

Case 6

Lung Parenchyma Analysis Software with Automated Three-Dimensional Quantification of Emphysema

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HISTORY

A 72-year-old male, a former smoker on home oxygen with history of severe COPD, was referred for a DSCT scan of the thorax for follow-up due to worsening dyspnea. The patient had bilateral upper lobe lung volume reduction surgery 8 years ago.

DIAGNOSIS

The DSCT scan with lung window setting showed diffuse severe emphysema and bullous changes were identified throughout the upper lobes. Severe centrilobular emphysema was also identified including the lower lobes (Fig. 1A). Surgical clips and architectural distortion from prior bullectomy were noted in the upper lobes.

syngo InSpace Lung Parenchyma Analysis software was then used to quantify the amount of emphysema, characterized by lung attenuation below -950 HU¹. Results were stratified by lung thirds (upper, middle and lower) to evaluate the distribution of the disease. As illustrated in Figs. 1B and 1C, the software allowed the automatic three-dimensional quantification of total lung volume and relative volume percentages, mean lung density, and low and high attenuation volumes. The low attenuation volume (LAV) corresponds to the volume of emphysematous lung and is displayed as a percentage of the total lung volume. In this case, the analysis showed that 51.5% of the left lung and 38.4% of the right lung volume corre-

sponded to emphysema (Fig. 1C, arrows). It also confirmed the upper lobe predominance of the disease.

Emphysema cluster analysis was automatically performed, showing clusters class 1 (> 2mm³), class 2 (> 8mm³), class 3 (> 65mm³), and class 4 (>187mm³) colored in blue, green, yellow, and red, respectively (Figs. 2A-B). The vast majority of the emphysema in this patient was classified as cluster class 4, which involved 50.3% of the left lung volume and 37.0% of the right lung volume (Fig. 2C).

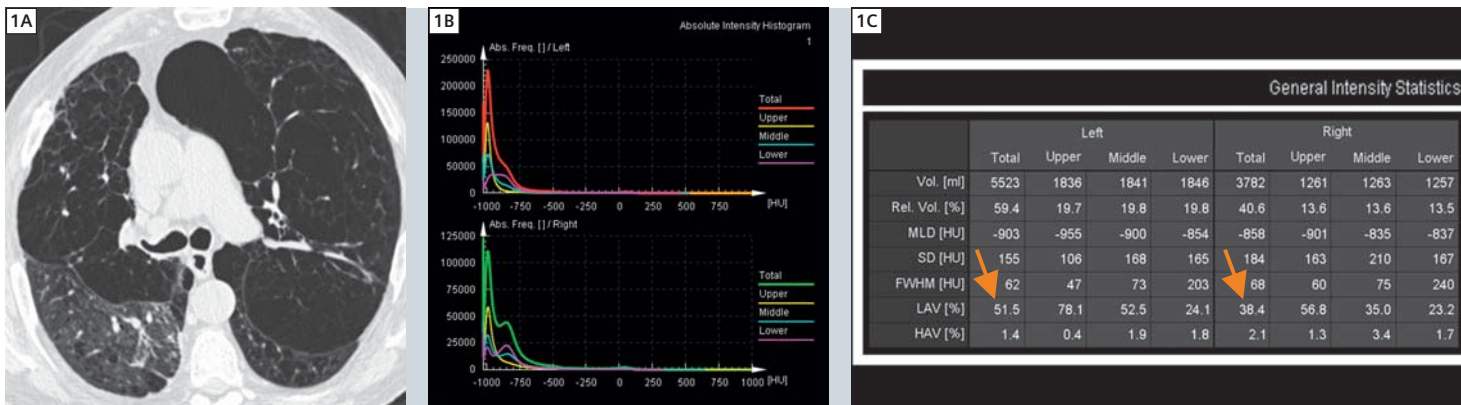
COMMENTS

The *syngo* Lung Parenchyma Analysis software enables automated evaluation of emphysema. It permits not only precise quantification of the amount of disease, but also classification of the foci of emphysema by size and distribution of the disease. The importance of these parameters resides in the preference for accurate quantification of disease when compared with routine pulmonary functional testing for assessing potential therapeutic options in patients with emphysema. While characterization of large bullae indicates the possibility of treatment with bullectomy, in fact, most patients present with either predominant centrilobular or panlobular emphysema. Over the past several years, a number of innovative therapeutic options have been developed for treating patients with predominant upper lobe centrilobular em-

physema. In addition to routine lung volume reduction surgery (LVRS),^{2,3} newer interventional bronchoscopic techniques have emerged as potential alternatives, including the placement of one-way endobronchial valves and bronchial fenestration.^{4,6} As emphasized in this case, in addition to preoperative evaluation, it is equally important to monitor disease progression following surgery. For this purpose, quantitative CT offers a potential alternative to less precise measurements of disease severity, including routine exercise testing and PFTs. In addition, CT allows identification of potential complications (including the development of lung cancer in this especially predisposed population). In this regard, the availability of a "user-friendly" CT application will be of critical importance in establishing quantitative CT as the gold standard for both pre- and post-operative assessment of patients with emphysema. In this case, the degree of residual emphysema following lung volume reduction surgery established this patient as a candidate for lung transplantation.

References

- 1 Gevenois PA et al. Am J Respir Crit Care Med 1996; 154:187-192.
- 2 Lederer DJ et al. Clin Chest Med 2007; 28:639-653, vii.
- 3 Fishman A et al. N Engl J Med 2003; 348:2059-2073.
- 4 Wan IY et al. Chest 2006; 129:518-526.
- 5 Reilly J et al. Chest 2007; 131:1108-1113.
- 6 Cardoso PF et al. J Thorac Cardiovasc Surg 2007; 134:974-981.



1 Lung parenchyma analysis: general analysis stratified into upper, middle and lower lung thirds. Axial CT scan at the level of the carina showing severe emphysema with bullous changes in the upper lobes and centrilobular emphysema in the superior segments of the lower lobes (Fig. 1A). Histogram showing severe emphysema bilaterally with upper third predominance in both lungs (Fig. 1B). Quantitative three-dimensional analysis of lung volume, mean lung density, low and high attenuation volumes are displayed (Fig. 1C). The low attenuation volume (LAV %) indicates the percentage of the lung with emphysema.



2 Lung Parenchyma Analysis: Cluster classification stratified by thirds in the left and right lung. Axial and coronal reformats (Figs. 2A-2B) showing emphysematous clusters, color-coded by size. The red color corresponds to the largest clusters (Class 4, ≥ 187 mm³). Results displayed in the table (Fig. 2C) show the percentage of lung volume involved by specific cluster's size. In this case there is severe emphysema characterized by Class 4 clusters involving 50.3% of the left lung volume and 37% of the right lung volume.

EXAMINATION PROTOCOL

Scanner	SOMATOM Definition	
Scan area	thorax	Slice width 0.75 mm
Scan length	348 mm	Reconstruction increment 0.5 mm
Scan direction	cranio-caudal	Reconstruction kernel B40
Scan time	8.2 s	Slice collimation 0.6 mm
Tube voltage	120 kV	Pitch 0.8
Tube current	160 qual. ref. eff. mAs	Rotation time 0.33 s
CTDI_{vol}	11.5 mGy	Postprocessing syngo InSpace Lung Parenchyma Analysis