resists an alternative to surgery in poor surgical candidates. We aimed to investigate the clinical efficacy and safety of 2-SSRS in patients with LBM. METHODS: LBM of patients treated with 2-SSRS between 2014 and 2020 were evaluated. Demographic, clinical, and radiologic information was obtained. Volumetric measurements at first SSRS, second SSRS, and follow-up imaging studies were obtained. RESULTS: Twenty-six patients with 28 LBM were included in the study. Fifteen patients (58%) were male. Median age at first SSRS was 61 years (range: 31-94). Median marginal dose for first and second SSRS were 15 Gy (range: 12-18 Gy) and 15 Gy (range: 12-16 Gy), respectively. Median duration between sessions was 32 days. Two patients (8%) failed to receive their second SSRS due to local progression. Median time between SSRS was 3 months (range: 1-6 months). Median follow-up for 6 months after the first SSRS was 20 Gy. Median survival was 18 years. The tumor control rate as well as the survival time were related to a number of patients, tumor and treatment parameters. RESULTS: The local tumor control rate was 100% at one year and 92% at five years, and the overall median survival was 17 months. A good performance status and a treatable extracranial disease were favorably related to survival time. Two complications were observed, one was intraventricular hemorrhage at the day of the treatment and one transient complication three months following GKS, while six remained unchanged. CONCLUSIONS: High local control and a low complication rates can be achieved using GKS for BMs using lower doses as compared to brain metastases in other locations.

RADI-06. GAMMA KNIFE SURGERY FOR BRAIN STEM METASTASES
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INTRODUCTION: Gamma Knife Surgery (GKS) is widely used for treatment of brainstem metastases (BSMs) with or without whole brain radiation therapy (WBRT). We hypothesized that BSMs treated with GKS using lower doses and omitting WBRT result in acceptable tumor control rates and low complication rates. METHODS: A retrospective single center study was performed to investigate the outcome following GKS of BSMs. All 33 patients with follow-up information treated with GKS for 39 metastases located in the cerebral peduncle, midbrain, pons or medulla oblongata were included in the study. The median treatment dose delivered as the lowest dose to 95% of the tumor volume, was 18 Gy. The tumor control rate as well as the survival time were related to a number of patients, tumor and treatment parameters. RESULTS: The local tumor control rate was 100% at one year and 92% at five years, and the overall median survival was 17 months.

RADI-07. INDIVIDUALIZED NOMOGRAM FOR PREDICTING SURVIVAL OF PATIENTS WITH BRAIN METASTASES AFTER STEREOTACTIC RADIOSURGERY
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BACKGROUND: Given the increasing use of stereotactic radiosurgery (SRS) for brain metastases (BM), there is a need for a more precise assessment of survival outcomes after SRS especially in the modern era of immunotherapy. METHODS: Patients with BM and treated by SRS were eligible in this study. Primary endpoint was overall survival (OS). Cox models were used to identify independent prognostic factors. Survival predictive nomogram was constructed and evaluated by Concordance-index (C-index) 780 under the curve (AUC) and calibration curve. RESULTS: From January 2016 to December 2019, a total of 336 BM patients were eligible. Median OS was 17.7 months (95%CI 15.5-19.9) and actual OS at 1- and 2-year measured 63.2% and 37.6%, respectively. Nomogram for OS was developed by incorporating four independent prognostic factors: Karnofsky Performance Score, cumulative tumor volume, driver gene mutation status and serum lactate dehydrogenase. The nomogram was validated in a separate cohort demonstration of well calibration and good discrimination (C-index 0.780, AUC 0.784). The prognostic accuracy of the nomogram (0.792) was considerably enhanced compared with classical prognostic indices, i.e., GPA (0.708), RPA (0.387) and SIR (0.584). Kaplan-Meier curves showed significantly lower survival outcome among stratified low-, intermediate- and high-risk groups (p < .001). CONCLUSION: In conclusion, we developed and validated an individualized prognostic nomogram by integrating physiological, volumetric, clinical chemistry and molecular biological surrogates. This nomogram, should be validated by independent external study, has a potential to facilitate more precise risk-stratifications to guide personalized treatment for BM.

