Expiratory chest HRCT in rheumatoid arthritis patients

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Aims and objectives

The presence of pulmonary functional and morphological abnormalities related to small airways disease (SAD) in rheumatoid arthritis (RA) patients has been studied in literature since 1979 but its exact prevalence and clinical significance is still nowadays a subject of debate.\textsuperscript{1-9} Irrespective of smoking habitus or the presence of interstitial lung disease, SAD seems to be present in RA patients, since a large percentage of non-smoking RA patients may have abnormal pulmonary function test (PFT) values related to bronchiolar disease.\textsuperscript{2}

Pathologically, SAD is divided in obliterative (constrictive) bronchiolitis and follicular bronchiolitis, with an unclear exact pathogenesis.\textsuperscript{3,7} SAD in RA patients that are non-smokers, has not been emphasized in the literature.

The aim of the present study was to investigate the prevalence of small airways disease in non-smokers with rheumatoid arthritis based on chest HRCT and PFT findings with emphasis on the contribution of expiratory CT scans.
Methods and materials

PATIENT CHARACTERISTICS

62 consecutive patients, 14 males, 48 females, aged 42-76 years (median age 59 years), diagnosed with RA according to the revised classification criteria for RA of the American College of Rheumatology and the European League Against Rheumatism\textsuperscript{10}, were prospectively recruited. Disease duration's range was 9.2 ± 3.55 years. Patients with pre-existing lung disease, bronchial asthma, emphysema, primary pulmonary hypertension, exposure to silica or other dusts, as well as smokers were excluded from the study. Among them, 28 (45\%) patients were receiving anti-TNF-\# treatment (Infliximab), while the remaining 34 (55\%) were under non biologic DMARDs therapy (Methotrexate).

CHEST HRCT STUDIES

All patients underwent chest HRCT and pulmonary function tests (PFTs). Chest HRCT exam consisting of paired inspiratory and expiratory scans performed on a multislice CT scanner (Siemens Somatom Sensation 64, Erlangen, Germany) using identical technical parameters with submillimeter slice thickness. In order to achieve reproducibility, all patients were thoroughly trained before the examination to deeply inhale and hold their breath for each inspiratory scan and to deeply inhale then to forcefully and rapidly exhale and do not breathe for 10 seconds for the expiratory scan in order to achieve adequate end-expiratory phase images.

Inspiratory scans were evaluated for the presence of bronchial/bronchiolar wall thickening, bronchiectasis and nodules. Positivity for bronchial wall thickening was considered when the ratio between bronchial wall thickness and diameter of bronchus was > 0.2. Bronchiectasis was considered present when the broncho-arterial ratio was >1.

For the detection of air trapping on expiratory scans, a side by side comparison of inspiratory and expiratory CT images of the same area was performed. Hypodense areas on expiratory scans showing attenuation increase less than 80 HU and involving more than 25\% of the lobe, were regarded as air trapping. The extent of air trapping (AT) on expiratory scans corresponding to small airways disease was evaluated by visual scoring using a semi-quantitative scoring system estimating the percentage of lung that appeared abnormal on each scan. A 5\%-point scoring system, as the one proposed by Stern et al.\textsuperscript{11} and Naidich et al.\textsuperscript{12} estimated air trapping on expiratory scans, at three different lung fields for each lung: upper, middle and lower lung fields. At each level and for each lung, a 5-point scale was used to estimate the percentage of air trapping extent visible:
0 = no air trapping, 1=1-25% of cross sectional area of the lung affected by air-trapping, 2= 26-50%, 3=51-75% and 4=76-100% of cross sectional area of the lung affected by air-trapping.

STATISTICAL ANALYSIS

Statistical analysis for comparisons between data was performed by analysis of variance, Student t test, Wilcoxon rank-sum test, or chi-square testing as appropriate. Linear (Pearson) correlation test was also performed between HRCT and PFT data. A p value of < 0.05 was considered statistically significant.

