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(Abstracts)

Contents

A Novel Approach for Assessment of the Efficacy of Somatosensory Evoked Potentials for Detection of Peripheral Nerve Injury: A Proof-of-Concept Study

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Background: Somatosensory evoked potentials (SSEP) has been routinely used intraoperatively to detect nerve injury; however, the diagnostic property of SSEP has not been clearly defined in the literature (1-4). One fundamental limitation to demonstrating such a relationship is that intraoperative SSEP monitoring is used in patients under general anesthesia which precludes the possibility of real-time correlation. Another limitation is due to the rare and unpredictable occurrence of intraoperative nerve injury that requires a very large sample size study. This prospective cohort study aimed to use brachial plexus block in awake patients as an experimental model to assess the relationship between an abnormal SSEP and the symptoms of nerve dysfunction, as well as to evaluate the diagnostic values of SSEP.

Methods: Ethics approval was obtained from the local REB. Fourteen adult patients were prospectively included. We obtained baseline SSEP readings and neurological function, which was then followed by the placement of a brachial plexus block (mimicking nerve injury). We monitored the changes of SSEP and neurological symptoms simultaneously during the onset of the block to determine the temporal relationship and the diagnostic values of SSEP. Since all study participants were awake during the assessment, raw SSEP data was contaminated with motion artifacts. We custom built a graphical user interface (PySide (v1.2.4), Python (v3.6.5)) to analyse the raw data of this study. This interface allows post-hoc adjustment of the sample frequency, frequency filters, threshold and number of averaging to obtain satisfactory SSEP signals for analysis.

Results: Fourteen patients' data (170 pairs of data point) were included for final analysis. After a brachial plexus block (mimicking chemical induced nerve injury), the onset of abnormal SSEP signals almost always preceded the impairment of power (≤ 4/5), followed by impairment of cold sensation, and of two-point discrimination (Fig. 1). The sensitivities and specificities of SSEP to detect the impairment of power (≤ 4/5), cold sensation, and two-point discrimination were 100% and 67.4%, 99.1% and 54.9%, and 100% and 46%, respectively.

Conclusion: This is the first study that demonstrated a clear temporal relationship that abnormal SSEP almost always preceded the onset of neurological deficits. It also suggested that SSEP possesses a diagnostic property of high sensitivity and moderate specificity. Our findings suggested subcortical SSEP is a reliable screening test to detect impending intraoperative peripheral nerve injury before the injury is severe enough to become clinically apparent. This finding is highly relevant for the development of an automated SSEP nerve monitoring device for the early detection and prevention of intraoperative peripheral nerve injury

(4-6). They also suggest that a brachial plexus block in awake patients can be used as a model for studying nerve injury to overcome a variety of methodological limitations.

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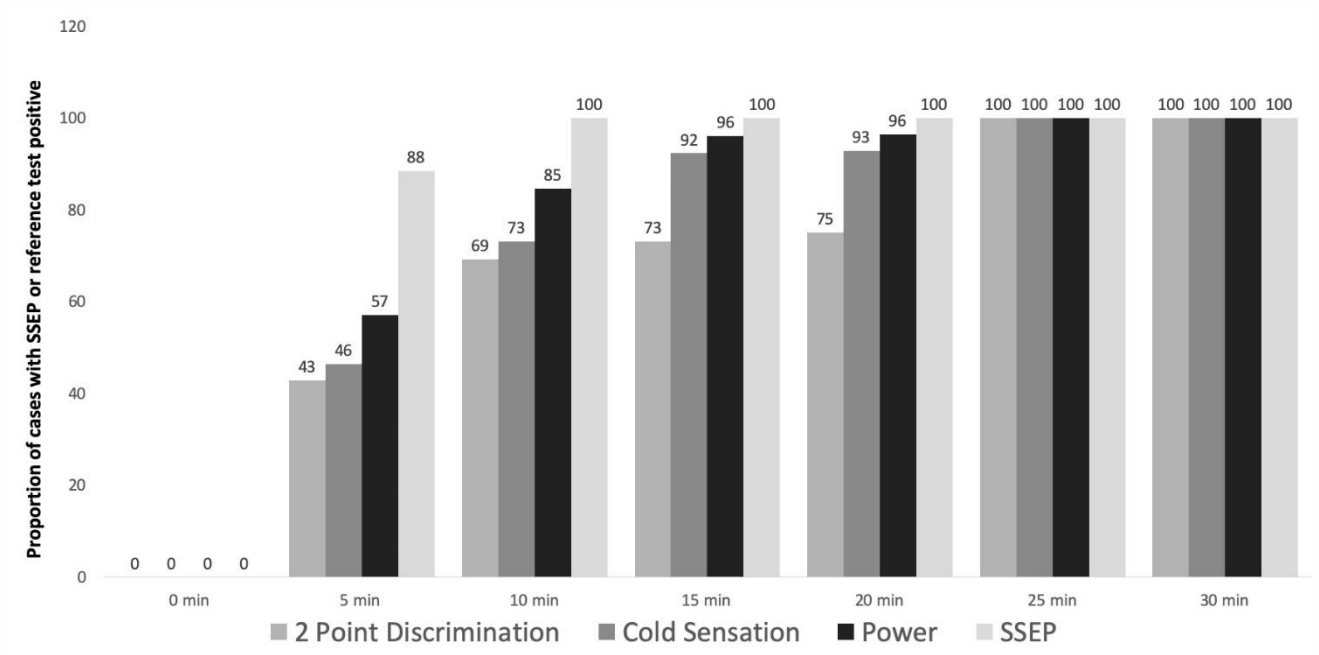

Anesthesia Care for Endovascular Therapy in Acute Ischaemic Stroke: A Quality Improvement Project

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Introduction: Acute ischaemic stroke (AIS) for endovascular therapy is a time-critical emergency, with the number of patients who undergo this procedure currently on the rise. SNACC published an expert consensus statement in 2014 [1], however very little is known about current involvement and anesthesia care strategies in the treatment of these patients. In order to identify current anesthesiologists' approaches and potential improvements, we initiated a quality improvement (QI) project at the London Health Sciences Center in London, Ontario.

