A Comparison of Radiosurgical Planning Techniques for the Treatment of Trigeminal Neuralgia

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Objectives: To survey and analyze the current peer-reviewed literature on physical aspects of radiosurgical treatment of trigeminal neuralgia (TN), and objectively determine the comparative differences between common treatment planning techniques/modalities when variability in dataset and clinical approach are minimized.

Methods: Example treatment plans were created from eight distinct planning approaches on a unique CT/MRI dataset. Treatment plan selection comprised Gamma Knife, physical cone, and MLC-based plans. Prescription was standardized between plans to 85Gy at isocenter, as well as location of treatment isocenter. Dose distributions were characterized by multi-planar isodose line comparisons, dose line profiles in two dimensions, Gradient Indices, dimensional and volumetric analysis of 50% and 80% isodose coverage, and maximum (0.1 cc) dose to the brainstem as singularly contoured on the unique imaging dataset.

Results: Dose coverage, distribution shape, dose line profiles, and gradients differ significantly between Gamma Knife, physical cone, and MLC-based planning techniques, even when dose prescription, treatment isocenter, and imaging dataset/anatomy are identical between treatment plans. Gamma Knife (4 mm collimator) provides broadest coverage of the trigeminal nerve, most closely approximated by the 5 mm physical cone LINAC-based plan. Contrastingly, the narrowest coverage in this treatment plan selection was created by the 4 mm physical cone. All dose distributions were approximately spherical in shape except the 11-arc physical cone LINAC-based plan which produces a more elongated distribution (broadest adjacent to the brainstem).

Conclusion(s): The selection of radiosurgical technique for TN should be weighed in the context of differences in dose distributions between treatment techniques, as demonstrated by the plans analyzed in this study: It cannot be assumed that all TN radiosurgical techniques produce the same dose distribution, either to the trigeminal nerve or adjacent normal tissues. Differences between planning techniques may be amplified in real clinical scenarios with differences in clinical approach and anatomy.