Purpose/Objective(s): Patients with brain metastases are commonly treated with Radiation therapy (RT). Commonly used RT options include whole brain radiation (WBRT), Stereotactic radiosurgery (1 fraction, fx) or stereotactic radiation therapy (SRT, 2-5 fractions) depending on the number of lesions, primary cancer, KPS and other patient and tumor characteristics. The purpose of this study was to compare 1-year survival outcomes between WBRT, 1 fx SRS, 3 fx SRT and 5fx SRT.

Materials/Methods: A retrospective analysis of 910 treatments with radiation therapy (RT) for 700 patients with brain metastases was performed (2012-2018). Treatment variables were extracted using Oncora software platform. Data for the four treatment groups (1fx, 3fx, 5fx and WBRT) was collected. Baseline characteristics between the treatment groups were compared using Chi-square test, Analysis of Variance, and the Kruskal-Wallis test. Mortality at 1 year was compared between the four treatment groups using a logistic regression model, adjusting for age, gender and KPS. Hosmer-Lemeshow test was used to determine whether the model provided a good fit. Tukey's method was used to adjust for the multiple comparisons between the 4 treatment groups. $P<0.05$ was considered statistically significant. SAS 9.4 was used for the statistical analysis.

Results: Mean age (SD) was 63.3(12.3) years. Gender distribution was 397 (56.7%) females and 303 (43.3%) males. Treatment modalities were 244(34.9%) 1fx, 65(9.3%) 3fx, 14(2.0%) 5fx and 377(53.9%) whole brain (WBRT). Median 1fx dose was 20Gy, 3fx dose 24Gy and 5fx dose 30Gy and WBRT dose of 30Gy. Treatment groups were similar in term of age ($p = 0.44$). There were significant differences in the terms of the KPS distributions between treatments ($p<0.0001$), with median of 80, 80, 80 and 70 for treatments 1fx, 3fx, 5fx and WBRT, respectively although no significant gender differences were observed among the treatment groups ($p = 0.44$). The overall mortality rate at 1 year was 69.3%, with 136(55.7%), 42(64.6%), 8(57.1%) and 299(79.3%) for 1fx, 3fx, 5fx and WBRT, respectively. In the 6 pairwise comparisons (table1), 1fx had 62% lower odds of death compared to WBRT (OR = 0.38, 95% CI 0.23 to 0.63, $p<0.0001$). Age was significantly associated with mortality (OR = 1.03, 95% CI 1.02 to 1.05, $p<0.0001$), with 3% higher odds of 1-year mortality, for every 1-year increase in age. In women, 10 units increase of KPS had 31% lower odds of 1-year mortality (OR = 0.69, 95% CI 0.56 to 0.85, $p = 0.001$), while not significant in men (OR = 0.93, 95% CI 0.74 to 1.17, $p = 0.56$). We found that "Non-WBRT" group had 59% lower odds of 1-year mortality (OR = 0.41, 95% CI 0.28 to 0.59, $p<0.0001$) compared to the WB group.

Conclusion: There was no difference in 1-year mortality in the three stereotactic protocols. Single fraction SRS had improved survival compared to WBRT at 1 year. Prospective studies are needed are needed to confirm survival and toxicity in the treatment groups.

Author Disclosure: **A. Malik**: None. **D. Stefanov**: None. **A. Goenka**: None. **L. Potters**: RO-HAC members receive an honorarium of $1500 per year. Service on RO-HAC is sponsored by ASTRO and AAPM.; Clarity PSO/RO-ILS RO-HAC. Honoraria; Clarity PSO/RO-ILS RO-HAC. Consultant; Clarity PSO/RO-ILS RO-HAC. Partnership; SRO Health LLC, LPRAD LLC. Board Member; SCAROP. **B. Parashar**: Northwell Health/Zucker School of Medicine at Hofs.

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Hypofractionated SRS Or Single Session SRS For Perioptic Lesions

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Purpose/Objective(s): In this study, we present the results of stereotactic radiosurgery (SRS) and hypofractionated stereotactic radiosurgery (HFSRS) on 255 patients with perioptic lesions.

