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### Title

SURG-20. IDENTIFICATION OF INFILTRATIVE CANCER CELLS AT THE GLIOMA RESECTION CAVITY MARGIN USING STIMULATED RAMAN SCATTERING MICROSCOPY

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#### SURG-15. SURVIVAL OUTCOMES FOLLOWING RE-RESECTION FOR RECURRENT GLIOBLASTOMA MULTIFORME

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**BACKGROUND:** While the treatment of primary Glioblastoma Multiforme (GBM) is well defined, the role of surgical resection in recurrent GBM is not firmly established.<sup>1</sup> Treatment options for recurrent GBM include second-line chemotherapy, re-irradiation and surgical re-resection.<sup>2</sup> This review examines current practice in a national neuro-oncology centre. **AIMS:** To investigate survival outcomes in patients undergoing surgical re-resection for recurrent GBM in our institution and to compare our findings to the relevant published literature. **METHODS:** A retrospective review of our institution's neuro-oncology database was performed. We evaluated all patients who underwent re-resection for recurrent GBM following standard adjuvant treatment between 2015–2018. Patients who did not have an initial diagnosis of Grade 4 GBM and patients who were re-operated on within one month were excluded. We analysed overall survival using Kaplan Meier curves. Patients not known to have died were censored to the last known alive date. We also examined factors which may affect patient outcome, including age, sex, extent of resection, tumour characteristics and tumour location. **RESULTS:** 34 patients were eligible for inclusion into this study, of these 21 (61%) were male. Median age was 52. A radiologically confirmed initial resection of > 80% was achieved in 52% of patients. Median time from initial surgery to re-resection was 13.5 months. Median survival from initial surgery was 28.6 months and median survival after re-resection was 9.5 months. **CONCLUSION:** Re-operation appears to have a role in the management of recurrent GBM in carefully selected cases. Overall survival in this patient cohort remains poor and further studies into the benefit of re-resection in comparison to second-line chemotherapy and re-irradiation would be of value.

#### SURG-16. SUPRATOTAL VERSUS GROSS TOTAL RESECTION OF GLIOBLASTOMA: A SYSTEMATIC REVIEW

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**INTRODUCTION:** Due to the infiltrative nature of glioblastoma(GBM) outside of the contrast enhancing region in the peritumoral zone, there is increasing movement to perform supratotal resections (SpTR) by extending the edge of resection beyond the contrast enhancing portion of the tumor. However, there is currently no consensus on the potential survival benefit of SpTR in GBM as compared to gross total resection (GTR). **METHODS:** Therefore, we performed a systematic review using PRISMA guidelines and performed a comprehensive literature search on Pubmed, EMBASE, The Cochrane Library, Web of Science, Scopus, and ClinicalTrials.gov, from inception to August 16, 2018, to identify articles comparing overall survival (OS) after SpTR versus GTR. Furthermore, we assessed study quality using the Oxford Centre for Evidence-Based Medicine guidelines. **RESULTS:** We identified 8902 unique citations, of which 11 articles and 2 abstracts met study inclusion criteria. 925 patients underwent SpTR out of a total of 2137 patients. 9 of the 13 studies demonstrated improved survival with SpTR compared to GTR (median improvement in OS of 10.5 months), with no significant difference in post-operative complication rate. Conversely, one abstract found worsened outcomes with SpTR compared to GTR (median decrease in OS of 4 months). However, overall study quality was poor, with 12 of the 13 studies of level IV evidence and one study of level IIIb evidence. We were unable to perform a meta-analysis due to significant clinical and methodological heterogeneity amongst the studies (e.g. differences in adjuvant therapy and lack of standardization of definition of supratotal resection). **CONCLUSIONS:** Our systematic review indicates that SpTR may be associated with improved OS compared to GTR for GBM. However, this is limited by poor study quality and significant clinical and methodological heterogeneity amongst the studies. There is need for prospective clinical trials to further establish standardized guidelines for SpTR in GBM.

