Computed Tomographic Diagnosis of Mycobacterium avium-intracellulare Complex in Patients With Bronchiectasis*

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We tested the hypothesis that bronchiectasis and multiple small lung nodules seen on chest computed tomography (CT) are indicative of Mycobacterium avium-intracellulare complex (MAC) infection or colonization by reviewing CT scans and histories of 100 outpatients with CT diagnosis of bronchiectasis. Of the 24 patients with multiple pulmonary nodules, 19 had lung nodules and bronchiectasis in the same lobe. Mycobacterial cultures were performed on 63 of the 100 patients, including 15 of the 24 patients with lung nodules and 48 of the 76 patients with no lung nodules. Of the 15 patients with lung nodules, 8 (53 percent) had cultures positive for MAC, as did 2 of the 48 (4 percent) patients with no CT evidence of lung nodules. The number of cultures positive for fungi was approximately the same in both groups. In our outpatient population, CT prediction of cultures positive for MAC in bronchiectatic patients with multiple small lung nodules has a sensitivity of 80 percent, a specificity of 87 percent, and an accuracy of 86 percent.

Assessment for bronchiectasis has become a frequent indication for high-resolution computed tomography (CT) of the lungs. Bronchiectasis, often an occult disease on chest radiographs, can be accurately evaluated with high-resolution CT. We have observed that many patients with bronchiectasis also had segmental collections of multiple small well-circumscribed pulmonary nodules. Many of these patients were subsequently found to have cultures positive for Mycobacterium avium-intracellulare complex (MAC).

We have previously described retrospective evidence that suggested that the concomitant findings of bronchiectasis and multiple small well-circumscribed lung nodules were indicative of infection or colonization with MAC. In the same article, we identified a characteristic subgroup of patients with MAC composed predominantly of older women without clinical evidence of immunosuppression or malignancy. An important unanswered question from that study is, how sensitive and specific is CT in predicting positive MAC cultures in patients with bronchiectasis?

Our study was undertaken to test the following hypothesis: the presence of bronchiectasis and multiple small well-circumscribed lung nodules on chest CT is indicative of MAC infection or colonization.

MATERIAL AND METHODS

The chest CT examinations of 100 outpatients that were prospectively interpreted as showing bronchiectasis were retrospectively reviewed. At the time of initial interpretation, all CT scans at our institution were computer coded by radiologic diagnosis. From a list of all patients with a CT diagnosis of bronchiectasis, we selected the last 100 patients on the list. The primary clinical indications for the CT scans indicated on the referral forms included the following: evaluation of bronchiectasis (48 percent), inflammatory or infectious process (20 percent), diffuse lung disease (7 percent), and others (25 percent). These CT studies were performed between March 1990 and October 1991 with one of two scanners (Picker 1200SX, Highland Heights, Ohio, and GE Medical Systems CT 9800, Milwaukee, Wis). Of the 100 CT scans, 99 of them included or were composed entirely of high-resolution CT sections (1.0 to 1.5-mm collimation with high spatial frequency reconstruction algorithm). None of these CT examinations was included in the previous study.

The scans were reviewed with consensus reading by two observers (S. J. S. and T. E. H.) without knowledge of the culture results. The diagnosis of bronchiectasis was confirmed in all 100 cases, and the presence or absence of multiple small well-circumscribed pulmonary nodules was determined. Analysis of both CT and high-resolution CT sections was performed to distinguish true lung nodules from the nodular opacities that may result from transaxial CT sections through mucoid impaction of small distal airways. Mucoid impactions tended to be more linear than round on CT and coursed adjacent to the pulmonary artery. The examinations were grouped according to the size of the majority of pulmonary nodules (<5 mm or ≥5 mm diameter), and it was noted whether the majority of lung nodules were in the same lobes as the bronchiectasis. Computed tomographic evidence of emphysema was also recorded.

The medical records of the 100 patients with CT evidence of bronchiectasis were then reviewed. The results of all fungal and mycobacterial cultures obtained from sputum, induced sputum, and bronchial washings were recorded if they were performed within 1 month of the CT examination.

