered PNI if the cortical SSEP amplitude decreased by >50% along with a decrease in the peripheral control (Erb's or popliteal) or improvement following an action to relieve peripheral injury. Patient demographic data, medical co-morbidities, clinical notes, and neurophysiologic data were collected and analyzed.

Results: The average age of patients was 51.4 (SD 24.7). There were 9 males and 4 females. Mean BMI was 27.3 (SD 8.1). Pertinent characteristics: 15% of patients had diabetes, 69% were spine cases and performed in a prone position, 84% of cases affected the arm, and 92% of IONM changes were positioning-related. SSEPs improved in all cases after corrective action was taken. During 3/13 cases motor evoked potential (MEP) changes were observed in a muscle in the associated limb, prior to the SSEP changes. MEP changes only occurred in cases with a >75% decrease in SSEP amplitude. No patients developed post-operative neurologic deficits.

Conclusion: Changes consistent with PNI were identified at a much higher rate than expected, primarily affected the upper limbs and were associated with prone positioning. IONM resulted in corrective action and reversed neurophysiologic changes in all cases. SSEPs appeared more sensitive than MEPs in detecting peripheral changes.

Electrode Integrity and Safety During Presurgical Stereo-EEG Monitoring

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Introduction: In stereo-EEG, the integrity of depth electrodes is crucial to obtain high quality intracranial EEG recordings. Here we explore rates of electrode malfunction and complications over 2-year period using electrodes from 2 manufacturers, Ad-Tech Medical Instrument Corporation® and DIXI Medical ®.

Methods: Clinical and EEG data was retrospectively reviewed from subjects implanted with depth electrodes at our level IV Epilepsy Center from Nov 2018 - Oct 2020. Data collected included number of electrodes implanted, monitoring duration, number of malfunctioning electrodes, time to malfunction and electrode specific complications.

Results: 60 patients (30 Ad-Tech, 30 DIXI) underwent implantation between Nov 2018 - Oct 2020. Median number of electrodes placed per patient was 15 (range 4-29) (Ad-Tech 14.5 (range 4-29) and DIXI 16 (range 9-23)) with median monitoring duration of 12.2 days (range 4.3-54.8) (Ad-Tech 11.9 (range 4.3-54.8) and DIXI 12.9 (range 5.7-27.1)). Total 139/11,169 contacts malfunctioned: 99 among 16 Ad-Tech cases and 40 among 6 DIXI cases. Median percentage of contact malfunction per patient was 1.7% for Ad-Tech vs 0.8% for DIXI ($p = 0.06$). The number of electrodes malfunctioning increased with time for both groups. Electrode specific complications included intracranial hemorrhage in 4 cases (1 Ad-Tech and 3 DIXI, $p = 0.24$), bolt displacement in 4 cases (0 Ad-Tech, 4 DIXI, $p = 0.06$) from being pulled by subject. No infections reported.

Conclusion: Electrode malfunction was occasionally seen during depth electrode recordings, although complications were uncommon. While not statistically significant, we report trends including higher percentage of contacts malfunctioning with Ad-Tech electrodes, though more complications with DIXI electrodes. Given increasing number of electrode malfunctions over time, attempts to reduce duration of monitoring while capturing the necessary data will promote higher quality recordings.

Hippocampal Spindles and Barques: Normal Intracranial EEG Variants

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Introduction: We assessed the incidence of the hippocampal spindle (HS) and barque (HB), and investigated whether their occurrence is indicative of non-epileptogenicity in a large group of epilepsy patients.

Methods: We reviewed 333 8-hr long night-time seizure-free iEEG studies of 75 adult patients, unilaterally or bilaterally implanted in the hippocampus, and documented the systematic appearance of HSs and HBs. 102 hippocampi were implanted; 59 were not involved at seizure onset. 27 patients were diagnosed with MTLE/TLE, 27 with TLE+ and 21 with extra-temporal epilepsy (xTLE). 29 patients are seizure-free at 48.3 ± 26.7 months. Fisher's exact test was used to assess statistical significance at $p \leq 0.05$.

