AbstractID: 10275 Title: The utility of surrogates of the distribution of pulmonary function in individualizing thoracic radiotherapy

Purpose: Heterogeneity of lung tissue density and function is a hallmark of pathologic changes in chronic obstructive pulmonary disease (COPD). However, the standard risk assessment approaches, based on dose-volume histograms (DVH), do not currently use the functional information in evaluating pulmonary tolerance to radiation therapy. We investigated the utility of weighting of dose distributions by surrogate metrics of the lung function (parenchyma density, ventilation distribution) as complementary sources of information for assessing the risk of complications, and for further individualizing of thoracic radiation therapy.
Methods: The tissue density and the distribution of ventilatory activity were estimated from respiration-correlated CT scans of 19 patients. Dose distributions from clinical IMRT (N=17) and proton (N=2) therapy plans were reevaluated by applying importance weighting to separate 1-cc volume elements in the lung, accordingly with their estimated relative functional load. The histogram metrics: mean lung dose (MLD), share of the 5-Gy isodose (V5), etc., were compared between various dose-weighting methods. Regions characterized by high ventilatory activity were segmented, and research IMRT plans were optimized with objectives aiming to maximize sparing of lung function.
Results: Substantial differences between the metrics of DVH and ventilation-weighted histograms were observed, e.g., change of over 5% in MLD in 8 patients, relative increase of over 10% in V20 in 3 patients out of 19. The correlation between the density- and ventilation-weighted metrics was insignificant. The use of additional optimization constraints for highly-ventilated lung subvolumes allowed for a reduction in the ventilation-weighted MLD, without compromising the target coverage, or causing deterioration in the standard DVH.
Conclusions: Elevated values of ventilation-weighted MLD may indicate the increased risk of complications in patients with COPD. The use of ventilation distribution maps for selection of beam angles, and definition of optimization constraints for functional avoidance, can potentially reduce the risk, without compromising the therapy efficiency.