RESULTS

Of the 100 patients with CT evidence of bronchiectasis, 24 had multiple pulmonary nodules (Table 1), and
Table 1—Results of Culture for Mycobacterium avium-intracellulare Complex in Patients With Bronchiectasis

<table>
<thead>
<tr>
<th>100 patients with bronchiectasis</th>
<th>Multiple small lung nodules seen on CT</th>
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<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>24 patients (92% female)</td>
<td>8 of 15 patients (53%) with cultures positive for MAC</td>
</tr>
<tr>
<td></td>
<td>3 of 12 patients (25%) with cultures positive for MAC</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>76 patients (62% female)</td>
<td>2 of 48 patients (4%) with cultures positive for MAC</td>
</tr>
<tr>
<td></td>
<td>12 of 47 patients (26%) with cultures positive for fungi</td>
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*CT = computed tomography; MAC = Mycobacterium avium-intracellulare complex.

21 of these patients had nodules that were predominantly <5 mm in diameter. Three patients had nodules that were predominantly ≥5 mm in diameter. No nodules were >15 mm in diameter. In 19 of the 24 patients, the lung nodules were in the same lobe as the bronchiectasis (Fig 1), and in the 5 other patients, the bronchiectasis and lung nodules were in different lobes. Of 14 patients with CT evidence of emphysema, 4 had lung nodules.

Mycobacterial cultures were performed on 63 of the 100 patients with bronchiectasis. Of the 63 cultures, 49 were obtained from sputum or induced sputum and 14 were from bronchial washings. Cultures were considered positive if multiple colonies were demonstrated.

Fifteen of the 24 patients (63 percent) with bronchiectasis and lung nodules had cultures obtained for mycobacteria. Forty-eight of the 76 patients (63 percent) with bronchiectasis and no lung nodules had mycobacterial cultures obtained. Of the 15 patients with lung nodules and bronchiectasis, 8 (53 percent) had cultures positive for MAC. No other mycobacterial species were cultured in these patients. Two of the 48 (4 percent) patients with bronchiectasis and no CT evidence of multiple lung nodules also had cultures positive for MAC. In addition, two other patients in this group had positive mycobacterial cultures; one had cultures positive for Mycobacterium fortuitum and the other for both Mycobacterium fortuitum and Mycobacterium xenopi.

Twelve of the 24 patients (50 percent) with lung nodules and bronchiectasis had fungal cultures performed and 3 (25 percent) had cultures positive for species of Aspergillus. Only one patient with positive fungal cultures and lung nodules also had cultures positive for MAC. Of the 76 patients with bronchiectasis and no lung nodules, 47 (62 percent) had fungal cultures performed, and in 12 (26 percent) of these patients, the cultures were positive. The fungal cultures in these 12 patients were positive for species of Apergillus (n=4), Fusarium (n=2), Alternaria (n=1), Beauveria (n=1), Cladosporium (n=1), Epicoccum (n=1), Penicillium (n=1), and Rhinocadiella (n=1). Most of the species are not considered pathogens. Of these, Aspergillus and possibly Alternaria may be the only organisms of significance. Specifically, the following fungal pathogens were not isolated from any of the cultures: Blastomyces dermatitidis, Coccidioides immitis, Cryptococcus capsulatus (Histoplasma capsulatum). The two patients in this group who had cultures positive for MAC also had positive fungal cultures.

The patients (69 females and 31 males) ranged in age from 6 to 83 years (average, 58 years). In the subset of patients with bronchiectasis and lung nodules, 22 were female (92 percent). This is in contrast to 47 female patients (62 percent) in the subset of patients who had bronchiectasis without lung nodules. The average age of the female patients in the two groups was 64 and 51 years, respectively. None had cystic fibrosis or significant history of immunocompromise.

Figure 1. Chest computed tomographic scan of patient with bronchial washings positive for Mycobacterium avium-intracellulare complex. Note varicose bronchiectasis (arrowheads) and small well-circumscribed nodules (arrows).
Two-sided 95 percent confidence intervals (CI) for sensitivity, specificity, and accuracy were estimated assuming a binomial distribution. The CT prediction of positive cultures for MAC in patients with bronchiectasis and multiple small lung nodules has a sensitivity of 80 percent ([8/10] 95 percent CI=44.4, 97.5), a specificity of 87 percent ([46/53] 95 percent CI=74.7, 94.5), and an accuracy of 86 percent ([54/63] 95 percent CI=74.6, 93.3).

