AbstractID: 5002 Title: The impact of 4D breathing motion effects versus tissue heterogeneity in lung cancer treatment planning

Purpose: To investigate the relative magnitudes and clinical importances of the dosimetric effects related to 4D breathing motion and tissue heterogeneity for thoracic tumors treatment planning.

Methods: Scans were acquired at normal exhale/inhale breathing phases. The target was the union of the exhale and inhale GTVs, uniformly expanded by 5mm(ITV). Patients were planned with both AP/PA and 3-D conformal plans using the exhale ("static") dataset, assuming unit density, for 100$\pm$5% ITV dose coverage. Each of these plans was further used to calculate: (a) heterogeneous "static" dose; (b) homogeneous cumulative dose; (c) heterogeneous cumulative dose. The same number of MU were used for each of the calculations and was based on the homogeneous "static" plan. Cumulative dose distributions consisted of a time-weighted sum of exhale and inhale doses. Doses were calculated using the DPM_MC code which includes secondary electron transport for the heterogeneous computations.

Results: Relative to unit-density plans, tumor EUD, and lung NTCP increased in the heterogeneity corrected plans; primarily due to the reduced beam attenuation through lungs and the larger than coin-size tumors investigated. In comparing 4D cumulative dose plans with static plans, clinical EUD and NTCP estimates were relatively unchanged. The insignificant tumor EUD change was a consequence of good target design, while the small lung NTCP change was due to its large volume effect. Accounting for tissue heterogeneity resulted in average changes of 10% in MLD. Accounting for 4D breathing motion effects resulted in <1% changes in MLD from the static value. The magnitude of these effects was not correlated with the dose distribution conformality.

Conclusions: In this study we found that tissue heterogeneity effects are likely to have a larger clinical significance on tumor (if ITV is properly designed) and normal lung clinical treatment evaluation metrics than occurs with 4-D respiratory-induced changes.

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