error (FRE)Results: Ninety-nine patients were analyzed, with a median FLE of 0.76mm, 0.74mm, 0.71mm and 0.66mm for the right electrode, left electrode, AC and PC respectively (no significant difference, Wilcoxon sign rank). The median FRE was 1.59mm for AC and 1.21mm for PC, significantly higher than FLE at those coordinates (Wilcoxon sign rank, $p<0.001$). Conclusions: Raters can accurately localize DBS electrodes, AC and PC from clinical images with sub-millimetric accuracy. Higher FREs at AC and PC suggested registration errors may contribute more than localization errors to electrode uncertainty in a common space.

Neuroscience Education

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Quantitative evaluation in competency-based medical education – a nationwide survey of the spinal surgical training landscape

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Background: The competency-based medical education (CBME) model has been recently implemented in spinal neurosurgical and orthopedic residencies. This model is grounded on entrustable professional activities (EPAs) that allow the assessment of clinical milestones. Integrating quantitative metrics to evaluate procedural competencies could refine the assessment's scope. This survey, administered to program directors (PDs), aims to evaluate the current state and anticipated needs for quantitative evaluation to develop innovative assessment techniques. Methods: We surveyed 32 PDs of neurosurgical (N=14) and orthopedics (N=16) programs with a spine service via RedCap. We collected information on the programs' characteristics. We inquired about existing assessment methods and the perceived values of developing quantitative metrics to assess spinal technical competencies using thirteen questions. Results: The response rate was 53%. All programs use EPAs to assess procedural competencies through direct observation in the operation room. One surgical program employed quantitative metrics for examination. Four PD valued the profitability of quantitative evaluation methods in a clinical or simulatory context. Conclusions: The use of quantitative metrics to assess spinal surgical competencies in Canadian neurosurgical and orthopedic residency programs is seldom. Despite its underutilization, PDs acknowledge the potential for quantitation to improve the accuracy and reliability of CBME assessments in both simulated and clinical settings.

Neurotrauma

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Near infrared spectroscopy based indices of cerebrovascular reactivity cluster with intracranial pressure based indices in moderate to severe TBI patients

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Background: Cerebrovascular reactivity has been identified as an important contributor to secondary injury following moderate to severe traumatic brain injury (TBI). "Gold-standard" intracranial pressure (ICP) based indies of cerebrovascular reactivity are limited by their invasive nature poor spatial resolution. Near infrared spectroscopy (NIRS) based indices of cerebrovascular reactivity are minimally invasive and have improved spatial resolution. In this study, classical machine-learning algorithms are leveraged to better characterize the relationship between these indices. Methods: High-resolution physiologic data was collected in a cohort of adult moderate to severe TBI patients. From this data both ICP and NIRS based indices of cerebrovascular reactivity were derived. Utilizing Agglomerative Hierarchical Clustering (AHC) and Principal Component Analysis, the relationship between these indices in higher dimensional physiologic space was examined. Results: A total of 83 patients with 314,395 minutes of unique and complete physiologic data was obtained. Through AHC and PCA there was higher order clustering between NIRS and ICP based indices, separate from other physiologic parameters. Conclusions: NIRS and ICP based indices of cerebrovascular reactivity relate to one another in higher dimensional physiologic space. NIRS based indices of cerebrovascular reactivity may be a viable alternative to ICP based indices.

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Quantification of the relationship between near infrared spectroscopy based and intracranial pressure based indices of cerebrovascular reactivity in moderate to severe TBI

