Changes in Pulmonary Blood Flow Heterogeneity measured with ASL-FAIRER in Asymptomatic Smokers and Patients with COPD

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Background

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide, and in the United States it affects approximately 6% of the adult population. Cigarette smoking is the most important preventable risk factor for the development of COPD. However, less than 25% of smokers will develop significant airway obstruction. Early detection and intervention is essential to prevent progression of the disease. Recent evidence suggests that early COPD has both an airway and a pulmonary vascular dysfunction. In this study, we used arterial spin labeling (ASL) techniques to evaluate pulmonary blood flow in asymptomatic smokers and patients with severe COPD. We hypothesized that some asymptomatic smokers would demonstrate pulmonary perfusion abnormalities when compared to healthy non-smokers.

Methods

Two groups of subjects were studied (1) asymptomatic smokers (N=3) and (2) patients with severe COPD (N=3). Data from these subjects were compared to similar data obtained from 33 healthy non-smokers. Each subject underwent magnetic resonance imaging using a Vision 1.5 T whole-body magnet (Siemens Medical Systems, Erlangen, Germany). An ASL-FAIRER sequence was used. This sequence characterizes pulmonary blood flow distribution (resolution ~ 2 x 3 x 15 mm) by creating a magnetically tagged bolus using specialized radiofrequency pulses. Pairs of images, with and without spin tagging, were obtained and subtracted to yield perfusion weighted image maps where signal intensity is directly proportional to blood flow. Data were collected during a breathhold from a single, posterior, coronal slice while the subject was breathing room air. Relative dispersion (RD, = standard deviation/mean), an index of blood flow heterogeneity, was determined from the signal intensity of the perfusion weighted image for each subject.

Results

For healthy subjects, RD increases with increasing age. All of the subjects with COPD had an RD at, or greater than, 2 standard deviations above the predicted RD for age. Additionally, 2 of the 3 asymptomatic smokers also had a measured RD greater than 2 standard deviations above predicted RD for age.
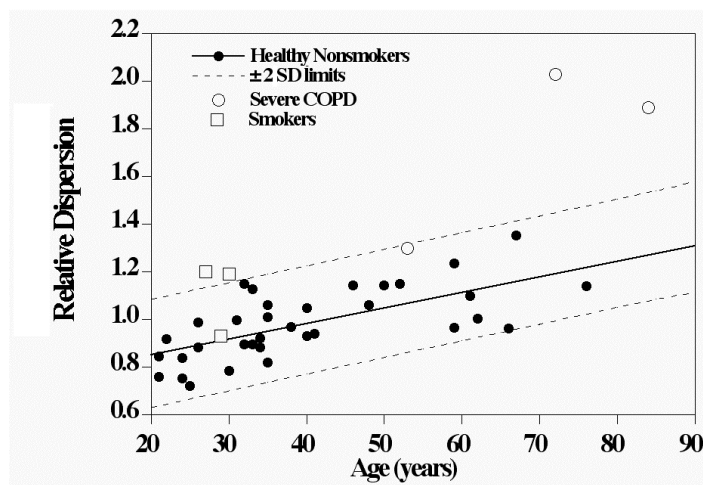

Figure 1. RD for asymptomatic smokers (open squares) and patients with severe COPD (open circles) is shown relative to healthy non-smokers. The dashed lines represent ± 2 SD for the regression of RD vs. age. Data points above this line are significantly different from predicted values for age.

Conclusion

Significant changes in pulmonary perfusion are seen in subjects with severe COPD. In this study, we have demonstrated that MR techniques can demonstrate changes in the normal pattern of pulmonary perfusion even in asymptomatic smokers. Currently, there is no effective therapy to reverse the parenchymal changes of COPD. MR evaluation of pulmonary blood flow using ASL-FAIRER may identify early changes of COPD that occur prior to the development of clinical symptoms and may identify a subset of smokers that are at greater risk for the development of COPD.