#### SURG-18. 5-AMINOLEVULINIC ACID FLUORESCENCE (5-ALA) GUIDED RESECTION OF GLIOBLASTOMA, LESSON LEARNED FROM 19 CASES

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**BACKGROUND:** 5-ALA is known as useful tool for high grade glioma resection and the accumulation extent of 5-ALA is known as far beyond gadolinium enhancement. Extent of resection is key factor for favorable outcome and long-term survival for high grade glioma patients and 5-ALA might increase extent of resection. We present our experience of

5-ALA guided glioma surgeries **METHODS:** Total 19 patients were performed 5-ALA guided surgery. They ingested 20mg/kg, four hours before craniotomy. We tried to perform supra-total resection rather than gross total resection according to the tumor consistency and if the tumor located relatively non-eloquent area, we tried to perform lobectomy rather than lesionectomy. After tumor resection, we inspect the tumor bed under 5-ALA fluorescence, and we confirmed the complete loss of fluorescence on the tumor resected bed. We check the MRI within 48 hour after operation and assess the extent of resection **RESULTS:** Among the 19 patients, 15 patients were confirmed glioblastoma and 3 anaplastic astrocytoma and 1 anaplastic oligoastrocytoma. We confirmed all enhancing lesion was completely removed, however, 2 patients show residual non-enhancing lesion in post-operative MRI. Two patients suffered temporary hemiparesis and 2 patients show permanent visual field defect. **CONCLUSION:** 5-ALA is useful tool for glioma surgery. Resection extent could be increased, however, non-enhancing lesion in the high grade gliomas, might be missed under 5-ALA guidance.

#### SURG-19. REORGANIZATION OF LANGUAGE ENABLES SAFE RESECTION OF TUMORS IN AND AROUND BROCA'S AREA

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**INTRODUCTION:** Since its discovery in the 1800s, Broca's area has been viewed as a critical node for language production. Previously, pathologies in this area have been considered unresectable due to concern for producing iatrogenic language production deficits. Emerging literature suggests that although acute lesions in this area can cause widespread deficits, slow growing lesions are less correlated with these deficits due to cortical language reorganization. Based on this data, we managed a cohort with Broca's area lesions with surgical resection using awake intra-operative language mapping. **METHODS:** All 150 awake craniotomies performed by the senior author over a twelve-year period (2006–2017) at a single institution were reviewed. For each patient the imaging was carefully evaluated to localize the neoplasm relative to pars triangularis or pars opercularis in the language dominant hemisphere. Language dominance was confirmed using WADA testing or fMRI. All patients underwent cortical language mapping using a battery of tasks coupled with cortical stimulation. **RESULTS:** A total of 31 surgeries in 29 patients (65.5% male, 86.2% righthanded) were identified. The average age was 41. Patients presented with seizures (64.5%), speech difficulties (35.5%) or headaches (19.4%). A gross or near total resection was achieved in 26/29 (89.7%) of patients. Pathological evaluation revealed grade 2 gliomas (8), grade 3 gliomas (13) and glioblastoma (9). Post-operatively, 8 (25.8%) patients had new or worsening speech deficits, all of which resolved to baseline at follow-up. **CONCLUSION:** Broca's area lesions can be safely resected in patients using an awake craniotomy technique with language mapping. In our series, the majority of patients had gross or near total resections, few patients had new deficits, and none had permanent new deficits. Considering the increasing evidence in favor of cytoreduction to manage glial neoplasms, this technique should be employed routinely for pathologies in this area to optimize patient outcomes.

#### SURG-20. IDENTIFICATION OF INFILTRATIVE CANCER CELLS AT THE GLIOMA RESECTION CAVITY MARGIN USING STIMULATED RAMAN SCATTERING MICROSCOPY

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**INTRODUCTION:** Microscopic residual disease at the tumor margin is the primary barrier to complete resection which impacts outcome. Stimulated Raman scattering microscopy (SRM) has proven effective to classify CNS tumor tissue and detect tumor cells within grossly normal post mortem glioma specimens. In this study, we use SRM for detection of residual glioma cells within the resection cavity margins. **METHODS:** Patients with gliomas undergoing surgical resection were included. Margin samples were taken after the primary surgeon determined the resection cavity wall to be grossly normal and were analyzed using (1) true H&E, (2) SRM pseudo H&E, (3) immunohistochemical stains (IHC) for IDH1-R132H or p53. The sections were scored on a scale of 0–3 by a neuropathologist blinded to the corresponding results from each modality (0=no definite tumor cells; 1=rare tumor cells; 2=moderate tumor cells with preserved neuropil; 3 = abundant tumor cells). Positive and negative predictive values and Spearman correlation coefficients were calculated. **RESULTS:** Ninety-one margin samples from 19 patients were included. Tumors were WHO grade II (29.7%), III (38.5%), and IV (31.8%). There was a strong correlation between SRM and H&E (Spearman correlation ( $r$ ) = 0.76), SRM and IHC ( $r$ =0.81), and H&E and IHC scores ( $r$ =0.91). PPV of SRM score of 3 was 100%. The presence of tumor cells on SRM (scores 1–3) strongly correlated with the presence of tumor cells on H&E

(PPV = 95%) and IHC (PPV = 91%). The absence of tumor cells on SRM correlated with absence of tumor on H&E and IHC only 10% and 50% (NPV) of the time, respectively. **CONCLUSIONS:** The PPV of utilizing SRM to detect residual glioma cells in grossly normal resection cavity margins is high however the NPV is low. SRM may have utility as a rapid point-of-care intraoperative tool for identification of infiltrative glioma within resection cavity margins.