DISCUSSION

Pulmonary infection with MAC has become a more frequently reported cause of infection in both normal and immunocompromised patients. We tested the following hypothesis: bronchiectasis and multiple small lung nodules are indicative of MAC infection or colonization.

We found that the concomitant presence of multiple small well-circumscribed lung nodules and bronchiectasis on CT (Fig 1) is an indication that the patient is likely to have sputum or bronchial washing cultures (or both) positive for MAC. It is unclear whether MAC caused the bronchiectasis and multiple pulmonary nodules or whether bronchiectasis predisposed some of the patients to MAC colonization or infection, with subsequent development of multiple pulmonary nodules. However, the two findings appear to be associated. A review by E. H. Moore, M.D. and N. Muller, M.D. (read at the meeting of the Society of Thoracic Radiology, Laguna Niguel, Calif, Jan 19 to 23, 1992) has shown in at least one case that the small lung nodules were indeed MAC granulomas. In addition, these authors have observed the subsequent development and progression of bronchiectasis in a patient with positive MAC cultures, indicating that M avium-intracellularare may be the cause of bronchiectasis in some of these patients. Others have direct histologic correlation showing that the lung nodules demonstrated on CT in two patients with bronchiectasis and positive cultures for MAC are granulomas (W.T. Miller, MD, personal communication, Sept, 1992).

Although we have no direct histologic correlation, we believe that the lung nodules are MAC granulomas. Only one of the eight patients with positive MAC culture, nodules, and bronchiectasis also had positive fungal cultures (Aspergillus). Of the 47 patients without nodules, 12 (26 percent) had positive fungal cultures, and only 2 of these also had positive MAC cultures. This seems to indicate that the likelihood of the nodules having fungal origin is very low. It is also possible that some of the small well-circumscribed "lung nodules" actually represented areas of distal bronchiectasis with mucoid impaction. The vast majority, however, clearly represented discrete parenchymal nodules (Fig 1). The results of our study and of our previous work indicate that the nodules in these patients with bronchiectasis are probably MAC granulomas.

The implications of a culture positive for MAC in patients with these CT findings are controversial. It is not clear whether these patients are colonized or infected with MAC. However, if the nodules are truly MAC granulomas, by definition the process is infection and not just colonization. It is also unclear whether MAC leads to progressive lung or airways disease if the patient is not treated with antibiotics for bacteria or mycobacteria.

There may be a subset of patients (older nonimmunocompromised women without emphysema) who have a predisposition to bronchiectasis and pulmonary MAC colonization and infection. Twenty-two (92 percent) of the 24 patients with bronchiectasis and lung nodules were women who had an average age of 64 years. This subset was older and predominantly female in comparison with the subset of patients without multiple pulmonary nodules. No relationship with emphysema was demonstrated. Evaluation of other forms of chronic obstructive pulmonary disease was not performed. The subset of patients with lung nodules may have a constellation of relatively sensitive (80 percent) and specific (87 percent) CT findings at our institution.

The association of MAC and bronchiectasis may be related to the population base studied. For instance, the population studied did not include patients with immunocompromise or cystic fibrosis. In addition, other conditions, such as diffuse panbronchiolitis which is prevalent in the Orient, may show small nodular opacities and dilated thick-walled bronchi on high-resolution CT scans. The primary clinical indication for CT in this study was to evaluate for bronchiectasis, an inflammatory process, an infectious process, or diffuse lung disease. These clinical indications reflected a unique population with a presentation that warranted CT evaluation.

Identification of multiple small lung nodules on CT in patients with bronchiectasis should prompt culture of sputum or bronchial washing for mycobacteria. If the cultures prove positive for MAC and the patient's clinical response to the usual treatment of bronchiectasis, i.e., periodic courses of antibiotics and postural drainage, are inadequate, antimycobacterial therapy may be indicated.

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