Purpose: To develop a semi-automated segmentation method for generating novel helium-3 (3He) magnetic resonance imaging (MRI) functional information from 3He and proton (1H) MRI, determine the relationship between measurements obtained by manual and semi-automated segmentation, and apply this method in chronic obstructive pulmonary disease (COPD) patients to evaluate the lung functional effects of bronchodilator therapy.

Methods: Fourteen COPD ex-smokers provided written informed consent and underwent hyperpolarized 3He and 1H MRI, before and 25±2 minutes after administration of salbutamol. Semi-automated segmentation was accomplished in three steps: 1) hierarchical K-means clustering of 3He MR images into 5 clusters where cluster 1 (C1) represented regions of ventilation defect and background, and cluster 2 to cluster 5 (C2-C5) represented gradations of signal intensity/ventilation, 2) 1H MRI segmentation using seeded region-growing algorithm, and 3) registration of 1H and 3He MRI to differentiate the ventilation defects from the background. 3He VDP was generated using ventilation defect volume (VDV or C1) normalized to the thoracic cavity volume. 3He VV was generated by summing the remaining ventilation clusters (C2-C5).

Results: Manual and semi-automated segmentation were significantly correlated for 3He VDV ($r=.95$, $p<.0001$) and VV ($r=.94$, $p<.0001$). The time for manual segmentation was approximately 60 to 90 minutes per subject dataset, whereas the time for semi-automated segmentation to complete a dataset was between 4 and 8 minutes. Following bronchodilator therapy, there was a significant decrease in VDP and 3He C2 ($p=.01$), and significant increases in C3 ($p=.03$), C4 ($p<.0001$) and C5 ($p=.02$).

Conclusions: We developed a method for generating novel quantitative 3He MRI functional information that enables sensitive detection of regional lung functional improvements that occur following inhaled therapy in COPD patients. This has implications for the broader translation of functional MRI in clinical therapy studies including those for smoking-related lung cancer.

Funding Support, Disclosures, and Conflict of Interest:

Research funding support from CIHR Operating grants MOP 97748 and Team Grant CIF 97687.