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Original Report

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CT Findings in 14 Patients with *Mycobacterium chelonae* Pulmonary Infection

OBJECTIVE. The purpose of this report is to describe helical and high-resolution CT findings in 14 patients with pulmonary infection caused by *Mycobacterium chelonae*, a nontuberculous mycobacterial species that has become increasingly recognized as a rare but significant cause of chronic lung infection in immunocompetent patients.

CONCLUSION. Bronchiectasis, nodules, and consolidation are the most common CT features of *M. chelonae* pulmonary infection. Cavities are less common. These CT findings resemble those reported for *Mycobacterium avium* complex. In this study, *M. chelonae* pulmonary infection occurred exclusively in middle-aged and older women.

Nontuberculous mycobacterial species, although still relatively uncommon pathogens, have become increasingly recognized as significant causes of chronic human pulmonary infections in nonimmunocompromised individuals. The CT findings of nontuberculous mycobacterial lung disease in immunocompetent hosts have been described in several reports [1–5]. Most published data refer to CT findings resulting from *Mycobacterium avium* complex pulmonary infection, although two studies have included a total of three patients with coexistent *M. avium* complex and *Mycobacterium chelonae* infections in their subject groups [1, 3].

M. chelonae is a rapidly growing environmental mycobacterial species that has been implicated as a rare human pathogen in both cutaneous and pulmonary infections. DNA homology studies have allowed laboratory classification of these microorganisms as a distinct species separate from *Mycobacterium fortuitum* and *Mycobacterium abscessus*, both of which are also rapidly growing nontuberculous mycobacteria that can be lung pathogens [6]. The purpose of this study is to describe the helical and high-resolution CT findings in 14 patients with confirmed pulmonary *M. chelonae* infections.

Materials and Methods

Patient Selection

Retrospective review of the medical records at a tertiary referral center for pulmonary mycobacterial disease for the period between November 1993 and May 1998 identified 34 patients (31 women, three men) with a clinical history of lung infection with nontuberculous rapidly growing mycobacteria. Of these 34 patients, 14 female patients (age range, 40–85 years; mean, 60 years) met the inclusion criteria of having clinically and microbiologically proven pulmonary *M. chelonae* infection without culture evidence for other mycobacterial species. All patients had undergone helical and high-resolution CT examinations. One patient with *M. chelonae* and underlying sarcoidosis was excluded from the study because it was difficult to distinguish the effects of sarcoidosis from those of mycobacterial infection. The remaining 19 patients were excluded from this study because of findings of other rapidly growing mycobacterial species (*M. fortuitum* and *M. abscessus*) or because of mixed cultures of nontuberculous pulmonary mycobacterial species (*M. chelonae*, *M. fortuitum*, *M. abscessus*, and *M. avium* complex). No male patients with isolated *M. chelonae* pulmonary infection were identified.

All 14 patients in the study had documented medical records of *M. chelonae* grown on one or more sputum cultures. In three of these patients, *M. chelonae* pulmonary infection was also diagnosed from bronchial washings in one, from a fine-needle aspirate of a

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lung nodule and from open lung biopsy tissue in another, and from a transbronchial biopsy specimen in a third. Based on culture data obtained at our referral center as well as on available medical records from outside institutions, all 14 of the study patients met the American Thoracic Society criteria for pulmonary disease caused by nontuberculous mycobacteria [7].

One patient with pulmonary *M. chelonae* also had lower extremity cutaneous lesions caused by *M. chelonae*. Another patient, who has insulin-dependent diabetes, had undergone left pneumonectomy for invasive aspergillosis after the initial diagnosis of *M. chelonae* lung infection before her referral to our center.

CT Imaging Technique

The helical and high-resolution CT examinations were performed on two scanners (HiSpeed CTi and HiSpeed Advantage; General Electric Medical Systems, Milwaukee, WI). Helical technique included 10-mm collimation for individual scans that were then reconstructed using a standard algorithm for mediastinal-windowed images and a lung (CTi) or bone (Advantage) algorithm for lung-windowed images. High-resolution CT technique consisted of 1-mm collimated images obtained at 20-mm intervals that were constructed using a high-spatial-frequency algorithm (bone algorithm) and retrospectively retargeted to each lung with a smaller field of view.

