AbstractID: 13954 Title: Image-based scoring of radiation injury in lung for dose-effect correlations: analysis of sources of uncertainties

Purpose: To investigate the robustness and uncertainties of an automated method of quantifying radiation-induced lung injuries (pneumonitis and fibrosis) from CT image density changes and to correlate the probabilities for the injuries with radiation dose at different post-radiation time points.

Methods and Materials: Using multi-resolution affine optimization technique, post-radiotherapy (RT) diagnostic CT images were registered to planning CT images. Following the registration and patient tissue-based CT number calibration, a change in physical density at each voxel position of the post-RT CT was evaluated and the voxels which density change is considered pathological was segmented as injury. The PTV was excluded from the analysis due to the lack of functional information to differentiate between recurrence and injury. Retrospective patient dose calculations using the anisotropic analytical method (AAA) and the Monte-Carlo (MC) were performed. The segmented injury was spatially correlated to the dose distributions to deduce a patient-specific dose-response relationship for the radiation-induced injury.

Results: Probability of lung injury as a function of dose and post-treatment time is patient-dependent and can be up to 70% at the highest dose. Due to the inaccuracy of the affine registration, the injury segmentation was manually corrected for the misalignment of normal tissue features, which gave rise to a case-dependent uncertainty of up to 10%. Inter-patient variability in CT calibration contributed by 4% or less to the uncertainty on the complication probability and was dependent on dose. Finally, dose calculation from direct MC simulation occasionally yielded a significantly modified complication probability than using the AAA model suggesting that dose calculation accuracy is important in the accuracy of dose-response model of lung.

Conclusion: The presented method facilitates dose-response analysis in normal lung tissues if the accuracy in image registration and dose calculation can be assured and will provide options to complication-driven treatment planning.