Methods: After REB approval, AIS cases that underwent endovascular therapy from March 2015 to December 2019 were retrospectively reviewed. In November 2017 a standard operational procedure (SOP) was introduced ("intervention") and the second cycle of data review was initiated covering November 2017 to December 2018. The SOP addressed an interdisciplinary management approach. A paging system, monitoring requirements, indications for anesthesia technique and physiologic targets were defined. According to SQUIRE guidelines, [2] patient characteristics, the timing of procedures, anesthesia techniques, and post-interventional transfer were evaluated. Data is presented as either an absolute number, percentage, or median (IQR). Mann-Whitney or Chi-square tests were performed where appropriate. A $p<0.05$ was considered as statistically significant.

Results: 400 patient records were analyzed (before intervention: 139, after 126). Presence of anesthesia was in 88/139 (63%) cases before and 126/126 (100 %; $p<0.001$) after. Time from hospital arrival until the start of anesthesia was 57 minutes (40-80), compared to 46 minutes (30-62; $p=0.002$). General anesthesia was used in 34/139 (24%) before, and in 25/126 (20%; $p=0.37$) after the intervention. Total procedure time was 110 minutes (85-145) and 100 minutes (66.25-130; $p=0.03$), respectively. After the introduction of SOP, fewer patients were transferred to ICU after endovascular therapy (19/126 (15%) vs. 36/139 (25%); $p=0.03$).

Conclusion: Use of a SOP for endovascular therapy in patients with acute stroke results in a frequent involvement of anesthesia, and reduces the time until the start of intervention, total length of procedure time, and ICU admissions. The next step is to evaluate the impact on neurologic patient outcome.

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Anesthetic Requirements and Repeat Awake Craniotomy for Tumor

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Introduction: Awake craniotomy (AC) can be a very stressful experience for patients, it has been associated with a risk of long-term psychological sequelae[1]. Some patients with brain tumors may need a repeat awake craniotomy (AC) for a recurrence of tumor. However, there is a very limited literature on patients undergoing repeat AC. The aim of this study is to compare anesthesia requirements, perioperative hemodynamics, complications and outcomes between repeat ACs (RAC) and the first AC (FAC). We hypothesized that anesthesia and analgesia requirements and anesthesia-related complications will be less in RAC compared to the FAC.

Methods: Ethics approval was obtained from the local REB. We performed a retrospective study of all patients who had an awake craniotomy for resection of brain tumor by a single surgeon in our institution from 2010 to 2018. From the database, we identified patients who had at least two ACs during the study period, and added previous ACs to the analysis when applicable. We compared preoperative comorbidities, anesthetic drug use, hemodynamic parameters, perioperative complications and postoperative analgesia requirements between the FAC procedure and subsequent RAC. Data were analyzed using Wilcoxon signed ranked test, paired and unpaired t tests as appropriate. All p-values are two-sided and the signification threshold is $p<0.05$.

Results: Out of 396 ACs that were performed during the study period, 28 patients had at least two ACs. After exclusion of 4 patients for missing data, 24 patients who underwent a total of 53 ACs between 2004 and 2018 were included in the final analysis; 3 patients had 3 ACs, and one patient had 4 ACs. There were no significant differences between FAC and RAC groups regarding baseline comorbidities, pre-operative and intraoperative drugs used, perioperative hemodynamic parameters and the length of surgery. However, the preoperative Karnofsky Performance Score (KPS) was lower in RAC group compared to FAC group (74.5 vs 84.5; $p<0.001$). The incidence of intraoperative mapping was also lower in RAC group (55.2% vs 83.3%). In analysis of paired FAC and second AC cases, the mean (SD) midazolam dose was lower in RAC compared to FAC (0.96 (0.87) mg vs 1.63 (1.56) mg; $p=0.0198$). There were no differences between the groups with regards to perioperative complications, postoperative analgesia and antiemetic use in the recovery. Although mean (SD) oral morphine equivalents used in PACU were lower in RAC group (12.9 (13.2) mg) compared to FAC group (9.4 (11.8) mg), this was not statistically significant.

Conclusion: Our study showed that anesthetic and analgesic requirements as well as perioperative complications were similar between first and repeat awake craniotomy. Further

prospective study is needed to look at the patient satisfaction and psychological status in patients undergoing repeat awake craniotomy.