#### **SURG-21. STEREOTACTIC BIOPSY FOR DEEP SEATED BRAIN LESIONS USING THE LEKSELL STEREOTACTIC FRAME SYSTEM**

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**PURPOSE:** To evaluate the results of stereotactic biopsies. **PATIENTS AND METHODS:** Fifty-two patients with intraaxial lesions suspected of brain tumor. The locations of lesions includes, 19 deep cerebral white matter, 9 basal ganglia, 10 thalamus, 4 midbrain and 6 pons. Patients age ranged from 9 to 86 years (median 65 years), 33 were men and 19 were women. Under local anesthesia the Leksell stereotactic frame was fixed and the MRI were taken. Neuroimages such as enhanced CT scan or PET study were also used as references. After MRI patients were transferred to OR and under general anesthesia, several samples were taken with 2.1mm diameter needle by aspiration. Most of the cases the biopsy was done through frontal lobe, but in some cases through temporal lobe or through cerebellum. The samples were taken deeper and nearer regions of the designed targets with same trajectory, also. If there were cysts, aspiration of the cyst was performed as much as possible. The trajectory should avoid sulci, cortical veins or ventricular system. After biopsy inside the needle were irrigated repeatedly with 0.1 - 0.2 ml saline using thin plastic tube until the fluid does not contain bloody fluids to ensure hemostasis. **RESULTS:** In all patients appropriate samples for pathological diagnosis were obtained. The diagnoses were 28 gliomas (pilocytic 1, grade II 8, grade III 11, grade VI (GBM) 6, high grade 1, glial tumor 1), 17 lymphomas, 3 germinoma and 2 were non-tumorous pathology. There were no symptomatic bleeding nor neurological complications. **CONCLUSION:** With detailed planning, stereotactic biopsy was safely performed even from basal ganglia or brainstem. Trajectories other than from frontal can be also considered for some lesions. Repeated irrigation with saline might effective to prevent symptomatic bleeding and this case series shows lower complication rates compared to the published literatures.

#### **SURG-22. CUSHING'S DISEASE: A DIFFICULT TO TREAT NEURO-ONCOLOGICAL CONDITION**

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**BACKGROUND:** Cushing disease (CD) comprises a spectrum of clinical manifestations secondary to hypercortisolism due to ACTH-secreting pituitary adenoma. Transsphenoidal adenectomy remains the standard treatment. Because of the significant rate of recurrence or persistence of CD, it is of interest to determine factors that may correlate with long-term outcomes following surgical intervention. **OBJECTIVE:** The objective of our study is to determine the remission rate after surgery with special emphasis on factors affecting remission. **METHODS:** Data of all patients undergoing surgery for CD from 2009 to 2017 was analyzed retrospectively. Transphenoidal resection was the preferred treatment with a recent trend in favor of endonasal endoscopic skull base approach. Post-operative cortisol level of < 2 µg/dL was taken as remission and value between 2 and 5 µg/dL as possible remission. **RESULTS:** 104 patients operated primarily for CD were included for analysis. 47 patients underwent microscopic surgery, 55 endoscopic surgery and two were operated trans-cranially. Remission was achieved in 76.47% of patients. In univariate analysis, factors significantly associated with remission were (1) type of surgery (p=0.01); endoscopy (88.23% remission) better than microscopy (56.6% remission) (2) postoperative day-1 morning cortisol (p=0.004) and; (3) postoperative day-1 morning ACTH (p=0.015). In multivariate analysis, however only postoperative day-1 cortisol was found to be significant as predictor of remission (p=0.02). **CONCLUSION:** Postoperative plasma cortisol level is a strong independent predictor of remission and value less than 10.7µgm/dl can be taken as cut off for predicting remission. Remission provided by endoscopy appears to be significantly better than microscopic approach.

