Impact Of Differing Convolution Kernels On Quantitative CT Measures Of Lung Density And Correlation With Physiology In Smokers: B31f Vs B35f

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Rationale

The purpose of this study is to evaluate whether quantitative CT (QCT) measures of emphysema (EMP) and gas trapping (GT) are significantly different when evaluated on images reconstructed with differing "soft" convolution kernels, and to evaluate whether one kernel correlates better with physiology.

Methods

From the full COPDGene cohort of 10,279 individuals, 391 met all of the following criteria for this study. Smokers with varying degrees of COPD underwent volumetric CT at full inspiration and at the end of a normal expiration. The scans were performed on Siemens scanners and the raw data were reconstructed utilizing two different "soft" convolution kernels, B31f and B35f. On QCT analysis (Pulmonary Workstation, VIDA Diagnostics), EMP was defined as lung tissue with attenuation values ≤ -950 Hounsfield Units (HU) on inspiratory CT. GT was defined as lung tissue ≤ -856 HU on expiratory CT. Subjects also underwent spirometric evaluation to determine pre- and post-bronchodilator values for FEV_1, FVC and the ratio FEV_1/FVC.

Results

Measurements of EMP and GT using the two kernels were highly correlated ($R^2 = 0.976$, $P<0.001$ for EMP, $R^2 = 0.997$, $P<0.001$ for GT). However, the mean values were significantly different. Mean EMP extent using B31f was 8.3% (SD 7.3), compared with 5.3% (SD 6.4) for B35f ($P<0.001$). Mean GT extent using B31f was 21.5% (SD 15.6), compared with 18.3% (SD 15.7) for B35f ($P=0.005$). R^2 values for correlation between %EMP with measures of FEV_1 and FEV_1/FVC were similar using the B31f reconstruction (0.23 and 0.52) and the B35f (0.27 and 0.54). R^2 values for correlation between %GT with FEV_1 and FEV_1/FVC were nearly equal between the B31f reconstruction (0.40 and 0.68) and the B35f (0.41 and 0.69). All correlations were highly significant with $P<0.001$.

Conclusions

The Siemens B35f convolution kernel provides significantly lower measures of %EMP and %GT than the B31f kernel in smokers. It is important to understand if there is a linear shift and to develop a correction in order to allow for direct comparison of QCT data obtained with different kernels. It is unclear whether one kernel is a significantly better correlate to clinical measures of lung obstruction.

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