AbstractID: 5492 Title: Monte Carlo Dose Calculation Procedure using a 4D Motion Simulating Chest Model

Purpose: To apply an anatomically detailed motion-simulating virtual patient model to the study of external beam treatment planning.

Method and Materials: Breathing induced organ motion modeling may be classified broadly into (a) geometry-based and (b) physics-based methods. We have been developing a 4D motion-simulating chest model from a 3D tomographic model of the Visible Human images by varying the shape, size and location of the organs. Anatomical features where from the VIP-Man model that contains 80 segmented organs and tissues. The Non-Uniform Rational B-Splines (NURBS) surfaces of the organs were reconstructed to deform the organs by changing the control points. Clinically measured motion patterns were used to guide the deformation and motion. Four-field conformal photon beams were simulated for the treatment of a lung tumor case. The energy of the beam was assumed to be 6 MeV and the 4-field irradiation geometry was assumed to be AP, PA, RLAT, and LLAT. The lesion was simulated in the left lung and the PTV is designed as a sphere of 5-mm radius. The motion-simulating model is implemented into the EGSnrc code to calculate the absorbed doses using various non-registration registration methods.

Results: The results showed that the dose to tumor could be up to 40% differences from phase to phase. DVH for this calculation showed less homogeneity for the whole breathing cycle. However, if the beam was gated to one phase, the result showed better homogeneity for target.

Conclusion: A 4D chest motion-simulating model has been developed using the segmented Visible Human images. This study summarized procedures to develop a 4D motion-simulating chest model and demonstrated the usefulness of the model for Monte Carlo calculations. Possible ways to improve the motion simulation using physics-based tissue properties available from surgical simulation community are discussed.