Screening for Bronchiectasis*
A Comparative Study Between Chest Radiography and High-Resolution CT

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Study objective: The aim of our study was to investigate whether in the search for bronchiectasis a correlation exists between abnormalities on the chest radiograph and high-resolution CT (HRCT), and if HRCT has an additional value when the chest radiography is normal.

Subjects and methods: In a prospective study, chest radiographs were compared with HRCT in 84 patients. Analysis of presence and extent of bronchiectasis were made for each bronchopulmonary lobe.

Results: Thirty-seven patients had a normal radiograph, from whom 32 had a normal HRCT. The other 5 had a low HRCT severity score with a mild cylindrical bronchiectasis. From the 47 patients with an abnormal radiograph, 36 had signs of bronchiectasis at HRCT; 11 patients, however, had a normal HRCT. The sensitivity for chest radiography to detect bronchiectasis appeared to be 87.8% with a specificity of 74.4%. We found a significant linear relationship between the severity of bronchiectasis at HRCT and abnormalities as seen on the chest radiograph (r=0.62, p=0.0001).

Conclusion: A normal chest radiograph almost always excludes relevant bronchiectasis and no further investigation seems necessary. There is a significant linear relationship between the severity of bronchiectasis at HRCT and abnormalities as seen on the chest radiograph. (CHEST 1996; 109:608-11)

Key words: bronchiectasis; chest radiography; high-resolution CT (HRCT)

At present, high-resolution CT (HRCT) has become the imaging procedure of choice in depicting bronchiectasis. It has been assigned an important role in establishing the presence and anatomic extent of bronchiectasis. In a substantial number of patients, it is clinically relevant to screen for the presence or absence of bronchiectasis, and for this reason, HRCTs are frequently made, irrespective of the findings of the chest radiograph.

Although the radiographic manifestations of bronchiectasis are nonspecific and a definitive diagnosis can rarely be made radiographically, Gudbjerg found a normal chest radiograph only in 7.1% of bronchographically proved cases of bronchiectasis.

The purpose of our study was to investigate whether in the search for bronchiectasis a correlation exists between abnormalities on chest radiography and those that are detected with HRCT. Moreover, we wondered whether the HRCT has additional value for a diagnosis of bronchiectasis when the chest radiograph is normal.

Materials and Methods

In a period of 28 years, 84 patients were suspected of having bronchiectasis as indicated by recurrent infections of the lower respiratory tract, recurrent episodes of hemoptysis, or a chronic cough. Patients with COPD or asthma were included in the study only if they had a persistent cough despite optimal treatment. Patients with cystic fibrosis, alpha-1-antitrypsin deficiency, and malignancy were excluded from the study. The plain chest radiographs and HRCTs were not performed within 2 months of the last infectious period.

The study group consisted of 44 men and 40 women with a mean age of 52.0 years (SD 15.6) and range of 22 to 82 years. Standard chest radiographs were made posteroanterior and lateral with a high kilovoltage technique (120 to 140 kV). The HRCT scans were obtained with a scanner (Philips Tomoscan 7000 CT-Scanner). Scanning was performed from the diaphragm to the apex of the lungs. During HRCT, 1.5-mm-thick slices were obtained at 10-mm intervals from the lung apices to the diaphragm (1 s scan time, 140 kV, 175 mA). The lung images were reconstructed with a high-spatial frequency algorithm. The lung window settings for HRCT were 700 HU level and 1,500 HU width. The scans were obtained during full inspiration with the patient in the supine position without IV administration of contrast medium.

The chest radiographs and CT scans were reviewed independently and in random order by two radiologists (senior staff mem-

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Table 1—Criteria for Bronchiectasis

<table>
<thead>
<tr>
<th>Chest Radiography</th>
<th>HRCT</th>
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<tr>
<td>1. Increased linear markings</td>
<td>1. Cylindrical</td>
</tr>
<tr>
<td>2. Crowding</td>
<td>Cylindrical</td>
</tr>
<tr>
<td>3. Cystic spaces</td>
<td>Signet rings</td>
</tr>
<tr>
<td>Air-fluid levels</td>
<td>Tramlines</td>
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<tr>
<td>4. Honeycombing</td>
<td>Varicose</td>
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</table>

