

Local Control and Toxicity as Function of Distance from Isocenter for Zero-Margin Single Isocenter VMAT Fractionated Stereotactic Radiosurgery for Brain Metastases

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Abstract

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Abstract

Objectives:

Radiosurgical treatment of multiple intracranial targets with a single isocenter is more efficient than sequential isocenter treatment. However, concerns persist that rotational error can lead to dosimetric underdosing of tumor and/or higher risk of toxicity to normal brain. In this analysis we examine the effect of distance from isocenter on local tumor control and toxicity among patients treated with multi-fraction, single isocenter fractionated stereotactic radiosurgery (fSRS).

Methods:

We evaluated 251 patients with a total of 1215 tumors that underwent either 9 Gy x 3 fractions or 6 Gy x 5 fSRS. Tumors were treated using single isocenter VMAT with manual (RapidArc™) or automated VMAT (HyperArc™) treatment planning. All tumors were treated with 0 mm PTV and treated on a 6-DOF couch. All treatments were administered with the Varian HD-120 MLC. Local tumor failure was defined as 25% increase in maximum tumor diameter (minimum 3 mm) or more than scant tumor cells at time of salvage surgery. Toxicity included CTCAE V5.0 CNS grade 3 or greater events.

Results:

Of the 1215 tumors evaluated, 540 and 358 tumors had clinical and radiographic followup at 6-months and 1-year, respectively. Median distance from isocenter was 4.9 cm (range 0 – 13.4 cm) and 68% of tumors in this study were >4 cm from the isocenter. Local control for the entire cohort was 92% at one year and 88% at two years. Freedom from grade 3 or higher toxicity among the entire cohort was 97% at one and two years. Tumor volume was inversely correlated with distance from isocenter. Increased tumor volume was associated with worse local control and toxicity. Regarding local control, univariate analysis showed decreased tumor distance from isocenter and increased tumor volume were associated with worse local control. On subsequent multivariate analysis, distance from isocenter was no longer predictive of local control when accounting for tumor volume ($p = .267$). Regarding toxicity, multivariate analysis showed increased distance from isocenter (HR 0.972; $p = .005$) and decreased tumor volumes (HR 1.072; $p < .001$) were associated with a lower risk of toxicity.

Conclusion(s):

For single isocenter VMAT fSRS treatments using an HD-120 MLC with no PTV margin, the distance from the isocenter was not associated with worse local tumor control or high-grade toxicity.