Purpose: Different breathing maneuvers typically result in slightly different tidal volumes that can lead to changes in alveolar recruitment. Recently, there has been tremendous interest in utilizing 4D-CT based measurements of regional ventilation for treatment planning and treatment assessment. In this work, we wanted to demonstrate the effect of different breathing maneuvers on fractional regional ventilation (FRV) extracted using 4D-CT.

Methods: In this work, we evaluate the effect of different breathing maneuvers: a) free-breathing (FB), b) audio-visual assistance (AV), and c) active breathing control (ABC), on FRV. We measured these changes using a 4D-CT based technique that quantifies changes in CT characteristics of the pulmonary parenchyma. Five subjects were imaged using 4D-CT during a single session under 3 different breathing maneuvers. 4D-CT images were used to extract fractional regional ventilation by applying a "mass correction" that is estimated using the ratio of the global inhale-mass and end-exhale mass. A subtraction of the corrected images is performed by spatially matching the images at each phase of the respiratory cycle using a deformable image registration algorithm in Insight Toolkit. A distribution of the fractional regional ventilation values is used to estimate a ratio of tidal volume to functional residual capacity.

Results: Increased fractional regional ventilation is observed in all the subjects when they were breathing using the ABC maneuver. Statistically significant difference (p=0.079) in fractional regional ventilation was observed when we compared the means for the FB and ABC breathing maneuvers. These global differences were also reflected on a regional level when we compared the fractional regional ventilation maps.

Conclusions: This is the first study to report that breathing pattern changes can significantly impact the recruitment of alveoli resulting in marked changes in the fractional regional ventilation.