The CT criteria of Naidich et al. were used to determine the presence and type of bronchiectasis (Table 1). Cylindrical bronchiectasis is classified depending on a horizontal or vertical course of the bronchi in the scan plane as “tramlines” or “signet rings” (Fig 1 and 2). Varicose bronchiectasis shows a greater degree of dilatation and the walls of the dilated bronchi assume a beaded appearance. Cystic bronchiectasis can be recognized by air-fluid levels, strings, or cluster of cysts. Other CT findings include lack of tapering of the bronchi, visualization of bronchi within 1 cm of the pleura, and bronchial wall thickening.

Both for HRCT and chest radiography, analysis of the presence and the extent of bronchiectasis was made for each bronchopulmonary lobe, the lingula being viewed as a separate lobe. This resulted in a total score for both lungs. The severity of the items mentioned in Table 1 was scored 0 to 3: 0, not present; 1, abnormalities visible only in a small part of the lobe; 2, intermediate; and 3, abnormalities visible in the whole lobe. In consensus, a definite score for each patient was derived from the individual scores of the two radiologists.

Statistical Analysis

The Mann-Whitney U test was used to analyze differences among the created groups a through d. The data are presented as the mean±SD. Probability values of less than 0.05 were considered to be significant.

Correlations between the scores of the chest radiographs and HRCTs were calculated with Spearman’s rank correlation coefficient. Two tailed p values of less than 0.05 were considered significant.

The interobserver variability was calculated with the paired t test for the scores of the chest radiograph and HRCT.

RESULTS

There were 37 patients with a normal chest radiograph (group A), 18 patients with increased linear markings (group B), 20 patients with increased linear markings and crowding (group C), and 9 patients with signs of group A and B but also circular markings and/or honeycombing (group D).

In group A, 32 patients (86%) had a normal HRCT, without signs of bronchiectasis. Five patients with a normal radiograph appeared to have cylindrical bronchiectasis with a low HRCT score (score of 2-6).

Five patients (28%) of group B and five patients (25%) of group C had a normal HRCT scan without signs of bronchiectasis. In group D, all patients (100%) had signs of bronchiectasis at HRCT.

In Table 2, the mean HRCT score is shown for group A through D. The mean HRCT score in group A is significantly lower than in the other groups (p<0.05).

Groups B and C are not significantly different from each other whereas the severity score of group D is significantly higher than in other groups.

At HRCT, there were 41 patients with signs of bronchiectasis, from whom 5 had a normal chest radiograph (12%). Cylindrical bronchiectasis was present in 100 lobes, varicose bronchiectasis in 15 lobes, and cystic bronchiectasis in 5 lobes. Table 3 shows the division of the types of bronchiectasis among

Figure 1. Cylindrical bronchiectasis. HRCT scan through the right upper lobe; tramline appearance (arrow) is seen when sectioned horizontally. Lack of tapering is well visible.

Figure 2. Cylindrical bronchiectasis. HRCT scan through the lower lobes. Signet-ring appearance (arrows) is seen when sectioned vertically.
In 43 patients, no signs of bronchiectasis were found at HRCT; 32 (72%) of them also had a normal radiograph. However, 11 patients (26%) had signs of bronchiectasis at chest radiography (6 of group A with increased markings and 5 of group B with signs of “crowding”) that were not present at HRCT. Figure 3 shows the linear relationship between the total score for signs of bronchiectasis at chest radiography and the HRCT score. A significant positive correlation was found (r=0.62, p=0.0001).

In this biased population using the criteria of Gudbjørg, the sensitivity for chest radiography to detect bronchiectasis appeared to be 87.8% with a specificity of 74.4%. The predictive value for positive results is 76.6%, with a predictive value for negative results of 86.5%. In our group of patients, no other serious occult intrathoracic abnormalities were found.

The interobserver variability was calculated for the scores of the chest radiograph and HRCT. For the chest radiograph, the mean difference was -0.28, with a 95% confidence interval of -0.89 to 0.31. The correlation coefficient was 0.87. For HRCT, the mean difference was -0.12, with a 95% confidence interval of -1.06 to 0.81. The correlation coefficient was 0.81.