CT Image Review

Images of the 14 patients with *M. chelonae* lung disease were reviewed by consensus interpretation of two thoracic radiologists. A total of 81 lung lobes (including the lingula as a separate "lobe") were scored with regard to the presence and severity of lung and other chest findings. Each lung lobe was evaluated with regard to the presence or absence of nodules (<3 mm, 3–10 mm, >10 mm), consolidation, atelectasis, cavitation, bronchial wall thickening, bronchiectasis, and bronchiolectasis, as suggested by centrilobular nodules and so-called "tree-in-bud" opacities. On the basis of morphology, the severity of bronchiectasis was graded as none, cylindrical (mild), varicose (moderate), or cystic (severe). Any radiolucent area in the lung, with or without an air–fluid level, surrounded by a wall or area of consolidation was considered a cavity. In contrast, radiolucencies in the lung that resembled dilated bronchi, contained air–fluid levels, and appeared as a string or cluster of cysts were classified as cystic bronchiectasis [8]. For the remaining categories, the extent of lobar involvement was estimated as no involvement of the lung lobe or involvement of either 1–25%, 26–50%, 51–75%, or 76–100% of the lung lobe. Other findings noted included the presence or absence of mediastinal and hilar adenopathy (lymph nodes >1 cm in greatest short-axis dimension), the presence or absence of pectus excavatum as evidenced by concavity of the anterior chest wall, and pleural effusion or pleural thickening. All 14 patients were also examined for the presence of other distinct parenchymal lung disease evident on high-resolution CT.

Results

The results for consensus scoring of each lung lobe with regard to the presence of the various lung findings are summarized in Table 1. Nodules smaller than 3 mm were seen in 83% of the evaluated lung lobes, nodules between 3 and 10 mm in 79%, nodules greater than 10 mm in 7%, consolidation in 68%,

TABLE 1 **CT Findings by Lung Lobe in 14 Women with Pulmonary *Mycobacterium chelonae* Infection**

Findings	RUL	RML	RLL	LUL	LUL Lingula	LLL	Total	
							No.	%
Nodules <3 mm	13	9	11	10	12	12	67	83
Nodules 3–10 mm	13	9	12	9	10	11	64	79
Nodules >1 cm	2	0	2	0	1	2	6	7
Consolidation	8	9	8	8	11	11	55	68
Atelectasis	6	8	4	7	10	6	41	51
Cavity	5	1	2	4	1	3	16	20
Bronchiectasis	12	10	10	12	11	10	65	80
Bronchial wall thickening	13	14	13	13	12	13	78	96
Small airways disease	4	1	7	1	0	1	14	17

Note.—Percentage is of 81 lung lobes in 14 patients (one patient had undergone left pneumonectomy). RUL = right upper lobe, RML = right middle lobe, RLL = right lower lobe, LUL = left upper lobe, LLL = left lower lobe.