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Brain Cancer Progression: Does Anesthesia Matter? – An Initial Analysis of Retrospective Multicenter Study

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Introduction: Brain tumors, depending upon type and grading, impose significant morbidity and mortality (1). Therefore, it is important to explore ways in which we can improve and prolong the lives of patients suffering from brain tumors. The role of anesthetics in this regard has yet to be explored (2, 3). Very few studies highlighted that volatile anesthetics have been associated with solid tumor progression whereas propofol has been shown to have a favorable effect. In addition, in some studies comparing craniotomy under sedation (awake) [AC] versus general anesthesia (GA), pain scores, plasma levels of cortisol, adrenocorticotropic hormone (ACTH), noradrenaline, and phenylalanine/tyrosine ratio were significantly higher in craniotomy under GA postoperatively (4). Thus, it is plausible that the awake craniotomy itself imposes less stress and may show less progression of the brain cancer (5). With this background, this present study will assess whether or not craniotomy without general anesthesia yields lower rates of cancer progression in patients with high-grade gliomas.

Methods: IRB approvals from all the sites were taken. This is an initial analysis of our ongoing retrospective multicenter database. All adult patients who underwent craniotomy for high-grade glioma (WHO grade III-IV) during the past ten years were included and divided into two groups: AC and GA group. The primary objective was to note progression-free survival (PFS) and secondary objectives, overall survival (OS), pain scores and length of hospital stay between two groups. Data collection included patient demographics, ASA grading, WHO grading, size and location of tumor, type of anesthetics, anesthetic and surgical duration, the extent of surgical resection, histologic type, molecular diagnosis (isocitrate dehydrogenase [IDH] and O6-methylguanine-DNA methyltransferase [MGMT] mutation), and postoperative adjuvant chemo/radio therapy. Progression information was retrieved using imaging and clinical signs and symptoms. Failure to return for evaluation due to death or deteriorating condition was considered to represent progression.

Results: Out of the first 500 patients, 306 patients (AC-44, GA-260) met the final inclusion criteria. Awake craniotomy cohort appears to have longer survival characteristics [both median PFS {AC group: 0.78 (0.57-1.20)} vs, {GA group: 0.49 (0.44-0.55)} and OS {AC: 1.72 (0.93-2.54)} vs. {GA: 1.04 (0.85-1.28)}. Patients in the awake craniotomy had a greater percentage of patients who were IDH mutant, received more than 60 Gy and more than 6 cycles of chemotherapy, which might explain the longer median survival in this group of patients. However, the extent of resection, tumor volume and histological types were comparable between the two groups. Our present multicenter study, once completed, would able to answer this association more precisely.

Conclusion: This is an attempt to explore the role of minimal anesthesia (AC) versus general anesthesia on high-grade glioma progression. Initial analysis favors craniotomy without general anesthesia, but not without confounding variables including genetic and adjunct radio/chemotherapy. This research will open a door for future prospective randomized trials in regards to the role of anesthetic in the brain cancer progression.

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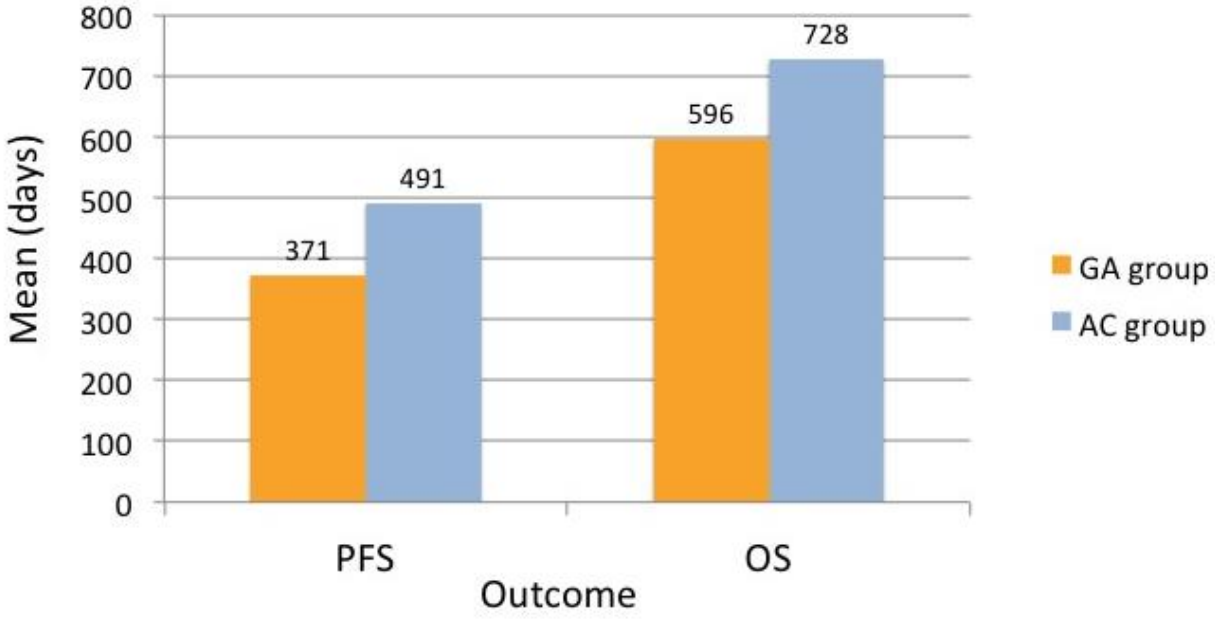
Figure 1. Difference in PFS and OS between GA and AC groups



Comparison of Propofol and Ketofol on Transcranial Motor Evoked Potentials (TcMEPs) in Patients Undergoing Thoracolumbar (TL) Spine Surgery

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Objectives: To compare effect of propofol and ketofol infusion (ketamine-propofol 1:4 admixture) on Motor Evoked Potential(TcMEPs), haemodynamic parameters and muscle power at discharge.