**Discussion**

For optimal treatment of patients with recurrent infections of the lower respiratory tract, recurrent episodes of hemoptysis, or chronic cough, it is important to demonstrate or exclude the presence of bronchiectasis. Until the introduction of HRCT, bronchography was used as a gold standard for the diagnosis of bronchiectasis. The question remains, however, whether “HRCT of the lungs” as a screening tool should be performed in every patient suspected of having bronchiectasis, since patients with bronchiectasis rarely have a normal chest radiograph. The common findings are loss of definition and increase in the number and size of the bronchovascular markings, which are caused by peribronchial fibrosis and retained secretions. Other findings include crowding of the bronchi and loss of lung volume, and in severe cases, honeycombing and cystic spaces may be present.

However, none of these findings are specific for bronchiectasis except in the case of cystic spaces. Increased pulmonary markings can be caused by purely vascular conditions resulting in coarse-meshed pulmonary markings that arouse a suspicion for bronchiectasis. Crowding or loss of volume and honeycombing are also not specific for bronchiectasis.

The sensitivity of the plain chest radiograph for the definitive diagnosis of bronchiectasis has been considered very low. In a study of 27 patients, Cooke et al. asked three radiologists to assess the presence or absence of bronchiectasis. They found a sensitivity of the chest radiograph compared with bronchography of only 37% with a specificity of 95%.

In a study of Currie et al. in 27 patients, chest radiography was diagnostic in only 47% of the patients with bronchographically diagnosed bronchiectasis.

When considering Gudbjørg’s signs diagnostic or suggestive for the diagnosis of bronchiectasis at plain chest radiography, we found in our selected group a high sensitivity of 87.8% with a rather low specificity (74%). Eleven patients (26%) without bronchiectasis at HRCT (n=43) showed increased linear markings and signs of crowding on the radiograph.

In our study in 41 patients with HRCT-proved bronchiectasis, only 5 (12%) had a normal plain chest radiograph. However, in these patients, there was only a mild degree of cylindrical bronchiectasis at HRCT.

We found a significant linear relationship between the severity of bronchiectasis at HRCT and abnormalities as seen at chest radiography. Especially when the chest radiograph shows "circular" markings or honey-

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**Table 2.—Mean HRCT/Bronchiectasis Severity Score ± SD for the Different Chest Radiography Groups**

<table>
<thead>
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<th>Group</th>
<th>Mean HRCT Score</th>
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<tr>
<td>A (n=37)</td>
<td>0.6±1.6</td>
</tr>
<tr>
<td>B (n=18)</td>
<td>3.2±4.1</td>
</tr>
<tr>
<td>C (n=20)</td>
<td>4.1±4.4</td>
</tr>
<tr>
<td>D (n=9)</td>
<td>11.8±6.9</td>
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**Table 3.—HRCT Patterns of Bronchiectasis in 41 Patients**

<table>
<thead>
<tr>
<th>Type of Bronchiectasis</th>
<th>Patients</th>
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<tbody>
<tr>
<td>Cylindrical</td>
<td>30</td>
</tr>
<tr>
<td>Cylindrical+varicose</td>
<td>4</td>
</tr>
<tr>
<td>Cylindrical+cystic</td>
<td>4</td>
</tr>
<tr>
<td>Cylindrical+cystic+</td>
<td>1</td>
</tr>
<tr>
<td>Varicose</td>
<td>2</td>
</tr>
</tbody>
</table>

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**Figure 3.** Correlation between mean HRCT bronchiectasis severity score and plain radiography score (r=0.62; p<0.0001).
combing there is a high suspicion of bronchiectasis.

However, when there is a normal chest radiograph, it is unlikely that clinically relevant bronchiectasis is present and when present it will not be a severe or extensive type.

In conclusion, in patients with clinical suspicion of bronchiectasis, chest radiography gives important information. A normal radiograph almost always excludes relevant bronchiectasis and no further investigation seems necessary. When there are signs according to Gudbjerg, there is a rather high probability for bronchiectasis, and HRCT can justify the diagnosis and show the extent and type of bronchiectasis. This can be important if there are therapeutic consequences, especially when surgery is considered.

REFERENCES