Results: The incidence of both HSs (91.52%) and HBs (33.89%) in the non-epileptogenic hippocampi was not different to their incidence in epileptogenic ones (79.06%, $p=0.08$ and 20.93%, $p=0.26$). No difference in HSs' and HBs' incidence was found among the different diagnostic patient groups (HBs: pTLEvsTLE+=0.54, pTLEvsXTLE=0.33, pTLE+vsXTLE=0.76, $p=0.46$; HSs: pTLEvsTLE+=0.66, pTLEvsXTLE=1, pTLE+vsXTLE=0.64, $p=0.73$). Similarly, no differences were found among the non-epileptogenic (HBs: pTLEvsTLE+=0.45, pTLEvsXTLE=0.51, pTLE+vsXTLE=1, $p=0.62$; HSs: pTLEvsTLE+=0.48, pTLEvsXTLE=1, pTLE+vsXTLE=0.54, $p=0.58$) and epileptogenic (HBs: pTLEvsTLE+=0.70; HSs: pTLEvsTLE+=0.25) hippocampi of our diagnostic groups. Among patients with Engel Class I outcome, the incidence of HBs was significantly higher in patients with xTLE (HBs: pTLEvsTLE+=0.34, pTLEvsXTLE=0.009, pTLE+vsXTLE=0.14, $p=0.01$), although the incidence of HSs was not (HSs: TLE 84.61%, pTLEvsTLE+=0.48, pTLEvsXTLE=0.54, pTLE+vsXTLE=1, $p=0.67$).

Conclusion: The lack of significant differences in the occurrence of HBs and HSs in our patient cohort, our hippocampi group, and across diagnostic and outcome subgroups suggests that they are most likely both normal variants of the iEEG. Our results also demonstrate a trend that HBs may be a marker of non-epileptogenicity.

Impact of Word Length on Social Media Outreach of Clinical Neurophysiology

Diksha Iyer; Hirotaka Iwaki, MD, PhD; Eishi Asano, MD, PhD

Introduction: Social media distributes information, helping research papers find a broad audience and investigators gain awareness for their work. With the official Facebook page for the International Federation of Clinical Neurophysiology, we asked questions to investigators who authored articles in Clinical Neurophysiology Practice and created interview-based posts with their answers. We hypothesized that posts with larger word counts would have lower user engagement.

Methods: We analyzed 335 posts from April 1 to July 9, 2020. Multivariate regression analysis determined whether an increase in the number of words would decrease a post's user engagement. The predictor co-variables analyzed were: 1) posted on a weekend (yes/no), 2) number of picture attachments (range 1-4), 3) the specific day posted (range 1-100), 4) video attached (yes/no), 5) interview article (yes/no), 6) if their latest paper was published in 2020 (yes/no). The outcome measures included [post reach] how many viewers a post reached, [engaged viewers] number of viewers interacting with a post, and [proportion of engaged viewers] percentage of viewers that saw a post and interacted with it.

Results: The number of post reach and engaged viewers increased daily ($p<0.001$ and $p=0.009$). Contrary to our hypothesis, a larger word count was associated with an increased number and proportion of engaged viewers ($p=0.003$ and 0.004). Interview-based posts were independently associated with a higher proportion of engaged viewers ($p=0.005$).

Conclusion: Our study did not support the hypothesis that a larger word count would lower a post's user engagement, and suggested that longer posts result in a higher engagement rate. This could be due to the need to click on long posts to view the full message, whereas short posts do not need further interaction to read the message. Our study supports the notion that interview-related posts more frequently garner the audience's attention.

Measuring Cortical Excitability Changes in Children with Brain Tumor Using TMS

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Introduction: Brain tumors in eloquent areas affect cortical excitability and function, and recent findings suggest they may also produce changes in excitability of the affected hemisphere regardless of location therein. These changes can be directly measured with transcranial magnetic stimulation (TMS) via the motor threshold (MT), where higher MT reflects lower excitation or greater inhibition. We examined children with brain tumor for pathological differences in cortical excitability between the normal and lesion hemispheres via change in motor threshold (ΔMT).

Methods: 39 children (age 4.4 to 17.9 years, 32 right-handed) with newly diagnosed brain tumor (23 temporal, 3 frontal, 7 parietal) underwent motor mapping with TMS prior to surgical resection. 25 patients had left hemisphere tumors (66.7%); 9 had high grade tumors (23.1%). MTs were recorded in terms of TMS machine output (%), with significant ΔMT defined as variance >10%.

