AbstractID: 8636 Title: Lung Mechanical Modeling Based on the 3He MR Tagging and Lobar Segmentation

Objectives: Direct measurements of the lung deformation by ^{3}He MR tagging during breathing motion revealed that the deformation is neither linear nor continuous. To improve the accuracy of deformable registration by finite element analysis, the lung is segmented into subanatomical regions, to allow sliding motion between lobes.
Methods and materials: One healthy volunteer underwent MR tagging studies. Multiple-slice two-dimensional and volumetric three-dimensional MR tagged images of the lungs were obtained at end-inhalation and end-exhalation, and deformation vector field (DVF) was computed. A patient CT was selected and the left lung was segmented into upper and lower lobes. The 2D contours were converted to 3D mesh and subsequently to tetrahedra for finite element analysis (FEA). Boundary conditions and material properties were assigned in the ABAQUS, FEA modeling software. Diaphragm provided the active driving pressure and the chest wall provided a passive constraint. The FEA computed DVF was compared with the measured DVF using a similarity index (SI) normalized to 1 for a perfect match and 0 for a complete mismatch.
Results: A 3D lung DVF was generated from the MR tagging. Distinct discontinuity was observed between lung lobes. With the assumption that the lung is a continuous elastic object, the FEA model failed to model the discontinuity along the fissure and resulted in a low SI (0.53), which was improved to 0.89 by segmenting the lung and introducing the additional freedom of inter-lobar motion.
Conclusion: DVF measured from ^{3}He MR tagging can be a reference in validating deformable registration of lung, particularly in regions with low imaging contrast. Using this reference, the authors were able to significantly improve the accuracy of deformable registration with lobar segmentation in the FEA modeling.