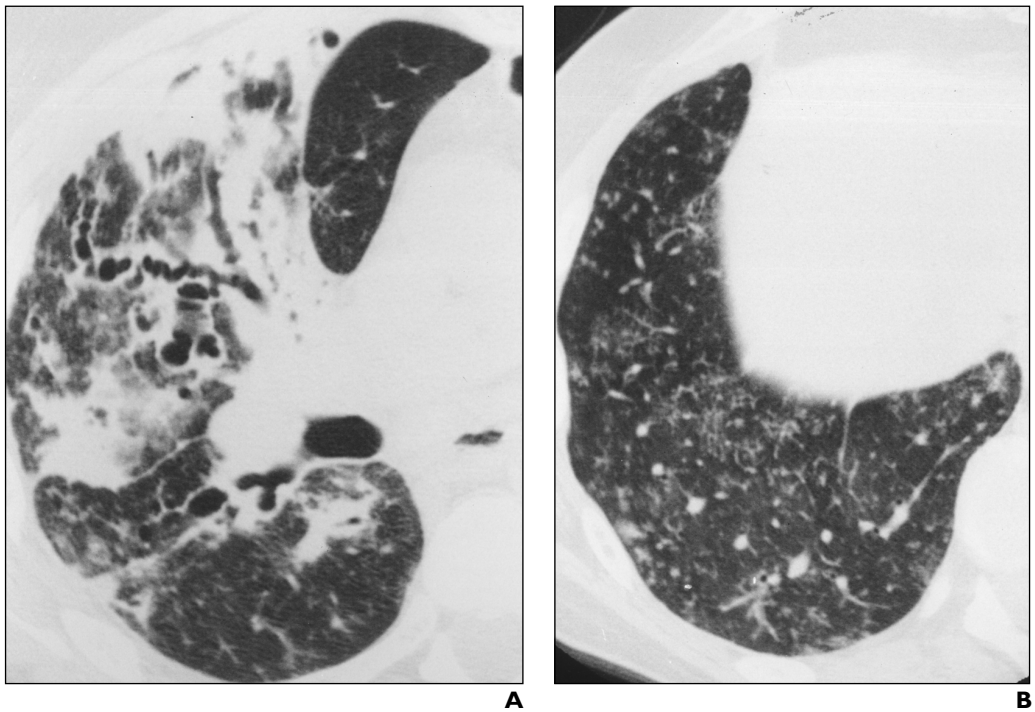

Fig. 1.—56-year-old woman with pulmonary *Mycobacterium chelonae* infection.
A, High-resolution CT scan of right lung shows right upper and middle lobe varicose bronchiectasis as well as areas of consolidation and tiny nodules.
B, High-resolution CT scan through right lower lobe reveals multiple tiny nodules likely caused by small airways disease.

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atelectasis in 51%, bronchiectasis in 80%, cavities in 20%, bronchial wall thickening in 96%, and small airways disease (tiny centrilobular nodules or tree-in-bud opacities) in 17%.

In the study subset, bronchiectasis (Fig. 1A) was found in 13 (93%) of 14 patients. In these patients, one patient had only cylindric bronchiectasis, four had varicose bronchiectasis, and eight had cystic bronchiectasis. In all but two patients, the presence of bronchiectasis was evenly distributed in the lung lobes, with no predominant pattern identified. In one patient the bronchiectasis primarily involved the right middle lobe and lingula, and in the other patient the bronchiectasis involved predominantly the right upper lobe, right middle lobe, and lingula. Bronchiectasis was least severe in the lower lobes. The severity of bronchiectasis in the remaining lobes was similar. Some degree of bronchial wall thickening was observed in all study patients.

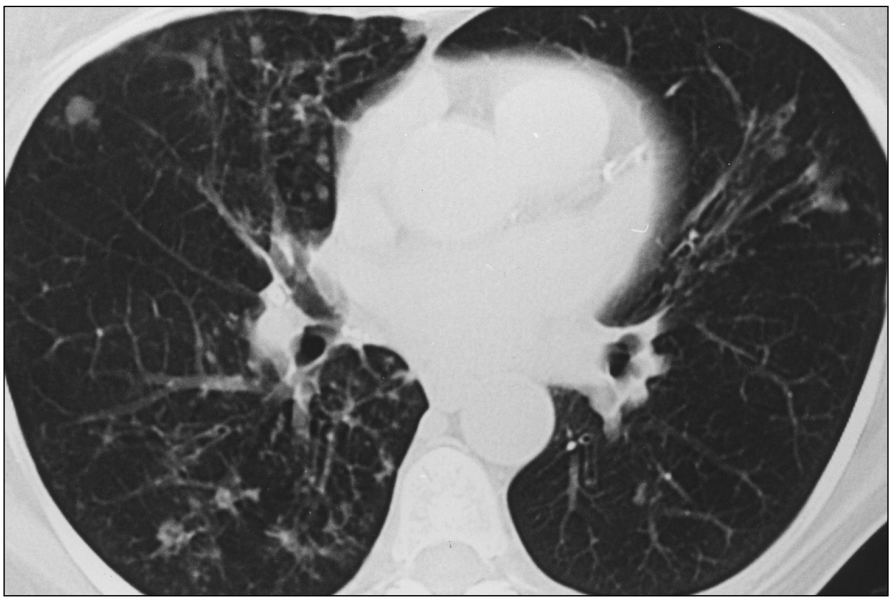

Fig. 2.—61-year-old woman with pulmonary *Mycobacterium chelonae* infection. Helical CT scan through lower lungs shows pulmonary nodules and cylindric bronchiectasis in lingula.