Results: 22 of 39 patients (56.4%) had significantly different MT in the tumor hemisphere compared to the normal hemisphere. Of these, 10 (45.5%) had increased MT in the tumor hemisphere, while 12 (54.5%) had decreased MT in the tumor hemisphere. Patients with high grade tumor were more likely to have ΔMT (77.8%), and tumor hemisphere MT was more likely to be decreased (85.7%). Half of patients with low grade tumor had ΔMT, and tumor hemisphere MT was slightly more likely to be increased (60%). There was no significant effect of tumor-hemisphere hand dominance on ΔMT; of the 28 patients with hand-dominant tumor hemisphere, 14 (50%) had ΔMT.

Conclusion: Pathological cortical excitability changes occur in some but not all children with brain tumor. In children with these pathological changes, tumor hemisphere excitability is sometimes increased and sometimes decreased. Further studies are needed for clarification. Particular attention should be paid to tumor type, grade, and contents, concurrent medications, and length of disease course prior to determination of excitability via TMS.

Status Cataplecticus in a Patient with Rapid Onset REM-sleep Behavior Disorder in the Setting of Acute Blood Loss Anemia

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Introduction: Status cataplecticus is a rare presentation of sleep disorders, usually narcolepsy, defined as repeated episodes of cataplexy lasting several hours. We present the case of a patient without a history of sleep disorder, presenting with rapid onset REM-sleep behavior disorder (RSBD) and subsequent Status cataplecticus after a complicated aortic dissection and acute blood loss anemia.

Case Report/Case History: A 69 year-old male with a history of hypertension and atrial fibrillation was transferred to our hospital for management of a type B aortic dissection. The patient underwent thoracic endovascular aortic repair (TEVAR). On post-op day 5, the patient developed altered mental status, auditory and visual hallucinations, and diffuse jerking movements. Clinically the patient appeared to have RSBD, with involuntary muscle twitches and purposeless movements interrupting sleep, with confusion on arousal. Continuous video-EEG monitoring recorded several periods of drowsiness evidenced by dropout of posterior dominant rhythm, followed by rapid onset of REM sleep. without entering stage 2 or 3 non-REM sleep, and myoclonic jerks on awakening, concerning for Status Cataplecticus. The patient was treated with a combination of Melatonin, Trazodone and Nortriptyline, achieving normal physiologic sleep and improvement in symptoms. The patient was discharged on this regimen.

Conclusion: Our patient had multiple instances of sudden REM sleep with myoclonus and altered sensorium. There is an association between RSBD and iron deficiency anemia, so our patient's condition appeared to be precipitated by blood loss. This condition is important for clinicians to recognize as a potential cause of delirium and sleep disturbance in critical care inpatients, as correction of the insomnia can lead to rapid improvement in the condition.

Inter-ictal Localization of the Epileptic Source Generator Changes by Sleep-Wake State in Human Brain

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Introduction: Sleep-wake states (SWS) can alter the localization of the presumed epileptic source generator, but this has not been studied in detail among all 5 canonical SWS: wakefulness, rapid eye movement sleep (REM), non-REM1 (N1), N2, N3. We systematically applied electrical source localization (ESL) to interictal epileptiform “spikes” of all 5 canonical SWS to quantitatively test the spatial agreement (concordance) and disagreement (discordance) of localizations yielded in the 5 canonical SWS.

Methods: 42 focal epilepsy patients were prospectively recruited from the adult epilepsy monitoring unit at the University of Manitoba. We analyzed 958 spikes from 260 day-night recordings. Spikes underwent ESL by standardized low resolution electromagnetic tomography analysis to yield probabilistic source localizations of spikes arising in each SWS for each patient. ESL results were mapped to cortical grey matter in individualized 3-D brain models using recent MRI when possible (n=33). One-way ANOVA had $p<0.05$ statistical significance threshold.

Results: The 5 SWS converged unanimously to mean 19.6% individualized cortical grey matter, involving just under half of each SWS source localizations, similar for each SWS ($p=0.983$). Intra-individually within the same patient, a given SWS used mean 60.6-79.4% of its source localizations to agree with those of any other SWS. REM showed less, N2 and N3 showed more, concordance with other SWS ($p=0.0074$). Pooling 2-way SWS comparisons, 35.3% (0-98.4%) of REM’s source localizations disagreed with those of any other SWS on average ($p=0.0003$).

