AbstractID: 11290 Title: Clinical Implementation and Evaluation of Monte Carlo Treatment Planning for CyberKnife

Purpose: To evaluate the clinical implication for dose prescriptions, of adopting Monte Carlo treatment planning for the CyberKnife Radiosurgery System, and to directly compare Monte Carlo dose calculations to those made using the Ray-Tracing algorithm.

Method and Materials: The anthropomorphic lung phantom from the Radiological Physics Center (RPC) was used to validate the accuracy of the CyberKnife Monte Carlo dose calculation algorithm (MultiPlan 2.1.0). A retrospective comparison of dose distributions calculated by the Ray-Tracing and Monte Carlo algorithms was made for a selection of CyberKnife patient treatment plans. In each case, a clinically acceptable treatment plan was developed using the Ray-Tracing algorithm. The beam sets for each Ray-Tracing plan were then recalculated using the Monte Carlo algorithm (Gaussian smoothing, 1%); beam orientations and monitor units for each respective pair of calculations were identical, only the resulting dose distributions changed.

Results: For highly heterogeneous cases, such as those involving the lungs, the Ray-Tracing algorithm consistently overestimated the target dose. For each lung plan comparison, the isodose prescription line needed to be lowered for the Monte Carlo-calculated plans to achieve similar target coverage. The average isodose prescription line for the Ray-Tracing Plans was 82.5% compared to 74.9% for the Monte Carlo plans. In certain cases, this isodose reduction may result in unacceptably high maximum target doses and sub par conformality.

Conclusion: There can be significant differences between dose distributions calculated by Monte Carlo and Ray-Tracing algorithms, particularly for treatment plans involving the lungs. As a result, isodose prescription lines and subsequent target coverage typically selected for treatment plans calculated with the Ray-Tracing algorithm may be different from comparable treatment plans calculated with the Monte Carlo algorithm. These differences may need to be evaluated on a patient-by-patient basis until a widespread consensus can be reached.