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doi: 10.1017/cjn.2023.209

Background: Cerebrovascular reactivity is an important contributor to secondary injury following traumatic brain injury (TBI). The poor spatial resolution and invasive nature of "Gold-standard" intracranial pressure (ICP) based indies of

cerebrovascular reactivity limit their use. Near infrared spectroscopy (NIRS) based indices of cerebrovascular reactivity are minimally invasive and have improved spatial resolution. The precise relationship between NIRS and ICP based indices is quantified utilizing times series analysis and advanced statistical techniques. Methods: High-resolution physiologic data was collected in a cohort of adult moderate to severe TBI patients at a single quaternary care site. From this data both ICP and NIRS based indices of cerebrovascular reactivity were derived. The times series structure of these indices was determined and used to correct for autocorrelation in a linear mixed effects model of ICP based indices from NIRS based indices of cerebrovascular reactivity. Results: A total of 83 patients were included in this study. Times series analysis coupled with mixed effects modeling was utilized to examine the relationship between ICP and NIRS based indices of cerebrovascular reactivity. Conclusions: Times series analysis coupled with mixed effects modeling allows for a more complete understanding of the relationship between ICP and NIRS based indices of cerebrovascular reactivity in the setting TBI.

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Traumatic penetrating head injury by crossbow projectiles: a case report and literature review

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Background: Penetrating head injury secondary to crossbows is a rare encounter in neurosurgical practice with only few cases reported in the literature. Methods: Chart review and literature review. Results: A 31-year-old man with a previous psychiatric history sustained a self-inflicted injury using a crossbow he bought from a department store. The patient arrived neurologically intact. He was not able to verbalize due to jaw fixation with the arrow. The trajectory of the object showed an entry point at the floor of the oral cavity and an exit through the calvarium just off the midline. The oral and nasal cavities, along with the palate and the skull base, and the left frontal lobe were all breached (figure). No vascular injury was identified on imaging (figure). The arrow was surgically removed in the operating room after establishing an elective surgical airway. A planned delayed CSF leak repair was performed. The patient made a substantial recovery and was discharged home in good status. Conclusions: - Multidisciplinary team is key.

Vascular imaging should be done pre and post-intervention.

Surgical approach is determined by the trajectory.

Psychiatric illness and access to weapons are major risk factors.

Elective surgical airway might be indicated.

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Memantine inhibits cortical spreading depolarization and improves neurovascular function following traumatic brain injury: results of a randomized pre-clinical trial

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Background: Cortical spreading depolarization (CSD) is associated with poor outcomes following traumatic brain injury (TBI). Here we aimed to: (1) determine the effect of NMDA-receptor antagonism on CSDs in healthy and TBI animals *in vivo*; and (2) conduct a randomized pre-clinical trial (RCT) of memantine for prevention neurological decline following repetitive mild TBI (rmTBI). Methods: Rodents received either one moderate (n = 23) or four daily mild (rmTBI; n = 30) head impacts (weight drop). Sham animals received brief anesthetic without TBI (n = 40). 93 animals underwent cranial window surgery with electrocorticographic (ECoG) monitoring and electrically triggered CSDs. Ketamine (100uM topical or 25 mg/kg IP) and memantine (10 mg/kg IP) were tested *in vivo*. An RCT was conducted (N=31) using memantine (10 mg/kg) or saline (2.5 cc/kg) for rmTBI with daily neurobehavioural testing. Results: In TBI animals, ketamine or memantine inhibited CSDs in 44-88%, and 50-67% of cases, respectively. Near-DC/AC-ECoG amplitude was reduced by 44-75% and 52-67%, and duration by 39-87% and 61-78%, respectively. RCT animals that received memantine had higher mean neurological scores (9.27 (SD 3.08) vs. 5.56 (SD 3.05), $p< 0.001$) vs. saline. Conclusions: Memantine suppressed CSDs following TBI, *in vivo*. In a pre-clinical RCT of rmTBI, memantine prevented neurological decline.

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Chronic subdural hematoma drainage under local vs. general anesthesia: systematic review and meta-analysis

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Background: Chronic subdural hematoma (CSDH) is one of the most encountered conditions seen in neurosurgery. Although mainstay treatment of cSDH has been burr hole drainage, no consensus yet exists on optimal anesthesic technique for surgical treatment between general (GA) and local (LA) anesthesia. Methods: A search was conducted in MEDLINE (1946 to November 11, 2022), Embase (1974 to November 11, 2022), and PubMed (up to November 11, 2022). We followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines to systematically screen studies.