Conclusion: Localization of the epileptic source generator varies dynamically by SWS, with REM having the greatest impact. Our findings suggest that REM may selectively “move” focal source generator localizations away from any other one SWS, but not away from all five SWS at once.

Neutrophil-to-lymphocyte Ratio in Narcolepsy Pediatric Patients

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Introduction: There is evidence that links narcolepsy with a chronic inflammatory state. The neutrophil-to-lymphocyte ratio (NLR) is a simple, cheap, rapid, and novel, promising inflammation biomarker for several diseases. The aim is to evaluate the differences of NLR in pediatric patients with narcolepsy type 1 and type 2.

Methods: In this exploratory study, it was analyzed the differences of NLR between pediatric patients with type 1 and type 2 narcolepsy. It was used the Wicoxon rank sum test for original sample and t-student test for simulated sample. The number of patients in the simulated sample was equal to probabilistic sample calculated.

Results: The original sample was composed of 13 type 1 (mean=2.22, sd=1.53) and 6 type 2 (mean=1.89, sd=1.20) narcolepsy pediatric patients. The non-parametric analysis of NLR not showed statistical differences (p value=0.48). In box-plot graph was observed a trend to higher values of NLR in narcolepsy type 1 patients. A probabilistic sample calculated was 84 patients (power=0.8) per group of narcolepsy type. This number of patients was simulated using the same means and standard deviations of NLR of the original sample. It was found statistical differences between mean of NLR in patients with narcolepsy type 1 and type 2 of the simulated sample (t-student test ; p value=0.0073). The direction of effect showed that NLR levels were higher in patients with type 1 narcolepsy.

Conclusion: Despite of potential biases of this univariate analysis, based on the potential rol of NLR as an inflammatory biomarker, this preliminary results suggests that narcolepsy type 1 have a higher inflammatory state in comaparison to type 2 narcolepsy in these pediatric patients. More studies that include higher number of patients or multicentric studies, as well as inclusion of other predictors (multivariant models) and other inflammatory biomarkers could confirm this association.

An Alternative to Collodion by Esperanza E. Wagner, R. EEG T Dr. Carlos Gama, Baptist Neurology, Jacksonville, Florida

Esperanza E. Wagner, R. EEGT

Introduction: Purpose: Improve Electrode Application for Long-term EEG/Video Monitoring without using Collodion

Case Report/Case History: Method: Prepare skin as usual. Cut gauze into one inch by one inch squares. Fill a 10 mm electrode cup with conductive paste (Ten20 conductive paste or Elifex, just enough to fill the cup. Squeeze a bit of cream (EC2 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" donductors, since there is almost no contact between the two.One conductor is inside de electrode cup and the other one is on the outsideand not serving any conductive function. The electrode impedance should be less than 5.000 Ohms and balanced. After the impedances are found to be satisfactory, apply apiece of 3MT Mixeopoew 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 evaluated for diagnosis of Epileptic seizures vs. non epileptic spells

Conclusion: 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 reapairs on patients monitored for 3 to 4 days. This procedure is also for patients who are allergic to Collodion. Most of the recordings are of high quality and the Epileptologists are able to see the beginning, evolution and end of the seizure.

SUDEP During Ambulatory Video EEG

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Introduction: SUDEP is a significant cause of death in epilepsy but its mechanism remains unknown. Although risk factors have been identified and postmortem data gives potential insights, VEEG recordings during these events are rare. The few cases of SUDEP that have been recorded with VEEG are during inpatient monitoring reported in the MORTEMUS study and a single case during invasive electrode monitoring. We report a case of what we believe to be the first case of SUDEP during ambulatory video EEG.

Case Report/Case History: The case is of 52 year old right handed lady of long standing epilepsy with poorly controlled nocturnal seizures who had failed multiple AEDs and with psychogenic non epileptic events (PNES) diagnosed in last few years documented by VEEG. AED were not reduced but inter-ictal generalized spike and wave became more frequent over the first 2 days. She suffered SUDEP after a nocturnal tonic-clonic seizure on day 3 in prone position. EEG correlate was generalized 3 Hertz polyspike and wave with prolonged postictal generalized EEG suppression [PGES]. EKG showed simultaneous severe bradycardia with ectopic which progressed to asystole. The CPR was unsuccessful. Postmortem was not carried out.

