AbstractID: 5598 Title: Optimize Spike Patterns For an Embedded Boost Technique For Gamma Knife Radiosurgery

Purpose: With the Gamma Knife Automatic Positioning System, high dose spikes can be placed inside a target using 4-mm shots to boost the central target dose without affecting adjacent normal brain sparing. Potential applications of the technique include target boost when nearby critical structures such as optical structure limit the peripheral dose or increasing the dose to centrally hypoxic regions. This study investigates how the spatial distribution and height of the spikes can be optimized for this purpose.

Method and Materials: A computer program was developed to optimize the pattern of spike boost placed over conventional Gamma Knife plans. The program first extracts the prescription isodose volume and then iteratively adjusts the positions and the heights of the spikes while accounting for the existing dose distribution. Different boost patterns were generated for both patient and phantom cases. The program calculated the stereotactic coordinates and weights of the spike shots, which were manually entered into the Leksell Gamma Plan for dose calculation and dose-volume evaluations of the modified treatment plans.

Results: The total number of dose spikes and the maximum dose for the spike shots correlates with the target size ($R^2 > 0.9$). For the cases studied, an increase in average dose to the target of 15-28% was noted while the conformity index of target volume coverage remained unchanged. The dose to the adjacent normal brain (defined as the volume enclosed by half of the prescription isodose line excluding the target) remained unchanged to better than 2% of the maximum dose. Overall, spike patterns arranged along the radial direction consistently give a higher average dose to the target than for spikes arranged along the translational directions.

Conclusion: Optimizing the shot weights and the spike patterns enhances dose to the target volume while maintaining normal brain sparing for Gamma Knife radiosurgery.