Abstract ID: 18146   Title: Improvement in Robustness and Delivery Efficiency of Intensity-Modulated Proton Therapy Using Single-Field Optimization with Energy Absorber

Purpose: Intensity-modulated proton therapy (IMPT) using multi-field optimization (MFO) could generate highly conformal dose distributions but it is more sensitive to setup and proton range uncertainties than IMPT using single-field optimization (SFO). This work evaluates the effectiveness of SFO treatment plans with the use of energy absorbers (EAs) to improve the robustness and delivery efficiency of IMPT for head and neck cancers.

Methods: IMPT treatment plans were generated using 2-field SFO with an EA in each field (EA-SFO) for four patients with head and neck cancers. We compared the plan quality, robustness, and delivery efficiency of the EA-SFO plan with a 3-field MFO plan that was used to treat the patient. Robustness analysis of each plan was performed to generate two dose distributions, consisting of the highest and the lowest possible doses from spatial and range perturbations at every voxel. Dosimetric indices and the numbers of energy layers required in the EA-SFO and MFO plans were compared.

Results: All the nominal EA-SFO plans are clinically acceptable. They achieved similar levels of target coverage compared to the MFO plans; the differences in D95 of the GTV and CTVs between the two plans were within 3.5%. Although some of the OARs received higher dose in the EA-SFO plan, they were all within tolerance. The EA-SFO plans yielded an average of 38.5% reduction of plan sensitivity to uncertainties in the targets and 18.5% overall. The EA-SFO plans used an average of 79 (46%) fewer energy layers than the MFO plans, which corresponds to nearly 3 minutes shorter delivery time.

Conclusions: The use of energy absorber greatly facilitated the design of clinically acceptable SFO treatment plans. Compared to MFO, EA-SFO not only improved the robustness to setup and range uncertainties, but also reduced the time required for delivery and patient QA.