

Dosimetric Evaluation of Cranial Stereotactic Radiosurgery with Dynamic Jaw Helical Tomotherapy

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Abstract

Objectives: To evaluate the dosimetry of single fraction cranial stereotactic radiosurgery (SRS) treatment plans for a newly implemented SRS program using helical tomotherapy with dynamic jaws. A custom metric to evaluate dose gradient specific to helical tomotherapy was utilized in addition other standard metrics to score dose conformity, heterogeneity, and gradient.

Methods: In past year since program inception, nineteen intracranial metastatic lesions have been treated using helical tomotherapy collimated by MLC and the new dynamic jaw mode. The program was developed per AAPM TG guidelines including verification of SRS delivery by successful treatment of the RPC SRS head phantom. Treatment plans were created with consideration prescription conformity to the target, dose falloff, dose heterogeneity within the target, and normal tissue structure tolerances. The dosimetry was evaluated using four criteria: Paddick's conformity index (CI), RTOG homogeneity index (HI), Paddick's gradient index (GI), and Sheth's helical tomotherapy specific gradient index (TGI).

Results: The 19 cranial SRS targets ranged in volume from 0.9 cc to 15.0 cc (mean 5.7 ± 4.0 cc). In all, 13 clinically acceptable treatment plans were created and of that 10 plans treated a single target while 3 plans treated 3 targets simultaneously. For all plans, the prescription dose ranged 15-21 Gy (median 21 Gy). For single target plans, the prescription dose ranged 15-21 Gy (median 21 Gy). For multiple target plans, the prescription dose ranged 18-21 Gy (median 21 Gy). For all plans, mean treatment time was 12.9 ± 5.0 minutes. For single target plans, mean treatment time was 15.5% less than all plans at 10.9 ± 3.1 minutes. For multiple target plans, mean treatment time was 36.4% greater than all plans at 17.6 ± 4.3 minutes. For all plans, the mean CI was 0.65 ± 0.29 . For single target plans, the mean CI was 15.8% more conformal than all plans at 0.80 ± 0.06 . For multiple target plans, the mean CI was 83.2% less conformal than all plans at 0.16 ± 0.06 . For all plans, the mean HI was 1.21 ± 0.05 . For single target plans, the mean HI was 0.8% hotter than all plans at 1.22 ± 0.06 . For multiple target plans, the mean HI was 2.5% cooler than all plans at 1.18 ± 0.02 . For all plans, the mean GI was 7.5 ± 4.4 . For single target plans, the mean GI showed 14.7% better falloff than all plans at 6.4 ± 4.5 . For multiple target plans, the mean GI showed 48.0% worse falloff than all plans at 11.1 ± 0.9 . For all plans, the mean TGI was 0.31 ± 0.42 . For single target plans, the mean TGI was 41.9% closer to maximal falloff than all plans at 0.18 ± 0.38 . For multiple target plans, the mean TGI was 141.9% further from maximal falloff all of than all plans at 0.75 ± 0.08 .

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Conclusions: A dosimetric evaluation of treatment plans for a newly developed cranial SRS was conducted. As seen with other SRS modalities, plans with multiple targets had reduced dose gradient falloff than plans with a single target. The prescription dose conformity and dose heterogeneity within the target was also less with multiple targets than with a single target. All plans were clinically acceptable and delivered with helical tomotherapy with new dynamic jaws mode.