RADI-08. ELUCIDATING THE ELECTROPHYSIOLOGY OF INTRAOPERATIVE RADIOTHERAPY – EXPERIENCE FROM TWO CASES
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Brain metastases require multimodality treatment, often combining surgical resection, radiation therapy, and individualized systemic pharmacotherapy based on oncogenic drivers. Intraoperative radiation therapy (IORT) is an emerging treatment option where radiation is delivered directly to the resection cavity at the time of surgery. We present two patients who underwent electroradiocigraphy (ECoG) during IORT, providing information regarding electrophysiological safety and tolerability of the technique. In the first case, a 63-year-old woman underwent resection of a hemorrhagic right occipital metastasis from non-small cell lung cancer. IORT was administered over sixteen minutes for a surface dose of 30 Gy. In the second case, a 73-year-old man with underwent resection of a right posterior frontal metastasis from non-small cell lung cancer. IORT was delivered over eleven minutes for a surface dose of 30 Gy. In both cases, a 1x6 contact array of subdural electrodes was placed adjacent to the planned field of radiation. Electrocorticography (ECoG) at 70 Hz, Te = 0.3 sec, sensitivity 150µV/mm) was obtained from the array two minutes prior to initiation of therapy, during therapy, and two minutes after completion of therapy in both cases. We found that IORT did not induce electrophysiological change in the tissue surrounding it, in both cases with no epileptiform or ictal discharges during 20 minutes of ECoG recording around the time of radiation therapy, nor did the patients have episodes suggestive of epileptic seizures in the acute post-operative period. One of the patients (case 1) experienced a single epileptic seizure 4 months after IORT, but this was temporally related to a new intraparenchymal hemorrhage and unlikely due to radiation therapy. These two cases illustrate the relative safety of IORT with respect to induction of immediate epileptiform changes within the brain parenchyma.

RADI-09. CLINICAL FACTORS ASSOCIATED WITH DEATH AFTER RADIOTHERAPY FOR BRAIN METASTASES
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INTRODUCTION: It can be challenging to accurately identify patients with brain metastases who have very poor prognosis and are unlikely to benefit from radiation therapy (RT). We characterized factors of patients who died within 30 days of receiving RT for brain metastases. METHODS: Patients who received whole brain RT (WBRT) or stereotactic radiosurgery (SRS) for brain metastases between 1/1/2017-9/30/2020 at a single institution were identified. Patient, tumor, treatment, and death variables were collected. Characteristics between those who did and did not die within 30 days were compared using the Wilcoxon Rank-Sum or Chi-Square test. Survival was estimated with Kaplan-Meier method. RESULTS: 636 patients received WBRT (n=117) or SRS (n=519). Median age was 61. Median survival was 6 months (95%CI = 5–7 months). 75 (12%) died within 30 days of RT. Patients who died within 30 days had worse median KPS (50 vs 80, p<0.001). A higher proportion who died within 30 days had innumerable intracranial metastases (45% vs 11%, p<0.001), leptomeningeal disease (16% vs 5%, p<0.001), and higher burden of neurologic symptoms at presentation (seizures (12% vs 4%, p<0.003); cranial neuropathies (32% vs 9%, p<0.001); motor/sensory deficits (51% vs 29%, p<0.001); altered mentation (60% vs 26%, p<0.001); head aches (48% vs 30%, p<0.001); steroid use (68% vs 48%, p<0.001)). Patients who died within 30 days had progressive extracranial disease (intrathoracic: 87% vs 50%; spinal: 57% vs 18%; liver/adrenal: 60% vs 24%), p<0.001. More patients who died within 30 days received inpatient RT (39% vs 4%, p<0.001) and did not complete RT (24% vs 1%, p<0.001). DISCUSSION: More patients who died within 30 days of RT had poor KPS, intracranial/extracranial disease burden, and neurologic symptoms. Future analyses will assess whether these factors can inform a prognostic model to identify patients with poor prognosis who may be appropriate for supportive care alone.