Materials and Methods: After taking Ethical approval from Institute local Etical Commettee (REB), 38 adult ASA I and II patients undergoing elective lower thoracic or Lumbar spine surgery were included i study.

Patients were randomly allocated into 2 groups (X and Y) in 1:1 ratio.

Amplitude and latency of Motor Evoked Potential (TcMEPs) were recorded bilaterally from Abductor Pollicis Brevis (APB) and Abductor Hallucis (AH) muscles in both upper & lower limbs.

Baseline recordings of TcMEPs in both groups were recorded under propofol infusion. Thereafter, in group X, patients received propofol and fentanyl 1mcg/kg/hr,and in group Y, patients received ketofol and fentanyl 1mcg/kg/hr. In both groups, bispectral index (BIS)was maintained between 40-60.

The amplitude and latency were recorded thereafter at 4 time points: T1 (30 mins), T2 (60 minutes), T3 (90 minutes) and T4 (120 minutes)

Results: In group X, propofol did not result in significant change in amplitude and latency in any muscle.

In group Y, ketofol resulted in significant increase in amplitude at all time points in bilateral APB muscles and 60, 90, and 120 mins in left AH muscle without change in latency.

When the 2 groups were compared, ketofol resulted in statistically higher amplitudes at 60, 90, 120 mins in (L) APB, at 30, 60, 90, 120 mins in (R) APB and at 120 mins in both AH muscles;

latency was comparable in both groups. Blood pressures were lower whereas fluid and vasopressor requirement were higher in group X. Muscle power was comparable between the two groups.

Conclusion: Ketofol increases amplitude of Motor Evoked Potential (TcMEPs), in comparison to Propofol, probably secondary to maintenance of haemodynamics.

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Intraoperative Hemodynamic Instability and Major Blood Loss during Extradural Spine Tumour Resection: A Retrospective Cohort Study

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Background: Patients who undergo resection of extradural spine tumours undergo often highly complex surgery that is associated with a high rate of postoperative adverse events. These procedures may require staging over multiple days and, in practice, these patients experience substantial blood loss and hemodynamic instability. Few reports exist in the literature describing in detail the intraoperative anesthetic complications and postoperative disposition beyond isolated case reports.

Objectives: 1) Describe the incidence and predictors of intraoperative hemodynamic instability and major blood loss and 2) Determine the incidence of postoperative ventilation, intensive care unit (ICU) admission and length of hospital stay (LOS).

Methods: With institutional ethics approval, we identified patients who underwent extradural spine tumour resection at our institution between January 1, 2009 and October 5, 2017. We extracted demographic and patient data, anesthetic and surgical management. Our primary outcome was a composite of 1) major blood loss (³4 packed red blood cells or estimated blood loss (EBL) >1000ml or >1000ml blood salvaged/returned) and hemodynamic instability (norepinephrine infusion >4 mcg/min, phenylephrine >0.8 mcg/kg/min or systolic blood pressure <90mmHg for >10 minutes). Secondary outcomes included postoperative ventilation, ICU admission, and LOS. Multivariate regression was used to determine independent predictors of the primary outcome. Data analysis was performed using STATA 12.1 (StataCorp, USA).

Results: We identified 101 patients and excluded 15 patients due to unavailable anesthetic records, leaving 86 patients for the analysis. Mean age was 49 (standard deviation [SD] 20) years and 58% (n=50) were male. Surgery was indicated for primary tumours in 85% (n=73) and metastatic tumours in 15% (n=13) and located in the cervical (15%, n=13), thoracolumbar (62%, n=53), sacral (23%, n=20) regions. Procedures were staged in 18 patients (21%), with an average surgical duration of 10.8 (SD 6.5) hours and EBL 2707 (SD 3711) ml. Cell salvage was used in 56 patients (65%) and tranexamic acid in 79 (92%) patients. Our primary outcome was present in 53 patients (62%) (n=29 major blood loss and n=43 hemodynamic instability; note n=19 had both). Independent predictors of the primary outcome (AUROC 0.713) were age (adjusted OR 1.32 per decade, 95% confidence interval [CI] 1.02 to 1.72, p=0.035) and staged procedure (adjusted OR 4.48, 95% CI 1.18 to 17.96, p=0.027) (Figure 1). Postoperative

ventilation (75% vs 36%, p<0.001), ICU admission (32% vs 9%, p=0.018) and longer LOS (median 24 [IQR 16-41] vs 10 [7-16] days, p=0.0075) were more common in patients who experienced the composite outcome vs those who did not, respectively.

Discussion: Our results quantified a high rate of intraoperative major blood loss and hemodynamic instability in patients undergoing extradural spine tumour resection. Anesthesiologists should prepare appropriately, particularly in older patients undergoing staged procedures. Postoperative ventilation, ICU admission and longer LOS should be anticipated.

