Superficial Endobronchial Lung Cancer: Radiologic-Pathologic Correlation

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Objective: To analyze the plain chest radiographic and CT findings of superficial endobronchial lung cancer and to correlate these with the findings of histopathology.

Materials and Methods: This study involved 19 consecutive patients with pathologically proven lung cancer confined to the bronchial wall. Chest radiographs and CT scans were reviewed for the presence of parenchymal abnormalities, endobronchial nodules, bronchial obstruction, and bronchial wall thickening and stenosis. The CT and histopathologic findings were compared.

Results: Sixteen of the 19 patients had abnormal chest radiographic findings, while in 15 (79%), CT revealed bronchial abnormalities: an endobronchial nodule in seven, bronchial obstruction in five, and bronchial wall thickening and stenosis in three. Histopathologically, the lesions appeared as endobronchial nodules in 11 patients, irregular thickening of the bronchial wall in six, elevated mucosa in one, and carcinoma in situ in one.

Conclusion: CT helps detect superficial endobronchial lung cancer in 79% of these patients, though there is some disagreement between the CT findings and the pathologic pattern of bronchial lesions. Although nonspecific, findings of bronchial obstruction or bronchial wall thickening and stenosis should not be overlooked, and if clinically necessary, bronchoscopy should be performed.

Index terms:
Lung, radiography
Lung neoplasm, CT

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Superficial endobronchial lung cancer may be defined as 'a tumor of any size with its invasive component limited to the bronchial wall and perhaps extending to the proximal bronchus', and is also classified as T1 at TNM staging (1). Although surgical resection of such a tumor yields an excellent result in terms of survival, delayed diagnosis is common because radiologists often fail to detect early lung cancer even where both plain chest radiography and CT have been employed (2–5). Lung cancer that is overlooked radiologically is an important diagnostic problem and is a major cause of medicolegal action involving radiologists (6). Although several papers have reported the radiologic or pathologic findings of superficial endobronchial lung cancer (2–7), only one has described both.

The purpose of our study was to analyze the radiological findings of 19 cases of proven superficial endobronchial lung cancer, and to correlate these with the histopathologic findings.

MATERIALS AND METHODS

Between March 1997 and July 2000, 462 male lung cancer patients aged 39–76 (mean, 61) years underwent surgery at Asan Medical Center. Among them, superficial

endobronchial lung cancer, defined as above, was proven in 19 cases. The clinical symptoms and signs in these patients included chronic cough and sputum (n=11), hemoptysis (n=5), and blood-tinged sputum (n=3). In all cases, both initial chest radiographs and CT scans were available.

Chest radiographs were obtained using a high-kilovoltage technique employing standard posteroanterior and lateral projections. After the administration of 100 mL of contrast materials (Iopromide, Ultravist 370®; Schering, Berlin, Germany) at a rate of 2.5 mL/sec and with 35-second delay prior to scanning, either a GE 9800 Quick scanner (GE Medical System, Milwaukee, Wis., U.S.A.) or a Somatom Plus-S scanner (Siemens, Erlangen, Germany) was used to obtain CT scans of the region between the lung apices and both adrenal glands. Both section thickness and interval setting were 7−10 mm.

Two thoracic radiologists, unaware of the location of a tumor, retrospectively reviewed both chest radiographs and CT scans, and decisions were reached by consensus. Chest radiographs were analyzed for the presence and location of air-space consolidation or atelectasis, and CT scans in terms of the location and size of endobronchial nodules, and the presence and location of bronchial obstruction and of bronchial wall thickening and stenosis. The location of endobronchial lesions was categorized as the lobar, segmental, or subsegmental bronchus, and their longest diameter was measured. The presence or absence of air-space consolidation or atelectasis, and enlarged mediastinal and hilar lymph nodes, and the location of these, as seen at CT, were also determined. For mediastinal and hilar lymph nodes, a short-axis diameter of more 10 mm was considered abnormal; for subcarinal lymph nodes, the corresponding figure was 12 mm (8).