RADI-10. IS THERE ANY BENEFIT FOR POST-OPERATIVE RADIATION IN BRAIN METASTASES? A SYSTEMATIC REVIEW AND META-ANALYSIS OF RANDOMIZED CONTROLLED TRIALS
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PURPOSE: The benefits of adding upfront post-operative radiation (either whole-brain or cavity radiation) have been debated, particularly due to the post-
sible detriment in cognition post-radiation. We sought to compare the efficacy and safety between the surgical resection of brain metastases (BM) plus radiotherapy versus surgical resection alone. MATERIALS AND METHODS: We searched various biomedical databases from 1983 to 2019, for eligible ran- domized controlled trials (RCT). Outcomes studied were local recurrence (LR), overall survival (OS), and serious (Grade 3+) adverse events (AE). We used the random-effects model to pool outcomes. The methodological quality of each study was assessed using the Cochrane Risk of Bias tool. RESULTS: We included 5 RCTs comprising of 673 patients. The odds ratio (OR) for LR ranged from 0.06–0.34 with a pooled odds ratio of 0.26 (95% confidence interval [CI] 0.19–0.37; P < 0.001), strongly favoring the patients who received postoperative radiation. The overall survival (OS) was only reported in 3 studies and did not show any significant difference. The hazard ratio (HR) ranged from 1.01–1.29 with a pooled HR of 1.1 (95% CI 0.90–1.34; P = 0.37). The treatment-related toxicities were inconsistently reported to draw any meaningful conclusions. The risk of bias was predominantly due to the lack of blinding and was deemed to introduce a low degree of bias. CONCLUSION: Postoperative radiation should be recommended after surgical resection of BM, for it significantly reduces the risk of local recurrence. However, we did not find any improvement in OS, suggesting that improvements in local control at the tumor bed alone may not impact survival. Balancing local control, and possible neuro-cognitive effects of whole-brain radiation, post-operative cavity radiation seems to be an attractive option.

RAD11. EVALUATING THE TISSUE EFFECTS OF DOSE- ESCALATED PRE-OPERATIVE STEREOTACTIC RADIOTHERAPY FOR RESECTABLE BRAIN METASTASIS
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BACKGROUND: Although the classic radiobiologic principles of radiotherapy are well understood, the unique effects of the large fractional dose that characterizes stereotactic radiotherapy (SRT), specifically in terms of antitumor immune cellular processes, vascular damage, tumor necrosis, and apoptosis on brain metastasis have yet to be adequately demonstrated. The objective of this study is to provide the first in-human evaluation of the biological effects of SRT in resected brain metastasis. METHODS: All paired primary tumors and metastases for patients who underwent dose-escalated preoperative SRT followed by resection were evaluated for tumor necrosis using hematoxylin-eosin staining. T cells (CD3+, CD4+, CD8+), natural killer cells (CD56+), vascular endothelial cells (CD31+), and apoptotic factors (caspase-3) were determined by immunohistochemical analysis. RESULTS: Fifteen patients with brain metasta ses from solid tumors received a median preoperative SRT dose of 18 Gy (range: 13–18 Gy) in 1 fraction, with 2 patients receiving 27–30 Gy in 3–5 fractions. Necrosis was defined by resection within a median interval of 90 hours (Range: 17.1–260 hours) after SRT. The rate of necrosis was found to be necrosis rate higher in irradiated brain metastases than in non-irradiated primary tumor sam- ples (mean paired difference: 0.347, SD: 0.29, p = 0.001). A decrease in immunomodulatory cell populations was found in irradiated metastases: CD3+ (mean paired difference -19.4, SD: 31.7, p = 0.031), CD4+ (<10.0, SD: 20.0, p = 0.01), and CD8+ (<17.4, SD: 22.1, p = 0.008). While irradiated samples had numerically lower CD 31, CD 56, and caspase-3 scores, the difference was not statistically significant. Time interval from SRT to surgery had no effect on these param- eters. CONCLUSIONS: There is complex interplay between tumor-associated cells and the unique radiobiological effects of SRT on tumor tissue. Although time interval from SRT to surgery was associated with increased tumor necrosis, differences in immunomodulatory factors may be multifactorial, including concurrent corticosteroids or the immunosuppressive effect of SRT.