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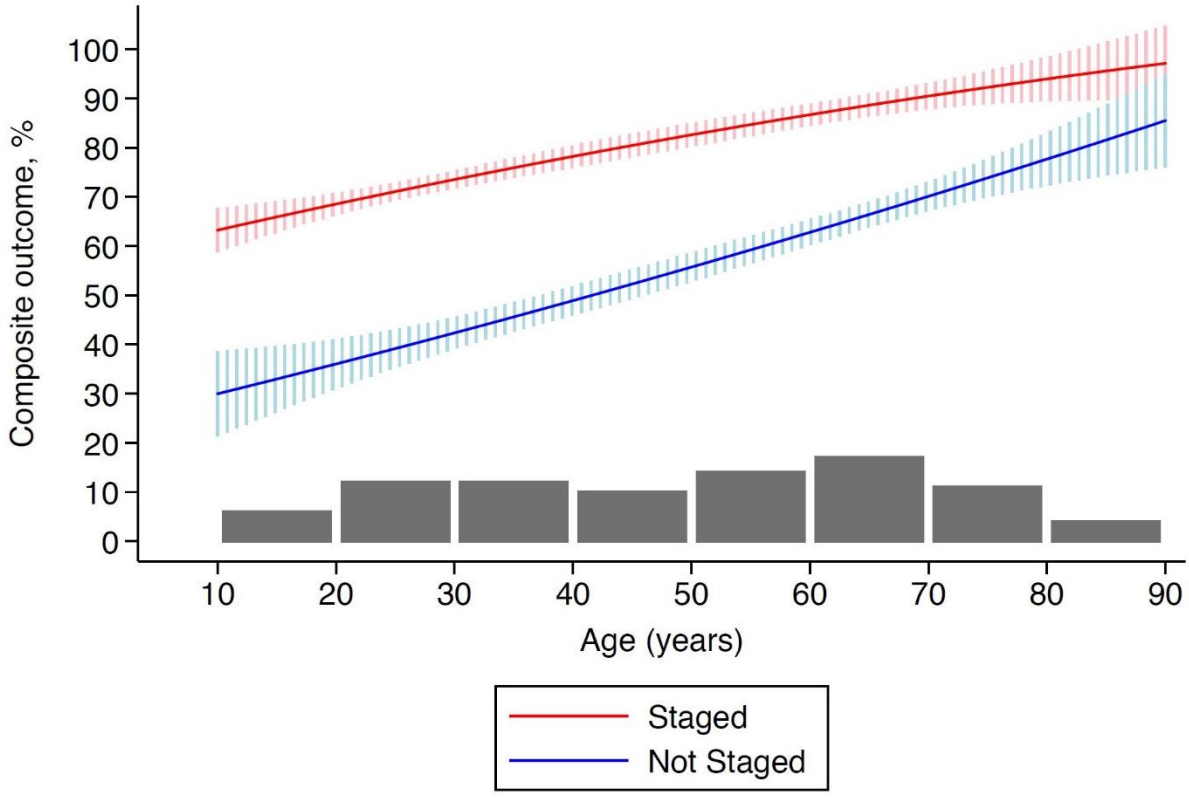

Novel Front Bar Removal to Facilitate Airway Management with a Leksell Headframe in Situ

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Background: Sterotactic headframes, such as the Leksell G model, are required for numerous neurosurgical procedures (Figure 1). In particular, this frame is used for MRI-guided Laser Interstitial Thermal Therapy (MRgLITT), a procedure requiring multiple patient transfers to allow for interoperative imaging and treatment (1). Therefore, loss of the airway during the procedure presents a real possibility and may present a major airway challenge for the Anesthetist as this Leksell frame is designed with a straight front bar which completely obscures oral access. Although previous papers have suggested the entire head frame to be removed during an airway emergency (2), we describe a novel method to remove only the front bar. Therefore, the objective of this paper is to first examine the ease of intubation with the stereotactic headframe in situ and secondly to describe and compare a novel approach to rapidly remove only the front bar.

Materials and Methods: Ethics approval was not applicable because the study did not involve human or animal research. This is an observational study where a Leksell G frame with the straight front bar was secured on a mannequin. Anaesthesiologists from a single centre were asked to intubate the mannequin using a CMAC 3 with the frame fully in situ and again with only the front bar removed. In addition, Neurosurgical staff were separately timed removing the entire frame and again removing only the front bar using a newly described technique.

Results: 18 Anaesthesia personnel participated in the study as well as 4 neurosurgeons. All anaesthesia personell were able to intubate the mannequin with both the leksell frame on and with the front bar removed. The average time to intubate the mannequin in the frame was 23.5 (11.4) seconds and with the front bar removed, 10.9 (2.5) seconds; $p<0.001$. The average time taken to remove just the front bar by the neurosurgeons was 35.4 (7.3) seconds compared to an average of 83.3 (18.6) seconds; $p<0.001$ to remove the headframe entirely.

Conclusion: Although it is still possible to intubate with the Leksell frame straight front bar in situ, it is much faster to intubate with the front bar removed. As well, difficult airway situations requiring complex airway manipulation using this frame will be greatly facilitated by removing the front bar. Additionally, removing the front bar takes less than half the time than removing the entire headframe. The other benefit, is that detailed surgical planning is completed with the frame in place and therefore having to remove the entire frame would negate the entire procedure, however, removing only the front bar would allow the procedure to continue once the airway was again secured. Therefore, this new method should be considered when developing airway management in Leksell frame guidelines.

