AbstractID: 9113 Title: Human Anatomy-based Monte Carlo dose calculation for external protons

Purpose

In this work, we aim to build an accurate dose calculation algorithm based on human anatomy-based model using Monte Carlo simulation for providing basic and benchmarking data for therapeutic protons.

Method and Materials

Both phantom-based and human anatomy-based models were used. The human anatomy model was developed from VHP® at National Library in Medicine. The human anatomy-based model was built with 4 mm x 4 mm x 4mm voxel resolution with total over 6 million voxels for describing the whole body. Each voxel was assigned physical properties, including density and isotopic composition. MCNPX was used to simulate the transport and energy deposit to each voxel. An in-house dosimety software package, Human Anatomy-based Monte Carlo Dose (HAMD) was developed to analysis the huge dose dataset based on Monte Carlo simulation and the three dimensional dose matrix was super positioned to the CT image correspondingly.

Results

The Monte Carlo simulation provided very close agreement to the two widely used proton range-energy tables with average depth peak difference less than 0.70% and -0.37% to ICRU Report 49 and Janni DNDT respectively from 40 MeV to 250 MeV energy range.

HAMD performed well in proton treatment dose calculation. HAMD offers very friendly and familiar interface for physicians to conveniently review a treatment plan. The isodose lines in transverse, sagittal and coronal views provided very conformal coverage to the contours in lung.

Conclusion

The simulated proton range-energy table has been accurately benchmarked compared to measurements. The in-house developed dose algorithm HAMD performs very well in dose calculation both in phantom-based and human anatomy-based heterogeneity. The HAMD needs further validation by using additional human anatomy-based models and specified beam source configuration. The long-term and board objective is to provide an extreme accurate dose calculation based on human model for benchmarking clinic treatment planning systems.