Surgical specimens were reviewed by an experienced lung pathologist and the location of each endobronchial lesion was thus determined. At histopathologic examination, a tumor's cell type, the gross pathologic findings, the longest diameter of the endobronchial nodule, and the depth of tumor invasion of the bronchial wall were evaluated. Depending on this depth, a classification of carcinoma *in situ*, intramucosal invasion, invasion of bronchial cartilage, or deep invasion of the full thickness of the bronchial wall was assigned (9), and lymph node metastasis was also evaluated. We compared the radiological and pathological findings of these cancers, focusing on the presence or absence of an endobronchial nodule, bronchial obstruction, bronchial stenosis, and their distribution.

RESULTS

Chest radiographs depicted abnormalities in 16 of the 19 cases (84%), while CT scans demonstrated endobronchial lesions in 15 (79%). These latter appeared as endobronchial nodules (n=7), bronchial obstruction (n=5), or bronchial wall thickening and stenosis (n=3). The spectrum of abnormalities at both chest radiography and CT scanning is summarized in Table 1, while the locations of endobronchial lesions in the involved lobar or segmental bronchi are illustrated schematically in Fig. 1. The longest diameter of a tumor ranged from 5 to 20 mm, and mediastinal or hilar lymphadenopathies were recognized in six patients.

All tumors were squamous cell carcinomas. Histopathologically, an endobronchial nodule was identified in 11 pa-

Table 1. Radiological Findings of Superficial Endobronchial Lung Cancer

Radiological Findings	No. of Cases (n=19)
Chest Radiographs	
Consolidation (Lobar/ Segmental)	9
Atelectasis (Lobar/ Segmental)	6
Both atelectasis and consolidation (Lobar)	1
Normal	3
CT Scans	
Bronchial abnormalities	
Endobronchial nodule	7
Bronchial obstruction	5
Bronchial stenosis	3
Normal	4
Parenchymal abnormalities	
Consolidation (Lobar/ Segmental)	12
Atelectasis	4
Normal	3

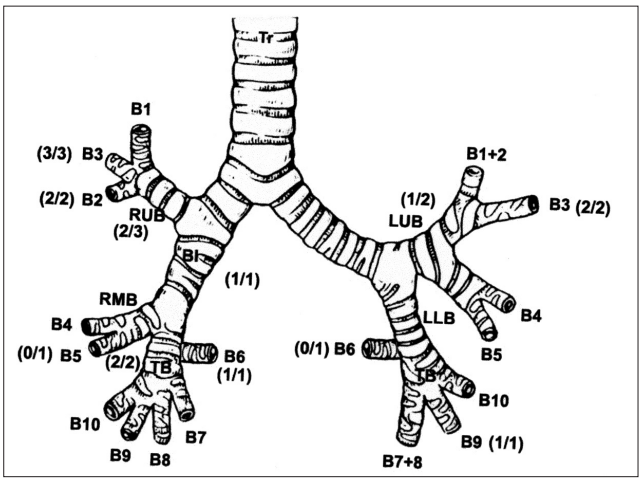


Fig. 1. Diagram showing the distribution of superficial endobronchial lung cancer according to its location. Numbers in parentheses indicate the number of endobronchial lesions identified at CT (the numerator) and the number of lesions histopathologically confirmed (the denominator).

tients, irregular thickening of the bronchial wall in six, slightly elevated mucosa in one and carcinoma *in situ* in one. The longest diameter of these nodules was 13–24 (mean, 18.2) mm. The depths of tumor invasion of the bronchial wall are shown in Table 2. Microscopically, lymph node invasion was observed in 4 of 19 tumors.

