AbstractID: 14339 Title: A mechanical stress model to analyze ventilation changes in normal lung tissue following radiation therapy

Purpose: It is known that radiation damages alter the elasticity properties of anatomical structures, and reduce the lungs' ventilation capabilities. However, the correlation between radiation dose and reduced ventilation in healthy lung tissue as measured by ventilation imaging, is not well established, due to factors, including regional stress variation as well as large uncertainties in quantitative assessment of ventilation images. This study sought to analyze the local mechanical effect on the resultant ventilation images, and present a novel method to correct for it. We hypothesize that our approach will improve the correlation between radiation dose and changes in normal lung ventilation.

Methods: A finite element model (FEM) based framework was developed to calculate elastic stress caused during lung respiration. The method uses displacements derived from deformable image registration (DIR). A cubic tetrahedral mesh was generated to cover the CT image domain. The geometric mesh was assigned with known elastic parameters. Displacements of each tetrahedral node were interpolated from B-Spline-based DIR. Resultant displacements were used to calculate the Jacobian-based ventilation images, and then stress images using the mechanical model. Lung compliance (a measure of lung function) was defined as the computed ventilation divided by the stress, on a voxel-by-voxel basis.

Results: Average displacement errors of B-Spline registrations were less than 0.85 mm, based on landmarks. Mean values of the Jacobian images J_i were 4.1%, 3.9%, 2.8% and 1.0%, and compliance C_i were 7.18%, 6.57%, 6.83%, and 7.32%, for the deformation from phase *i* to phase 5, *i*=1,2,3,4, respectively. Pearson correlation between J_1 and J_4 was 0.16 and correlation between C_1 and C_4 was 0.78.

Conclusions: Compared to the Jacobian ventilation images, computed lung compliance images are more stable to phase-to-phase variation, and may improve correlation between radiation dose and reduced ventilation in healthy lung tissue.

Conflict of Interest: No.