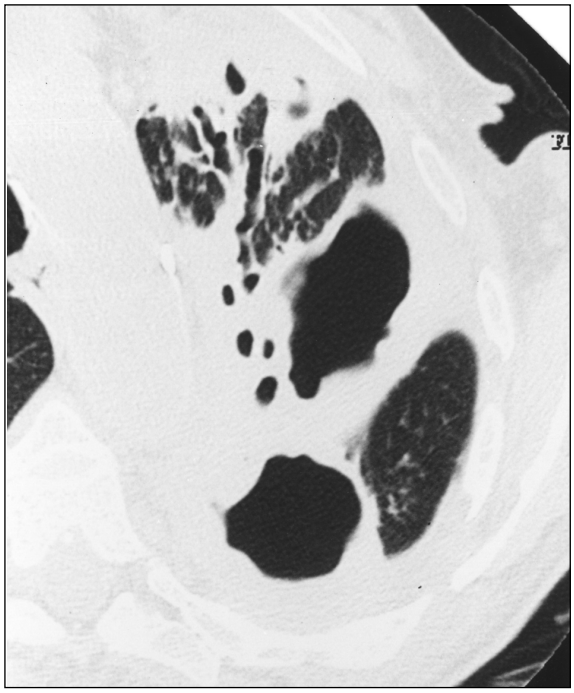

Fig. 3.—85-year-old woman with pulmonary *Mycobacterium chelonae* infection. High-resolution CT scan of left upper lobe shows two large cavities as well as cystic and varicose bronchiectasis, consolidation, and atelectasis.

Nodules less than 10 mm in diameter (Figs. 1B and 2) were present in 13 (93%) of 14 patients, and were diffusely distributed throughout the evaluated lung lobes in most patients. In one patient, small nodules were limited to the right upper and right middle lobes and to the lingula. Consolidation was present in 11 (79%) of 14 patients. Ten (71%) of 14 patients had some degree of atelectasis. Cavities (Fig. 3) were present in six (43%) of 14 patients (Fig. 3). More cavities occurred in the upper lobes.

Bronchiolectasis, manifested by tiny centrilobular nodules and by branching tree-in-bud peripheral lung opacities, was seen in six (43%) of 14 patients (Fig. 1B). Eight patients had mediastinal lymphadenopathy, hilar lymphadenopathy, or both. Of these, four had mediastinal lymphadenopathy only, one had hilar lymphadenopathy only, and three had both mediastinal and hilar lymphadenopathy. Two patients had mild pectus excavatum. Mild or moderate pleural thickening was seen bilaterally in two patients and unilaterally on the left in another patient. One patient had mild upper lobe centrilobular emphysema.

Discussion

With the exception of three patients with coexistent pulmonary *M. avium* complex and *M. chelonae* grouped within a larger series of patients with nontuberculous mycobacterial infection [1, 3], the CT findings of *M. chelonae* pulmonary infection have not been described. The most common CT features in patients infected with this pulmonary mycobacterial pathogen are bronchiectasis, nodules (≤1 cm), and consolidation. Bronchial wall thickening, likely caused by airway infection by the mycobacterial pathogen, was present to some degree in all 14 study patients. These CT features are similar to those reported for pulmonary *M. avium* complex disease [1–5]. The occurrence of this disease in middle-aged and older women, and the absence of other significant parenchymal lung disease in most patients are similar to that reported for *M. avium* complex, which can occur in individuals without predisposing lung disease, usually in older immunocompetent women [9, 10].

