Fully automated method for lung emphysema quantification for Multidetector CT images

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Outline

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- Purpose
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Lung emphysema is defined as an abnormal and persistent increment of the distal aerial spaces to the terminal bronchiole, it could be accompanied with lung parenchyma walls destruction and without fibrosis.
Lung emphysema is considered with chronic bronchitis part of the Pulmonary Obstructive Chronic Diseases (COPD).

→ Change of the paradigm between the qualitative and the quantitative information of the disease.

→ Development of zero-click automatic algorithm able to segment, quantify and characterize lung emphysema areas, lung parenchyma, blood vessels and lung parenchyma densities.
**Materials and Methods**

**Image Modality:** 39 standard MDCT scans

- 22 male and 17 female

**Acquisition Characteristics**

- Voltage: 120 kVp
- Current: 250 mA
- Slice thickness ≤ 2mm
- Pixel Size ≤ 1mm
Materials and Methods
Lung Emphysema Quantification

→ Fixed thresholding (-950 HU)
→ Adaptive thresholding (QUIBIM Patent)
Materials and Methods

• Quantification

1. Percentage:
Ratio between the total number of voxels of the ROI and the total number of the mask [%]

\[
\% = \frac{\text{Voxels Emphy. or vessels}}{\text{Total Lung Voxels}} \times 100
\]

2. Volume Quantification:
Product between the number of voxels of the ROI and the dimensions of a slice [ml]

\[
Vol = \frac{\text{Voxels Lung, Emphy, vessels or airways} \times \text{size (x)} \times \text{size (y)} \times \text{slice thickness}}{1000}
\]
• Algorithm execution takes 30-45 min on average depending study size
• Right lung volume is 8.7% and 9.5% greater than left lung volume for male and female respectively
• Lung emphysema quantification by adaptive thresholding is 50% smaller on average than lung emphysema quantification by fixed Thresholding

<table>
<thead>
<tr>
<th>Mean Volume</th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
<td>Right Lung</td>
<td>3209.78 ml</td>
<td>2515.07 ml</td>
</tr>
<tr>
<td>Left Lung</td>
<td>2979.18 ml</td>
<td>2136.17 ml</td>
</tr>
<tr>
<td>Total</td>
<td>6188.96 ml</td>
<td>5187.50 ml</td>
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• 29 patients were diagnosed of emphysema caused by external agents. Emphysema was mainly detected in the lung apex.

• 2 patients present alfa-1-antitripsine deficient being the emphysema detected mainly on lungs base.

• 8 patients were unspecific due to percentage of emphysema below 5%.
Conclusions

• Relation between the smoker status and the presence of emphysema exists

• Adaptive thresholding is able to perform a better characterization of emphysema due to image-threshold specificity

• Lung emphysema etiology could be inferred due to emphysema quantification by lung thirds.

Automated lung emphysema quantification can be used for the diagnosis and follow up of COPD.
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