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Comparison of Plan Quality Metrics for Gyroscopic Radiosurgery and Robotic Radiosurgery

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Abstract
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Abstract

Objectives:

Radiosurgery has evolved significantly over the years, with several advanced technologies and delivery systems now available. One technical innovation in the field is gyroscopic radiosurgery (GRS), which allows for precise and targeted radiation treatment of cranial lesions. In this study, we compare plan quality metrics of treatment plans using a GRS system with corresponding plans using a robotic radiosurgery (RRS) platform.

Methods:

Plan quality metrics were collected for 31 patients treated with single session GRS between July 2021 and September 2023. The 31 plans included 11 complex cases (6 meningiomas, 2 arteriovenous malformations, 3 T3b vestibular schwannomas) with the most delivered isocenters per target, supplemented with 20 additional standard vestibular schwannoma cases. RRS plans were created for comparison and normalized to the same coverage. A Wilcoxon rank test with a significance level of $\alpha = 0.05$ was used to analyze differences between dose metrics on the two systems.

Results:

The median prescription dose and isodose line were 13 Gy (range 13 to 18 Gy) and 52% (range 41% to 62%), respectively. The mean planning target volume was 2.5 cc (range 0.1cc to 8.7cc). The median new conformity index (nCI) was 1.23 (range 1.11 to 1.67) and the median gradient index (GI) was 3.03 (range 2.55 to 4.33). The median number of beams was 119 (range 41 to 265), distributed over a median of 10 isocenters (range 2 to 23). The median beam-on time was 8.2 minutes (range 4.3 to 17.0 minutes). While mean PTV dose, total healthy tissue volume receiving 10 Gy or more (V10Gy), GI, and homogeneity index (HI) were comparable between GRS and RRS, we found significant differences for the nCI, number of beams and beam-on time, with nCI and number of beams being higher for GRS and beam-on time higher for RRS. For vestibular schwannomas only, we compared dose to organs at risk and found similar mean and maximum dose to the cochlea ($p=0.99$ and $p=0.20$, respectively). In two cases with the GRS, the brainstem volume receiving 8 Gy or more exceeded 1 cc, which was the case in only one of these patients with RRS.

Conclusion(s):

Clinically acceptable plans could be created for all cases with both platforms. With the exception of nCI, beam-on time, and number of beams, plan quality metrics did not differ significantly. For clinical decision making, GRS and RRS platforms can be considered equivalent for standard and complex cases.