PULMONARY FUNCTION TESTS

All patients underwent spirometry, lung volumes and diffusion capacity measurement. Observed values were expressed as percentage of the predicted value were compared with individuals of similar sex, age and height and were considered as abnormal if they were <80% of the predicted values adjusted for age, sex and height.
Results

Chest HRCT findings are analyzed in Table 1. On inspiratory HRCT scans mild cylindrical bronchiectasis were detected in 42 (68%) patients (Fig. 1). Bronchial wall thickening was depicted in 38 (62%) patients (Fig. 2) while in 29 (69%) patients bronchial wall thickening and cylindrical bronchiectasis coexisted (Fig. 3). Both cylindrical bronchiectasis and bronchial wall thickening involved secondary (lobar) and tertiary (segmental) bronchi. Small pulmonary nodules were depicted in 22 (35%) patients.

Patchy areas of air trapping were depicted on expiratory HRCT scans in 39 (63%) patients (Fig. 4) with its presence being statistically significant ($p<0.05$) (Table I). Among them, 28 patients in PFTs demonstrated abnormally low MMEF25-75 values and abnormally increased RV and RV/TLC values, parameters related to small airways disease. The remaining 11 (18%) patients had normal PFTs values and normal inspiratory HRCT scans and the only abnormal HRCT finding was air trapping (Fig. 5). A significant correlation was depicted between bronchial wall thickening and air trapping presence ($r^2=0.3322$, $p=0.0072$) and extent ($r^2=0.3132$, $p=0.0034$), respectively (Fig. 6).
Table 1: HRCT findings

<table>
<thead>
<tr>
<th>Table I: HRCT findings</th>
<th>Absent; Present</th>
<th>( p ) value</th>
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<tbody>
<tr>
<td><strong>Inspiratory scan</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylindrical bronchiectasis</td>
<td>20 ; 42</td>
<td>NS</td>
</tr>
<tr>
<td>Bronchial wall thickening</td>
<td>24 ; 38</td>
<td>NS</td>
</tr>
<tr>
<td>Nodules</td>
<td>40 ; 22</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Expiratory scan</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air trapping</td>
<td>23 ; 39</td>
<td>( p &lt; 0.05 )</td>
</tr>
</tbody>
</table>

NS : non significant

Table 1: Table 1 summarises the number of patients exhibiting inspiratory and expiratory chest HRCT abnormal findings. Probability values (p-values) \( < 0.05 \) were considered statistically significant.

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Fig. 1: HRCT scans of two different RA patients. A. Section through the lower lobes depicts mild cylindrical bronchiectasis bilaterally as ring-like segmental bronchi with a luminal diameter slightly greater that the accompanying vessel (arrows) B: Axial scan at the level of the carina shows long segment dilated bronchi at both upper lobes (arrows).

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Fig. 2: Inspiratory scan through lower lung fields in A and B showing mild bronchial wall thickening involving secondary (lobar) and tertiary (segmental) bronchi.
**Fig. 3:** HRCT scan through the lower lobes depicts mild wall thickening (white arrow). Also note cylindrical bronchiectasis with thickened bronchial wall on the left with a signet ring appearance (black arrow).

**Fig. 4:** Expiratory HRCT images of the same patient. A level of the carina B: lower lung fields. There are patchy distributed areas of air trapping (arrows) seen as hypodense geographic areas with a random distribution bilaterally.

**Fig. 5:** A: Inspiratory HRCT scan without abnormal findings, B: Same patient as in A with patchy air trapping areas on expiratory HRCT scan consistent with small airways disease. The present patient had normal PFT values.
Fig. 6: A significant correlation was depicted between bronchial wall thickening and air trapping presence ($r^2=0.3322$, $p=0.0072$) and extent ($r^2=0.3132$, $p=0.0034$), respectively.
Conclusion

- Bronchial wall thickening and cylindric bronchiectasis were common findings in nonsmoking RA patients, with pathogenesis possibly attributed to the disease itself.

- Bronchial wall thickening significantly correlated to air trapping presence and extent.

- Air trapping on expiratory HRCT scan, suggestive of small airways disease, was a common finding in expiratory HRCT scans of nonsmoking RA patients.

- In RA patients with normal parenchyma on inspiratory HRCT, air trapping may be the only abnormal finding.

- Expiratory HRCT scans proved to be very sensitive in detecting small airways disease in RA patients with normal values of PFT parameters.
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References