In 12 of the 14 patients examined, the lung findings were diffusely distributed without a predominant pattern of severity in specific lung

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lobes. The diffuse distribution of disease severity in most patients is different from two of the previously reported series of patients with *M. avium* complex in which bronchiectasis involved all lung lobes, but was more severe in the right middle lobe and lingula [1, 4]. In the study by Moore [1], bronchiectasis was identified in all lung zones but was most common in the right middle lobe and lingula. The study by Lynch et al. [4] found the combination of right middle lobe and lingular bronchiectasis in 30% of patients with *M. avium* complex and no patients with *M. tuberculosis*. In our study of 14 patients, only one did not have bronchiectasis. Of the 13 patients with bronchiectasis, one had only cylindrical bronchiectasis, four had varicose bronchiectasis, and eight had cystic bronchiectasis. Based on the number with varicose or cystic bronchiectasis in these patients with *M. chelonae*, the severity of bronchiectasis may be greater in more patients with this pathogen than previously reported for *M. avium* complex infection in the study by Hartman et al. [3]. In that study of 62 patients with *M. avium* complex pulmonary infection, 40 patients had bronchiectasis. Of these 40 patients, almost all had cylindrical bronchiectasis. Two had both cylindrical and varicose bronchiectasis, one had both cylindrical and cystic bronchiectasis, and one had only varicose bronchiectasis. However, the greater number of patients with more severe forms of bronchiectasis could also be related to the small number of patients in the study as well as to referral bias with more advanced cases being seen at our tertiary care center. Another possibility for this observation is that *M. chelonae* may only affect patients with diffuse bronchiectasis rather than cause bronchiectasis.

Many of the CT features of *M. chelonae* pulmonary infection are different from those reported for *Mycobacterium xenopi* pulmonary infection, another nontuberculous mycobacterial lung pathogen that frequently affects men with preexisting lung disease, chiefly emphysema [11]. In the study by Wittram and Weisbrod [11], the most common findings of *M. xenopi* pulmonary infection were cavities, fibrosis, and small airways abnormality, which occurred most commonly in the upper lobes. None of the examined patients in that study had detectable bronchiectasis, although some of the study patients did not have high-resolution CT scans available. In that series, six of eight patients were men and seven of eight patients had pulmonary emphysema. In contrast, our study patients with *M. chelonae* pulmonary infection were all women, most had bronchiectasis, and only one had mild centrilobular emphysema evident on high-resolution CT. One patient with pulmonary *M. chelonae* who was excluded from our study did have coexisting pulmonary sarcoidosis. *M. chelonae* and *M. xenopi* were similar in that, for both species, cavities were more common in the upper lobes (Table 1).

None of the patients in this study were overtly immunocompromised. One patient had insulin-dependent diabetes and had undergone left pneumonectomy for *Aspergillus* species infection before being referred to our institution. The degree of her blood glucose control at the time of pulmonary *Aspergillus* species infection was not known. The findings in this patient were relatively mild; CT showed diffuse small nodules in her right lung without bronchiectasis. The other 13 patients had no chronic medical illness. None of the patients were receiving medications known to be immunosuppressive.

In the patients of this study, CT represented only one moment during the course of each patient's disease, and CT was most often performed when the patients were initially referred to our institution for examination of the pulmonary mycobacterial infection. This study does not address differences in disease progression between *M. avium* complex and *M. chelonae* and may be biased toward more advanced lung disease because many of the referred patients had difficult or problematic cases. It has been our clinical experience that when both *M. chelonae* and *M. avium* complex are confined to one lobe, cure can be achieved with combined medical and surgical therapy. However, in patients with diffuse disease, medical therapy can achieve cure with *M. avium* complex, but almost never with *M. chelonae*. In the future, a longitudinal study may be helpful to evaluate disease progression of M. *chelonae* pulmonary infection compared with *M. avium* complex pulmonary infection.

On the basis of the small number of patients examined in this study, *M. chelonae* pulmonary infection seems to favor middle-aged and older women who do not have any other coexisting parenchymal lung disease, such as emphysema or interstitial lung disease, and who are not overtly immunodeficient. The presence of diffuse bronchiectasis, multiple small lung nodules, and focal areas of lung consolidation on conventional and high-resolution CT of the lungs in immunocompetent individuals without known malignancy is suggestive of nontuberculous mycobacterial infection. No specific CT findings of *M. chelonae* pulmonary infection were identified in this study to distinguish it from *M. avium* complex.

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