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Should Cranial SRS Planning for Multiple Brian Metastases be Performed With a Single or Multiple Isocenters?

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Abstract
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Abstract

Objectives:

Multiple brain metastases are increasingly being treated with focused SRS treatments, rather than whole brain radiotherapy, in order to reduce toxicity of treatment. While high definition multileaf collimators (HDMLC) can treat small targets conformally, the smaller (0.25 cm) leaves cover only a 7.5x7.5 cm2 field in the Varian HDMLC. In order to treat metastases throughout the brain with the smaller MLC leaves, it would be necessary to treat with multiple isocenters. Treating with multiple isocenters will extend treatment time, and there will be some additional dose delivered to the entire brain from each plan. The aim of the current study is to review the effect of leaf size on dose conformity and dose gradient in cranial SRS plans, and to determine whether single isocenter planning may be superior to multiple isocenter planning for multiple cranial metastases.

Methods:

A theoretical study was performed planning for for small (3-15 mm) spherical targets with 0.25 cm or 0.5 cm MLC leaves, with targets in both on-axis and off-axis positions, to determine at what target size the 0.25 cm MLC leaves significantly improved dose conformity for small targets. Then, 20 patients with multiple mets (range: 3- 20 mets) were planned with both single and multiple isocenter VMAT plans. The same planning criteria and planning control structures were used for all plans. Overall dose conformity and dose gradient were compared, looking at V100%, V50%, and V33%.

Results:

For single, spherical targets, 0.25 and 0.5 cm MLC plans produced approximately equivalent conformity and gradient for all target sizes down to 4 mm, if the target volume was off-axis. If the target was on-axis, the leaf size had a larger effect, and 0.25 cm leaf plans showed significantly improved conformity and gradient for targets less than 6 mm. In the patient plans, the single isocenter HDMLC plans had improved conformity compared to multiple isocenter plans in 19/20 patients (average ratio of CI multiple/single isocenter = 1.10 +/- 0.06). Single isocenter plans showed improved gradient at the 50% and 33% level for 15/20 plans and 18/20 plans, respectively, (ratio of multiple/single volumes = 1.12 +/- 0.15, and 1.26 +/- 0.27). There was no significant difference in these ratios for plans with average target size larger or smaller than the median value (1.15 cc).

Conclusion(s):

Larger (0.5 cm) MLC leaves are capable of delivering highly conformal radiation dose distributions to very small (5mm or less) targets, particularly if the targets are off axis. Single isocenter VMAT plans for multiple cranial metastases produced overall superior conformity and gradient compared to multiple isocenter plans, despite some of the treatment being delivered through 0.5 cm leaves.