Conclusion: Our case is the first reported case of SUDEP during ambulatory VEEG as a single prior case did not have video. Postictal EEG suppression, central apnea and asystole are considered to be neurophysiological markers suggestive of SUDEP. Studies to date have not been conclusive but our case did demonstrate their occurrence. The coexistence of PNES in this case may have contributed to SUDEP in a manner that is unexplained as VEEG monitoring during that diagnosis did not reveal cardiac arrhythmias despite PNES increasing the risk for SUDEP. Previous reports of in hospital interventions for SUDEP showed unsuccessful resuscitation similar to our case raising questions on how to prevent and respond to these occurrences.

Nest Study: Neonatal Seizure Burden During Therapeutic Hypothermia

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Introduction: The Primary aim of this study is to develop quantitative metrics for the use of continuous electroencephalography (cEEG) during Therapeutic Hypothermia (TH). The goal of the metrics is to determine the duration and need for the use of limited EEG resources during TH.

Methods: A retrospective analysis of the EEG data gathered from neonates undergoing TH, on cEEG at Norton Children's Hospital (NCH) from 2014-2018, to assess the background and timing of recorded EEG abnormalities and seizures.

Results: A total of 136 neonates underwent TH during 2014-2018, 24 were excluded sec to them either being deceased, prematurely removed from TH or having insufficient data. CEEG from 112 neonates were analyzed. Out of the 112 CEEG analyzed, 38 had either severe background or Seizures on day 1. 74 remaining neonates with no seizure on day 1 and normal or mildly abnormal background were followed until rewarming on CEEG. Only 1 out of 74 neonates had seizures during rewarming, but 98.6% of neonates remained seizure free. Mean number of seizure days when background was normal/mildly abnormal were 0.09 as compared to a mean of 1.27 days when background was mod-severely abnormal. Sarnat scoring, EEG background and seizures on day 1,2,3 and rewarming had a statistically significant positive correlation. Total number of seizures and MRI abnormalities also demonstrated a statistically sig positive correlation.

Conclusion: If the CEEG during TH has a normal or a mildly abnormal background with no seizures, during the first 24 hrs, EEG can be discontinued after 24hrs.

The Utility of Additional Depth or Subdural Electrodes Following Stereotactic EEG Evaluation

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Introduction: In the USA, there has been increasing use of stereotactic EEG (SEEG) for intracranial EEG monitoring. There are several reasons for this paradigm shift, including improved patient tolerance, lower complication rates, and the ability to sample from deep cortical structures in bilateral hemispheres. However, compared to subdural electrodes (SDE), there is less surface spatial resolution, an issue for suspected cases of epilepsy adjacent to eloquent cortex. One way to overcome this limitation is to refine the SEEG implantation scheme after initial placement of SEEG electrodes or a follow-up SDE evaluation.

Methods: Baylor incorporated SEEG as part of its phase II intracranial EEG practice in October 2017. A retrospective chart review was performed of all patients who underwent SEEG monitoring. Patients who required additional depth electrodes or SDE implantation following the initial SEEG monitoring were included in this study.

Results: A total of 47 patients underwent SEEG implantation during this period. In most cases (87.2%), the initial SEEG implantation answered the clinical question leading to a definite treatment. Six patients (12.8%) had additional depth electrodes or SDE implantation following the SEEG evaluation. The patients' mean age was 30.1 (20-55) years. One patient underwent implantation of additional electrodes during the SEEG evaluation, resulting in an extension of the surgical resection with concurrent RNS placement. Five of the patients had a follow-up SDE implantation; three were to define the extent of the EZ, and two were to determine the proximity of eloquent cortex to EZ.

Conclusion: We present our single center's experience transitioning to SEEG. Very few patients required additional electrodes, either during the SEEG evaluation or as a follow-up SDE evaluation. More strategic planning of the initial SEEG implant scheme or SDE utilization from the onset may help avoid such cases, especially when there is suspected overlap of the EZ and eloquent cortex.