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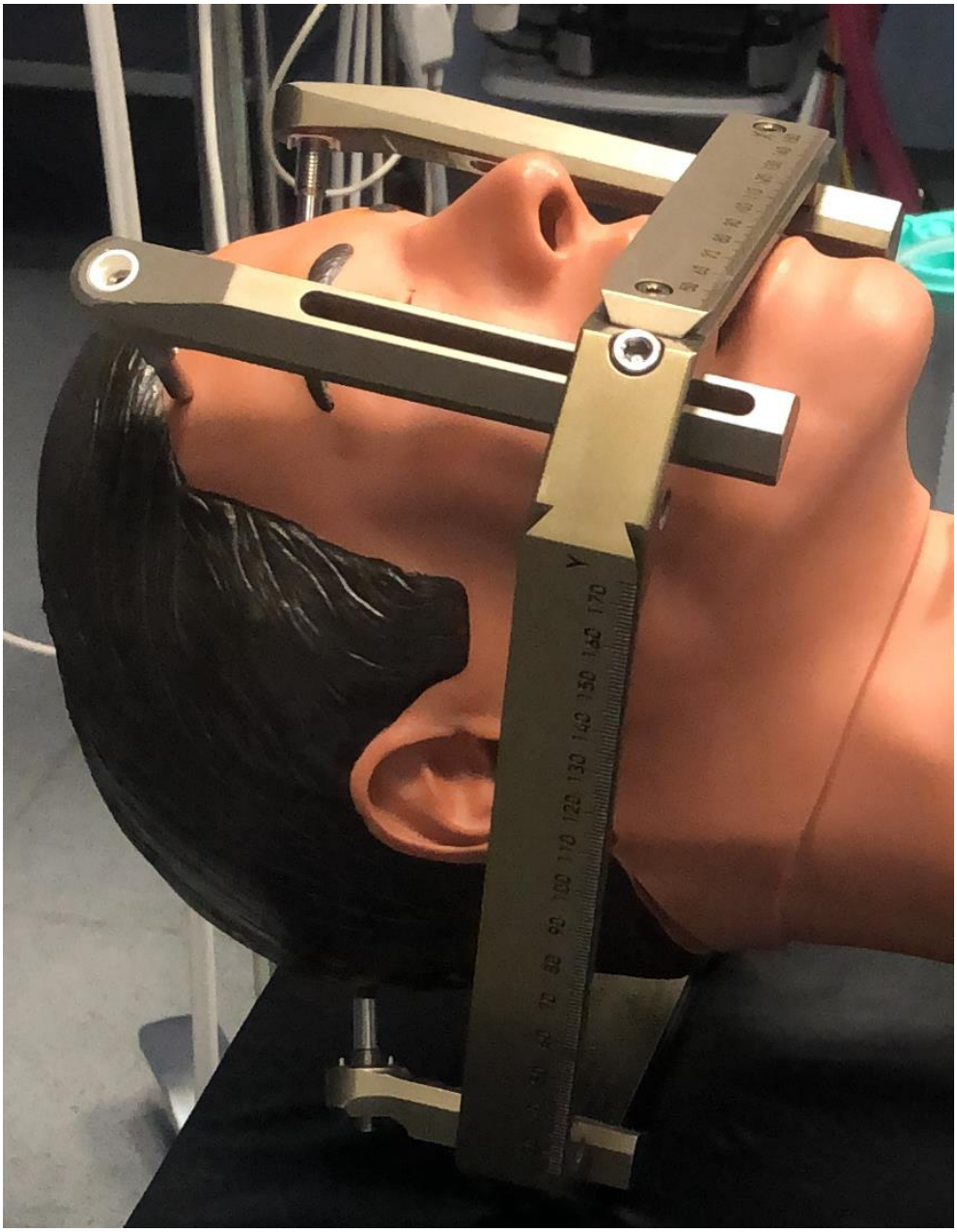

Seizures During Awake Craniotomy: A Retrospective Study on Incidence and Outcomes

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Introduction: Intraoperative seizures are one of the worrisome complications during awake craniotomy (AC) with reported incidences between 3 and 30%[1]. Intraoperative seizures may lead to loss of patient cooperation, airway complications, and unplanned conversion to general anesthesia (GA). The aim of this study was to characterize the incidence, causes, management and postoperative evolution of intraoperative seizures during ACs at our institution.

Methods: Ethics approval was obtained from the local REB. A retrospective review of all ACs performed by a single surgeon in our institution from 2004 to 2018 was done to identify cases of intraoperative seizures. Data collected included patient demographics, surgical pathology, incidence, presentation, management of intraoperative seizures and postoperative disposition of the patient. Data were analyzed and presented descriptively as either absolute number and/or % as indicated.

Results: 706 ACs were performed between 2004 and 2018, and 25 patients had intraoperative seizures, with an overall incidence of 3.5%. All seizures were focal except for one generalized seizure. The baseline diagnosis was high-grade glioma in 9 patients, metastasis or radiation necrosis in 9 patients, and other pathologies in 7 patients. A preoperative diagnosis of seizures was present in 13 patients (52.0%), all of whom received antiepileptic medication preoperatively. Seizures were associated with intraoperative electrical stimulation in 21 patients (84.0%). Data on intraoperative seizure treatment was not available in 6 patients (24.0%). Seizures stopped spontaneously in 6 cases (24.0%), needed cold saline irrigation of the brain in 8 cases (32.0%; cold saline alone in one case, combined with propofol or benzodiazepines in 7 cases), propofol bolus in 10 cases (40.0%), and benzodiazepines in two cases. Phenytoin was used with propofol in one case, and midazolam in one case. One patient required conversion to GA in the setting of a possible venous air embolism. No other airway related complication was recorded. Two patients had recurring seizures in PACU. 12 patients (48.0%) presented a new neurologic deficit in post-op, while 4 of 23 patients (17.4%) with available follow-up data still had a persisting deficit on follow-up. 8 patients were discharged from PACU to day surgery, 9 patients to the floor, 4 patients to the ICU, and 4 patients had missing discharge data. Three patients scheduled for day surgery had an unplanned admission to the hospital.