Materials/Methods: According to our protocol, we apply HFSRS on perioptic lesions when it is technically impossible to limit the maximum point dose (dose to $1mm^3$) to the anterior visual pathway (AVP) to 12 Gy. Exact delineation of the AVP was performed on high-resolution 3D T1w images and FGATIR sequences. Between 2011 and 2019 a total of 78 patients with perioptic lesions (mean distance lesion-to-AVP = 0.3mm, 70% in direct contact) were treated with HFSRS and 177 with SRS (mean margin dose 15.5 Gy, mean distance lesion-to-AVP = 2.4 mm, 29% in direct contact). In the HFSRS group, 7 treatments were performed with a 5-days course with a mean margin dose of 5x6.93 Gy, 59 treatments with 4x5.40 Gy, and 12 treatments with 3x6.43 Gy.

Results: After a mean imaging follow-up period (FUP) of 31 months [5-72m], local control was achieved in all but one lesion treated with HFSRS, with mean reduction in volume of 2.1%/m. Mean ophthalmologic FUP was 32m [6-74m]. Improved vision was observed in 11 cases; 1 case was confirmed for radiation induced optic neuropathy (RION) after delivery of 4x5.60 Gy as maximum optic point dose to the chiasm, which dose corresponds to a single fraction equivalent dose (SFED) = 11.7 Gy, (optic α/β ratio = 1.03 Gy, Speckter 2019). Spatial frame displacement during HFSRS course was measured < 0.3mm using CT imaging. In the SRS group, after a mean imaging FUP of 31m [3-100m], local control was achieved in all but 8 lesions, mean reduction of 1.5%/m. Mean ophthalmologic FUP was 37m [6-81m]. 1 case was confirmed for RION, after delivery of 10.2 Gy as maximum optic point dose. For all patients, DVH were analyzed for optic nerves, tracts, and chiasm. In the SRS group, in 20 cases the optic point dose surpassed 12 Gy, max. 18.4 Gy, while in 16 cases of the HFSRS group the optic point SFED was >12 Gy, max. 17.4 Gy. The mean dose gradient inside the AVP was 2.3 Gy/mm, with a maximum of 8.5 Gy/mm. Consequently, a geometric offset of only 1 mm can increase the applied dose to parts of the AVP by several Gray. According to our analysis, an increased SFED to the tumor can be achieved with HFSRS schedules, compared to SRS. HFSRS can increase SFED of up to 17% for non-functional pituitary adenomas (α/β = 5.81 Gy, submitted to ASTRO), up to 10% for benign meningiomas (α/β = 3.76 Gy, Vernimmen 2010), and of more than 5% for both craniopharyngiomas (α/β = 2.42 Gy, submitted to ASTRO) and chordomas (α/β = 2.45 Gy, Henderson 2009), while maintaining constant the risk for RION.

Conclusion: According to our preliminary results, HFSRS can be considered as an efficient and relatively safe alternative in the treatment of lesions even abutting the AVP. A single dose or SFED of 12 Gy to $1mm^3$ of the AVP can be applied safely with a risk equal or less than 1% for the development of RION. An increased SFED to the tumor of up to 17% can theoretically be achieved with optimized HFSRS schedules.

Author Disclosure: **H. Speckter**: None. **J. Santana**: None. **G. Lara**: None. **J. Bido**: None. **G. Hernandez**: None. **D. Rivera**: None. **L. Suazo**: None. **S. Valenzuela**: None. **P. Stoeter**: None.

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External Validation Of A Radiomics-Based Machine Learning Model For Distinguishing Radiation Necrosis From Progression Of Brain Metastases Treated With Stereotactic Radiosurgery

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Purpose/Objective(s): Radiation necrosis (RN) is common and potentially debilitating after stereotactic radiosurgery (SRS) for brain metastases (BM). The goal of this study is to validate a previously reported radiomics signature for distinguishing RN from true progression (TP) using an independent image set.

Materials/Methods: Patients with BM were treated with Gammaknife SRS at Wake Forest University between 2004 and 2012 (WF dataset).