AbstractID: 11407 Title: A method to evaluate region-specific pulmonary function using 4D CT images for lung cancer patients undergoing radiation therapy

Purpose: Collateral radiation exposure to healthy lung tissue during radiation therapy can result in changes in structural and biomechanical properties of the lung. These changes may cause various clinical symptoms. The purpose of this study was to develop a functional imaging technique to assess the lung's region-specific ventilation and pressure during or after radiation treatment.

Method and Materials: With an in-house developed finite element framework, a heterogeneous elastic model was developed for a lung patient and its Young's moduli were derived from a set of 4D CT images, acquired during radiation treatment. Each phase of the 4D dataset was registered, using deformable image registration (ITK demons algorithm) with the end-inhale reference dataset. The resultant deformation matrix was used first to calculate the volumetric variation of each image voxel to generate a 3D ventilation image, and then to compute its corresponding transpulmonary pressure with the mechanical model.

Results: Lung volumes on each phase of the acquired 4D dataset were compared with those derived from the deformed model, and were found to be within 1% of each other. The maximum ventilation occurs from phase 1 to phase 2, the earliest expiration phase. The average ventilation increased from 20.2% in phase 2 to 30.8% in phase 5 and their correspondent pressures increased from 1.57 Kpa to 2.25 Kpa. This result is generally consistent with published measurements.

Conclusion: This study describes a theoretical approach to calculate the region-specific ventilation and mechanical functions using deformable image registration. The method may be applied toward understanding how the mechanical properties of damaged lung differ from that of healthy lung tissue, and therefore it has potential applicability as a diagnostic indicator, as well as a tool for predicting radiation-induced lung damages. Work is underway to correlate this approach with other traditional functional-imaging modalities used to assess lung function.