Conclusions: Our study from a large volume of awake craniotomy cases show that the incidence of intraoperative seizures is about 3.5%. Almost all seizures were focal in nature and a majority were caused by electrical stimulation of the brain. Most seizures were controlled without converting to general anesthesia, and were not associated with long-term sequelae. Further analysis is underway comparing this series of patients with patients who did not have seizures to characterize risk factors of seizures in this setting.

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The Automated Nerve Monitor Reduces Neurological Deficits and Improve Quality of Life in Total Shoulder Arthroplasty Surgery: A Prospective Blinded, Randomized Controlled Study

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Background: Evoked potential (EP) monitoring is routinely used to prevent neurological injury in various surgical settings globally. However, its controversial efficacy and cost-effectiveness of EP monitoring has triggered the scrutiny of the health care funders (1-6). To address these limitations, we performed a prospective, blinded, randomized controlled trial to assess the efficacy of using an automated nerve monitor (EPAD®, SafeOp Surgical) (7-8) to reduce neurological injury in patient undergoing total shoulder arthroplasty (TSA).

Methods: Ethics approval was obtained from the local REB. Patients undergoing TSA in a single tertiary institute at Canada were randomized into either the automated nerve monitor or no monitor groups at 1:1 ratio. The patients and outcome assessors were blinded. The primary outcome was intraoperative nerve injury burden as assessed by the cumulative duration of nerve alert. The secondary outcomes were the neurological deficits and shoulder functional scores (ASES score) of the operative arm, and the quality of life health state index (EQ5D-5L) at postoperative 2 weeks, 6 weeks and 3 months. We further assessed the relationship between the postoperative outcomes and the day(s) since the study commenced using linear regression analysis.

Results: From September 2018 to July 2019, 213 patients were screened, of which 200 patients were randomized. There was no significant difference of the cumulative duration of intraoperative nerve alert between the nerve monitored and the control groups (mean (SD): 12.7 (19.4) and 15.5 (21.8) minutes; p=0.54). There were no differences of all the secondary outcomes between two groups, including postoperative neurological deficits, shoulder functional scores, and quality of life health state index at postoperative 2 weeks, 6 weeks and 3 months. However, there were statistically significant trends of reduction of the neurological deficits (β = -0.0009 (95 CI: -0.0015 to -0.0002), $p < 0.01$) and improvement of the quality of life (β =0.0002 (95 CI: 0.00003 to 0.0005), p =0.02) over the study period (Fig. 1).

Conclusion: The use of automated nerve monitor was associated with reduction in postoperative neurological deficits, and improvement in quality of life in both groups over the study period. This outcome benefit was corroborated by the clinical observation that the surgeons modified their surgical technique in response to the real-time feedback provided by the automated nerve monitor, suggesting either a learning or Hawthorne effect. Importantly, these benefits were found in patients who were not being monitored (i.e. control group), as well

as these surgical techniques improvement were seen even in a group of highly experienced surgeons participating in this study. This study also represents an important initiative to overcome the current logistic constraints that hamper the application of EP monitoring that may benefit many high-risk surgical patients worldwide.

