AbstractID: 5347 Title: Investigation of the effects of approximations in Gamma Knife stereotactic radiosurgery planning

Purpose: GammaPlan, the planning software for Gamma Knife stereotactic radiosurgery, approximates many parameters to increase calculation speeds. These approximations can introduce dosimetric errors. We investigate the magnitude of these errors.
Method and Materials: A planning algorithm was written to avoid the use of approximations. Skull scaling is accomplished through a simple edge detection algorithm on the imported images. Dose calculations are accomplished through the use of TMR measurements and beam profiles taken at various depths, and of all collimators. To measure the TMR of one beamlet, 200 of the 201 sources were plugged. A tungsten sphere was designed to provide additional attenuation of unwanted beamlets when taking film and ion chamber measurements in its center. Ion chamber measurements are obtained for various amounts of water-equivalent ABS plastic for the 14 and 18 mm collimator. Additionally, Gafchromic film is placed between the pieces of plastic to obtain both PDD and TMR measurements of all collimators. The Gamma Knife calibration sphere was then modeled in both GammaPlan and our algorithm, and treatment times for isocenters placed throughout the sphere were calculated using both algorithms.
Results: The 18 mm collimator TMR showed small deviations past 40 mm from the 0x0 curve used by GammaPlan, and differences up to 2% are seen at shallow depths. The 14 mm collimator showed similar behavior. Discrepancies of 3.8% on average (maximum 8.9%) were calculated for shots placed in various locations throughout the calibration sphere. Differences increased with the distance from the middle of the sphere and increasing gamma angle.
Conclusion: We developed a robust Gamma Knife planning software, effectively reducing errors due to approximations. Our results agree with GammaPlan's calculated times. Skull scaling differences are the major source of the discrepancies between the two calculations.