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Title: A new index to determine regional lung heterogeneity in healthy and emphysema

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Body: Specific gas volume (SVg, ml/g) converts CT lung density into the physiological meaningful index of volume of gas per gram of tissue (Salito, C. et al. Radiology 2009). The aim of this study was to study regional differences of SVg in the different bronchopulmonary segments in healthy and patients with severe emphysema. CT scans of 10 healthy subjects and 10 patients with emphysema were obtained at end inspiration (TLC) and end-expiration (RV). For each subject, ΔSVg ($\Delta\text{SVg} = \text{SVg}_{\text{TLC}} - \text{SVg}_{\text{RV}}$) vs ΔVL ($\Delta\text{VL} = \text{VL}_{\text{TLC}} - \text{VL}_{\text{RV}}$) was plotted for each bronchopulmonary segment and for entire lung (gray and black lines, respectively, in figure) and an Heterogeneity Index (HI) was defined as $\sqrt{(d_1^2 + d_2^2 + \dots + d_n^2) / n} / \Delta\text{VL}$ (d =distance of ΔVL - ΔSVg in the plot of each bronchopulmonary segment point and the entire lung at RV; n = number of bronchopulmonary segments; see figure). In healthy lungs all bronchopulmonary segments showed similar slopes, $\Delta\text{SVg} / \Delta\text{VL}$, while in emphysema an high variance of slopes was found. As a consequence HI was significantly higher in emphysema than in healthy subjects (0.80 ± 0.34 and 0.15 ± 0.10 , respectively, $p < 0.001$). In conclusion, SVg variations within the lung are highly homogeneous in healthy subjects. Conversely, the larger heterogeneity in emphysema reflects an inhomogeneous lung emptying and therefore HI can be considered as a biomarker for surgical planning and post-treatment evaluation.