



FUNCTIONAL RESPIRATORY IMAGING (FRI) SHOWS SIGNIFICANT REGIONAL VENTILATION DEFECTS IN COPD PATIENTS AS COMPARED TO HEALTHY DATA



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Introduction

Ventilation defects in chronic obstructive pulmonary disease (COPD) are associated with reduced exercise tolerance and worse quality of life. Standard lung function tests lack the ability to detect and quantify regional ventilation defects often resulting in sub-optimal treatment. For the first time, the current study uses high-resolution FRI to quantify and visualize ventilation defects in COPD and compared them to a healthy population.

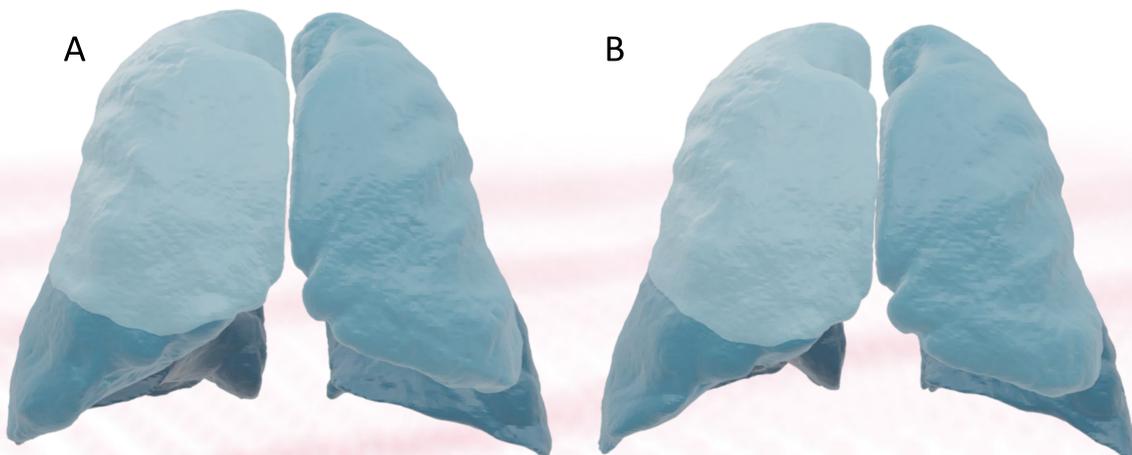


Figure 1. Lobar volumes in COPD at total lung capacity (A) and functional residual capacity (B). COPD is characterized by hyperinflation, resulting in bigger lobar volumes at FRC and TLC, and a smaller relative expansion from FRC to TLC when compared to a healthy subject. Hence, visually it shows that TLC and TLC volumes don't differ that much.

Materials and methods

Regional ventilation data derived from gated inspiratory/expiratory HRCT scans is assessed in 3 healthy and 3 matched COPD patients (4M/2F, 64±3 years, 173±2 cm). Lobar ventilation is calculated and compared between healthy and COPD.

	Healthy	COPD
Sex	2M/1F	2M/1F
Age	63±3.56	63±1.41
Height	174±1.63	173±2.16

Table 1. Demographics of healthy and COPD patients. Patients from both cohorts were matched based on sex, age and height.

Results

When comparing regional ventilation on a lobar level between the 3 matched healthy and COPD patients, the right upper lobe of a COPD patient as compared to a matched healthy patient showed a decrease of 21.8±8.5%, the right middle lobe a decrease of 21.8±4.5%, the right lower lobe a decrease of 26.6±8.0%, the left upper lobe a decrease of 21.2±11.6% and the left lower lobe a decrease of 25.6±12.3%.

Difference in regional ventilation COPD versus Healthy	Mean difference	Std. difference	p
RUL	-21.84%	8.49%	< 0.001
RML	-21.77%	4.49%	< 0.001
RLL	-26.64%	8.00%	< 0.001
LUL	-21.24%	11.60%	< 0.001
LLL	-25.64%	12.25%	< 0.001

Table 2. Mean and standard deviation of differences in lobar ventilation between 3 matched healthy and COPD patients. The results show significant decreases in lobar ventilation for the COPD patients, with the biggest differences in the lower lobes. This decrease in ventilation can mainly be attributed to the presence of air trapping in the lungs resulting in hyperinflation.

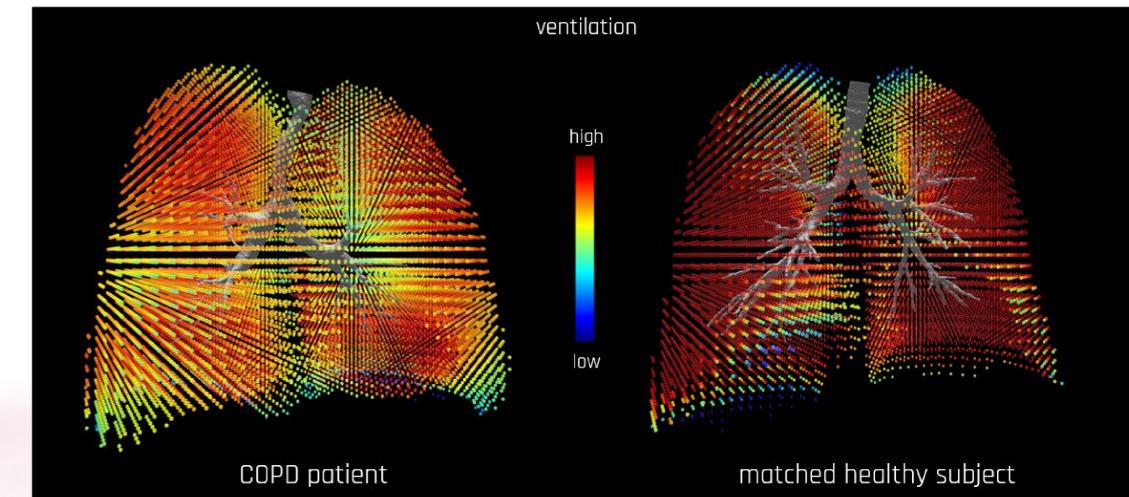


Figure 2. Regional ventilation map for a COPD patient and a matched healthy subject, as well as the relative effect between both. A substantial relative ventilation defect can be seen in both lung as a result of hyperinflation in COPD patients, with regional defect values up to 25%. Ventilation maps are CT-based representations of regional ventilation, derived from pulmonary CT images acquired at two different inflation levels, functional residual capacity (FRC) and total lung capacity (TLC), without the use of exogenous contrast, by assuming that regional changes in lung volume relate to regional ventilation. The Jacobian determinant of the deformation field from FRC to TLC is calculated, which measures the differential expansion of the image.

Conclusion

Ventilation defects express themselves in a heterogeneous manner in COPD patients. Lower lobes appear to be more affected by the disease, resulting in an overall larger reduction in ventilation as compared to the upper lobes. These findings are particularly relevant when optimizing inhalation therapies that rely on inspiratory airflow to ensure adequate drug delivery to the lung.