

AbstractID: 10955 Title: Physiological validation of 4D-CT-based ventilation imaging in patients with chronic obstructive pulmonary disease (COPD)

Purpose: Four-dimensional (4D) CT-based pulmonary ventilation imaging is a new technique and has advantages in speed, resolution, cost and availability. However, the physiological accuracy has not been validated, especially for regional ventilation. The purpose of this study was to validate 4D-CT-based ventilation imaging by comparison with distribution and progression of emphysema. **Method and Materials:** The 4D-CT images were acquired for radiotherapy treatment planning purposes using the GE multislice PET/CT scanner with the Varian RPM system. Ventilation was evaluated for five patients with chronic obstructive pulmonary disease (COPD) and lung cancer by calculating peak-inhale to peak-exhale displacement vector fields (DVF), and then ventilation based on the Jacobian determinant of deformation. To derive DVFs, we used two fundamentally different deformable image registration (DIR) algorithms: surface-based registration (DIR_s) and volume-based registration (DIR_v), of which the geometric accuracy has been validated. The peak-inhale 4D-CT images were used for emphysema quantification. Emphysematous lungs were detected by the density masking technique. The 15th percentile point was used as a measure of emphysema progression. **Results:** There were large discrepancies between distributions of emphysema and ventilation, and between ventilation calculated by two different algorithms. The mean relative volumes of emphysema outside poor-ventilated lungs were 0.665 (range, 0.520-0.901) and 0.709 (range, 0.464-0.933) for DIR_v and DIR_s, respectively. There were very weak (-0.013) to strong (-0.763) negative correlations between emphysema progression and the mean ventilation. The use of an algorithm parameter with more or less elasticity for DIR_v led to improved coverage of emphysema as well as correlations. **Conclusion:** This work represents the first physiological validation of 4D-CT-based ventilation imaging. Our results demonstrated large discrepancies between ventilation and emphysema. However, a trend toward negative correlation and effects of algorithm parameters indicated promise for this technique. **Conflict of Interest:** SK, JB, TK, TB and CL are employees of Philips Research Europe.