AbstractID: 5193 Title: A biomechanical lung deformation model based on MR grid-tagging using hyperpolarized 3He

Purpose: Deformable image registration is critical for advancements of lung tumor radiation. Commonly used mathematical deformable registrations do not provide actual biomechanical trajectories of anatomical motion. Therefore, we developed a biomechanical registration model (BRM) based on hyperpolarized ^{3}He MRI grid-tagging to automatically segment structures and generate BRM encoded cine CT images.

Method and materials: Normal volunteers underwent hyperpolarized ^{3}He MR imaging on a 1.5T whole-body MR scanner. Grid-tagging was achieved by applying sinc-modulated RF pulses with a composite flip angle of 90° prior to the acquisition of the images followed immediately by a multi-slice FLASH-based acquisition at full inspiration and exhalation. For each slice, a displacement vector was computed for each grid element. The complete lung motion was based on spatial and temporal interpolation of the displacement vectors. The motion and deformation of anatomical structures were obtained using the interpolated vector field through various phases. The displacement vectors were registered to a coronal CT image to generate a set BRM encoded cine CT images.

Results: Tagging signals were well preserved and sufficient for quantitatively resolving the tag motion. From the displacement vector map, the lower lobes exhibit the greatest motion magnitude especially in the craniocaudal direction. The motion of the structures driven by the displacement map is continuous and smooth. No substantial artifacts in the BRM generated dynamic CT images were observed.

Conclusions and Discussion: BRM provides an independent measure of lung motion and deformation. Compared to pure-mathematically constructed registrations, BRM relies on fewer assumptions and avoids errors induced by image matching processes. BRM encoded dynamic images are useful to cross-validate deformable registration by other imaging modalities and algorithms. We plan to explore the potential of this methodology for auto segmentation and treatment planning.