#### **SURG-23. INTRAPARENCHYMAL MUCOSA-ASSOCIATED LYMPHOID TISSUE (MALT) LYMPHOMA: A NOVEL DISEASE PRESENTATION**

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**INTRODUCTION:** Low grade B-cell lymphomas arising from the marginal zone of secondary lymphatic follicles constitute less than 10% of lymphomas. This condition was initially described in the stomach and the

nasopharynx. However, there have been several reports of isolated dural-based intracranial lesions. **METHODS:** A review of the literature using the EMBASE and MEDLINE databases yielded 12 previous cases of dural MALT lymphomas but none that were entirely intra-parenchymal. **RESULTS:** Here, we present the case of a 67 year male who was found to have a convexity meningioma; and another, intra-parenchymal, lesion with radiologic features consistent with a low grade glial tumor. Upon resection of both lesions, the intra-axial tumor was found to be a mucosa-associated lymphoid tissue lymphoma. He has subsequently been referred for initiation of needing adjuvant therapies. **CONCLUSIONS:** In addition to posing challenges for radiologic diagnosis, this case presents questions regarding the oncologic management of MALT lesions in the brain.

#### **SURG-24. A RISK SCORE FOR PREDICTING DEVELOPMENT OF DIABETES INSIPIDUS AFTER PITUITARY ADENOMA RESECTION**

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**INTRODUCTION:** The development of diabetes insipidus (DI) after pituitary adenoma resection is associated with worse post-surgical morbidity and longer hospital stay. Identification of clinical predictors of development of DI would allow for appropriate stratification of patients to optimize pre-operative counseling and postoperative management. **METHODS:** We conducted a retrospective review of 349 patients who underwent pituitary adenoma resection at Johns Hopkins Hospital between 2003 and 2017. We used unadjusted and adjusted logistic regression to identify predictors of developing DI. Factors which were associated with DI development (p< 0.1), were included in our multivariable model. Factors which remained associated with DI development were then used to develop a DI risk score. **RESULT:** 67 (19.2%) patients developed post-surgical DI. Patients who had symptoms of prolactinoma, surgery through one nare, or were on steroid treatment were more likely to develop DI. Conversely, patients who had unilateral cavernous sinus invasion were less likely to develop DI. We used these predictors to generate the DI risk score. Patients were assigned 1 point for each risk factor (symptoms of prolactinoma, steroids, or surgery through one nare) for developing DI, but 1 point was subtracted if they had a protective factor (unilateral cavernous sinus invasion). Patients with 0 points had a 10.7% probability of developing DI, patients with 1 point had a 18.5% probability of developing DI, patients with 2 points had a 41.2% probability of developing DI, and patients with 3 points had a 44.4% probability of DI. **CONCLUSIONS:** We identified several predictors of DI development after pituitary adenoma resection, and used these to generate a DI risk score. The DI risk score could help stratify patients' likelihood of postsurgical DI development, although validation through larger prospective multi-center studies are needed.

#### **SURG-25. LASER INTERSTITIAL THERMAL THERAPY (LITT) FOR INTRACRANIAL LESIONS: A SINGLE- INSTITUTIONAL SERIES, OUTCOMES AND REVIEW OF THE LITERATURE**

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**INTRODUCTION:** Laser interstitial thermal therapy (LITT) is a minimally invasive treatment method that provides surgeons with cytoreductive techniques to treat neurosurgical conditions such as primary brain neoplasms, brain metastases, radiation necrosis, and epileptogenic lesions, many of which are located in operative corridors that would be difficult to address via open surgical or are amenable via minimally invasive approaches. Although the use of lasers is not a new concept in neurosurgery, advances in technology have enabled surgeons to perform laser treatment with the aid of real-time MRI thermography as a guide. In this report, we present our institutional series and outcomes of patients treated with LITT for 8 glial neoplasms 12 brain metastases. **METHODS:** We retrospectively evaluated 20 patients (7 male, 13 female; age range, 28–77 years) who underwent LITT at one or more targets from 2015–2019. **RESULTS:** In our series, all patients included had prior craniotomy for either primary glioma or metastatic disease. Mean extent of ablation (EOA) was 98% on post-op MRI. Mean progression free survival varied depending on the intracranial pathology, with the glioma cohort (5 months (SDD: 3.51)) demonstrating worse outcomes than metastatic disease (8.2 months (SDD: 4.83)). Only 1 patient experienced immediate post-operative morbidity, 1 patient experienced post-operative mortality secondary to hemorrhage. Mean follow-up was 9.7 months (SDD: 5.35), with one patient lost to follow up immediately post-procedure and excluded from the study. Average hospitalization was 2.4 days (SDD: 1.0). Mean overall survival, post-diagnosis of intracranial lesion, is more favorable for metastatic lesions (48 months (SDD: 27.14)), as compared to pri-