RAD12. DEEP LEARNING FOR AUTOMATIC DETECTION AND CONTOURING OF METASTATIC BRAIN TUMORS IN STEREOTACTIC RADIOSURGERY: A RETROSPECTIVE ANALYSIS WITH AN FDA-CLEARED SOFTWARE ALGORITHM
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INTRODUCTION: Artificial intelligence-based tools can significantly impact detection and segmentation of brain metastases for stereotactic radiosurgery (SRS). VBrain is a deep learning algorithm, recently FDA-cleared, to assist in brain tumor contouring. In this study, we aimed to further validate this tool in patients treated with SRS for brain metastases at Stanford Cancer Center. METHODS: We included randomly selected patients with brain metas- tases treated with SRS from 2008 to 2020. Computed tomography (CT) and axial T1-weighted post-contrast magnetic resonance (MR) image data were extracted for each patient and uploaded to VBrain. Subsequent analysis compared the output contours from VBrain with the manually identified contours used for SRS. A brain metastasis was considered “detected” when the VBrain “predicted” contours overlapped with the corresponding physical-iscian contours (“ground-truth” contours). We evaluated performance against ground-truth contours using the following metrics: lesion volume similarity coefficient (DSC), lesion-wise average Hausdorff distance (AVD), false positive count (FP), and lesion-wise sensitivity (%). RESULTS: We analyzed 60 patients with 321 intact brain metastases treated over 70 SRS courses. Resection cavities were excluded from the analysis. The median (range) tumor size was 132 mm3 (7 to 24,765). Input CT scan slice thickness was 1.230 mm, and median (range) pixel resolution was 0.547 mm (0.437 to 0.977). Input MR scan median (range) slice thickness was 1.000 mm (0.940 to 2.000), and median (range) pixel resolution was 0.469 mm (0.469 to 1.094). In as- sessing VBrain performance, we found mean lesion-wise DSC to be 0.70, mean lesion-wise AVD to be 94.0% of lesion size (0.805 mm), mean FP to be 0.657 tumors per case, and lesion-wise sensitivity to be 84.5%. CONCLU- SION: Retrospective analysis of our brain metastases cohort using a deep learning algorithm yielded positive results. Integrating this technology into the clinical workflow can provide further clinical and research insights.

RAD13. SYSTEMIC THERAPY TYPE AND TIMING EFFECTS ON RADIATION NECROSIS RISK IN HER2+ BREAST CANCER BRAIN METASTASES PATIENTS TREATED WITH STEREOTACTIC RADIOTHERAPY
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BACKGROUND: Current standard of care options for HER2+ breast cancer brain metastases (BCBrM) include radiation therapy, brain permeable systemic therapies, and in select cases, neurosurgical resection. There is a concern that HER2-directed systemic therapies when administered concur- rently with stereotactic radiosurgery (SRS) may increase the risk of radiation necrosis (RN). This study explores the impact of timing and type of systemic therapy on the development of RN in patients treated with SRS for HER2+ BCBrM. METHODS: This was a single-institution, retrospective study including patients ≥18 years of age with HER2+ BCBrM who received SRS between 2013 and 2018 with at least 12-month post-SRS follow-up. Presence of RN was determined at one-year post-SRS. Demographics, radiotherapy parameters, and timing (“during” defined as four weeks before/after SRS) and type of systemic therapy were evaluated. RESULTS: Among 46 patients with HER2+ BCBrM who received SRS, 28 (60.9%) developed RN and 18 (39.1%) did not. Age (mean 53.3 vs 50.4 years, respectively), radiotherapy parameters (dose, fraction, CTV, GTV, CI, V12Gy, all p > 0.05), and receipt of any type of systemic therapy during SRS (60.7% vs 55.6%, p = 0.97) did not differ between patients who did or did not develop RN. However, patients who developed RN were more commonly received the HER2-directed therapy independent of SRS timing compared to those who did not develop RN (75.0% vs 44.4%, p = 0.08). In fact, a significantly higher proportion of those who developed RN received more than one line of HER2-directed therapy during a given SRS treatment compared to those who did not develop RN (35.7% vs 5.6%, p < 0.05). CONCLUSIONS: Patients with HER2+ BCBrM who receive multiple lines of HER2-directed therapy during SRS for BCBrM may be at higher risk of RN. Collectively, this data supports a practice of holding HER2-directed therapy during treatment with SRS if medically acceptable.

RAD14. BEVACIZUMAB VS LASER INTERSTITTIAL THERMAL THERAPY IN RADIATION NECROSIS FROM BRAIN METASTASES: A SYSTEMATIC REVIEW AND META-ANALYSIS
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OBJECTIVE: Radiation necrosis (RN) represents a serious post- radiation complication in patients with brain metastases. Bevacizumab...