AbstractID: 3358 Title: 4DCT Proton Treatment Planning for Lung Tumors

Purpose: We investigated the use of 4DCT data for proton radiotherapy of lung cancer patients.

Method and Materials: We used 4DCT scans at inhale, exhale and mid-exhale as well as a free-breathing scan for four typical lung cancer patient geometries. Separate proton treatment plans were designed covering the CTV in the free-breathing CT-scan (plan:*FB*) and the mid-exhale phase (plan:*MH*). A uniform margin, of half the peak-to-peak breathing amplitude was applied to apertures and range compensators of both plans to account for effects of breathing motion on the dose distribution. A third plan was designed using time-resolved knowledge of radiological path lengths to the tumor for all breathing phases (plan:*4D*). Per patient, all three 4DCT-scans were used to evaluate tumor coverage.

Results: Plan:*FB* covered the CTV in all breathing phases for 2 patients but severe underdosage occurred in 4/6 remaining scans, down to an equivalent uniform dose of 22.2 Gy (prescribed dose: 72 Gy). Plan:*MH* showed mild underdosage in only one scan while plan:*4D* guaranteed CTV coverage in all breathing phases. The average mean lung dose, evaluated using the free-breathing CT-scan was 100%, 104% and 93% for plan:*FB*, *MH* and *4D*, respectively, normalized to plan:*FB*. For the lung volume receiving at least 20 Gy these values are 100%, 102% and 91%, respectively.

Conclusion: Using a “snap-shot” free-breathing CT-scan can lead to geometrical misses and a severe reduction in target dose coverage for proton radiotherapy of lung cancer. Using the mid-exhale phase of a 4DCT-scan plus a margin of half the peak-to-peak breathing amplitude greatly improves tumor coverage at a small additional cost in dose to the lungs. We developed a treatment planning method based on 4DCT data that ensures target dose coverage under respiratory motion while still minimizing dose to the lungs.

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