

AbstractID: 4458 Title: Clinical use of Monte Carlo in proton therapy: Pencil-beam algorithm vs Monte Carlo for proton therapy of skull-base and para-spinal tumors

Introduction: Pencil beam algorithms rely on kernels to model proton range in density-scaled water equivalent material. Monte Carlo dose calculation methods are more accurate by design. This study addresses the issue of clinical significance of differences between a commercial pencil-beam algorithm and Monte Carlo dose calculation.

Skull-base or para-spinal tumors are challenging for dose calculations due to interfaces between high and low density areas in the irradiated volumes. In addition, for para-spinal cases, there are often metallic implants that not only distort the CT image but also affect the accuracy of dose calculations.

Methods: Proton treatment planning is done at our institution by using FOCUS/XiO (CMS Inc.). To do full Monte Carlo based dose calculation the treatment head was modeled including a simulation of the modulator wheel rotation as well as aperture and compensator. The patient CT data information was converted into materials with explicit element composition and density. All secondary particles were tracked.

Treatment plans designed with the treatment planning program were re-calculated with the Monte Carlo code and compared by analyzing dose distributions and dose volume histograms.

Results: In general, we found good agreement. Small differences are in part due to the difference between dose to medium and dose to water. Significant differences were found in and near air cavities as well as in areas affected by high density implants.

Conclusion: For some tumors in the head and neck region and near the spine, Monte Carlo based dose calculation shows significant differences compared to pencil-beam algorithms. Consequently, at our institution, a sub-set of the patient population receives Monte Carlo dose calculation to assist in treatment planning.