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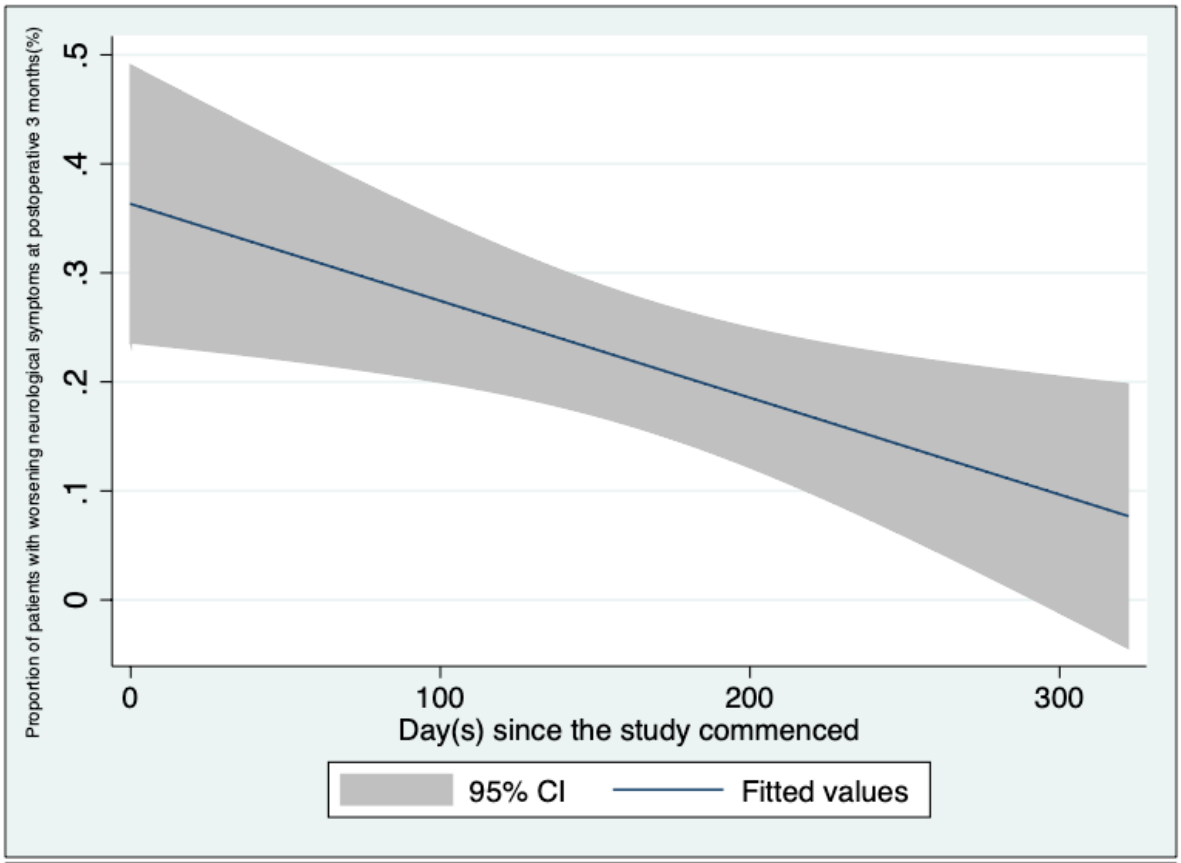
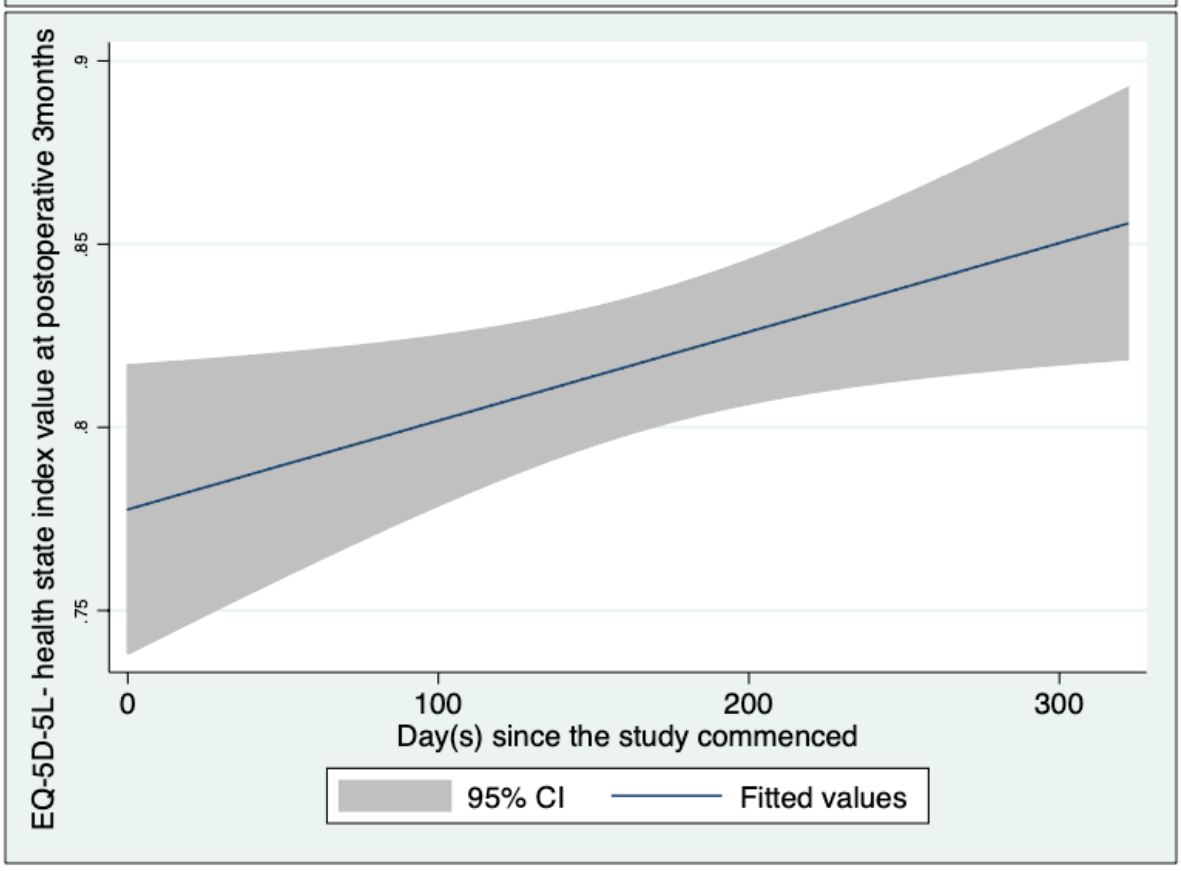

Proportion of patients with worsening neurological symptoms at postoperative 3 months(%)
0
.1
.2
.3
.4
.5
0
100
200
300
Day(s) since the study commenced
95% CI
Fitted values


EQ-5D-5L- health state index value at postoperative 3months
.75
.8
.85
.9
0
100
200
300
Day(s) since the study commenced
95% CI
Fitted values