A comparison between the CT and histopathologic findings, based on the nature of the endobronchial lesion, is

Table 2. Number of Cases of Superficial Endobronchial Lung Cancer According to Depth of Invasion of the Bronchial Wall

Depth of Invasion	No. of Cases (n=19)
Carcinoma in situ	1
Intramucosal invasion	6
Bronchial cartilage	2
Full thickness of bronchial wall	10

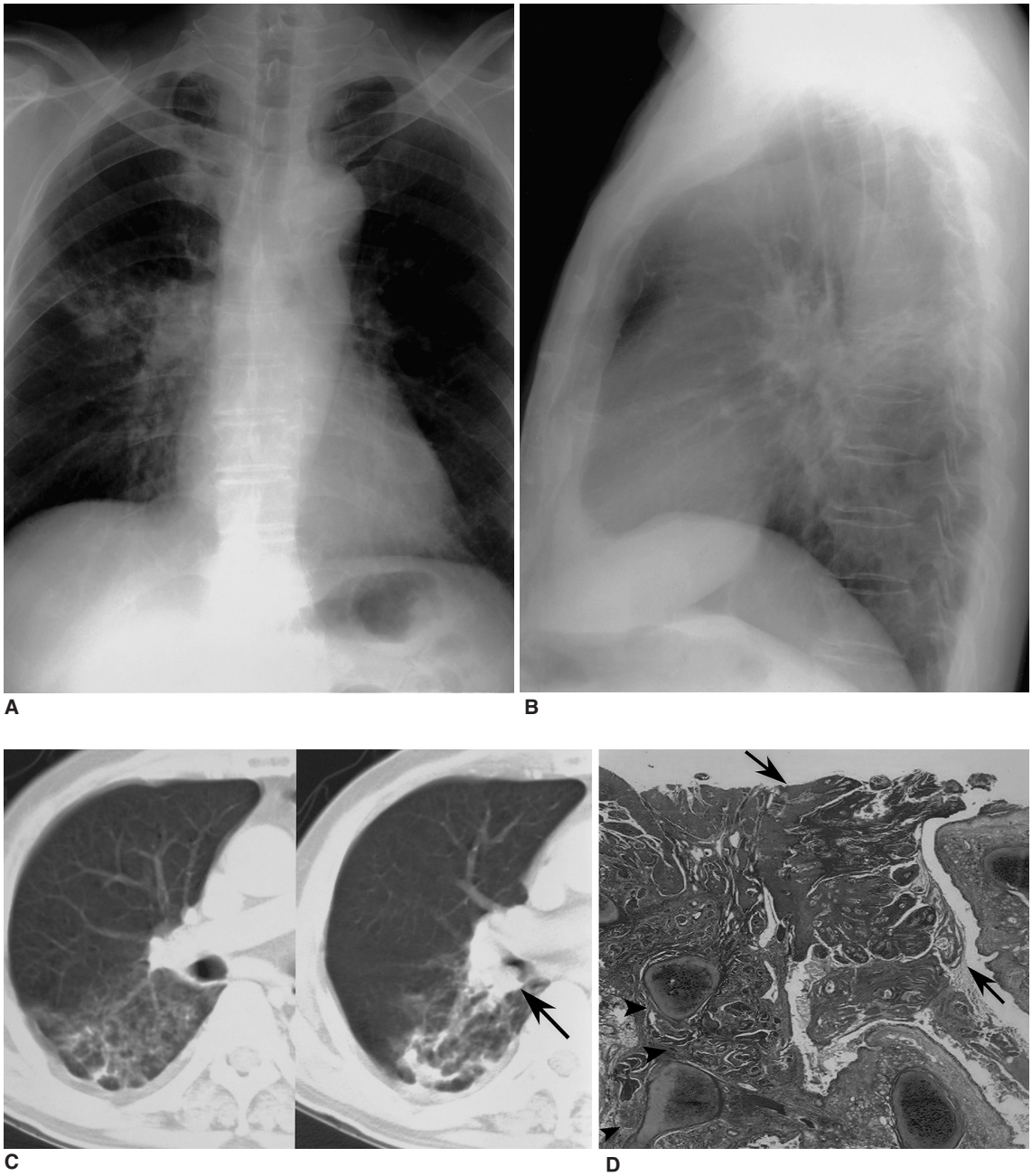


Fig. 2. A 66-year-old man with chronic cough.
A, B. Chest radiographs showing segmental consolidation in the superior segment of the right lower lobe.
C. CT scans (10-mm-thick sections) demonstrate an endobronchial nodule at the distal bronchus intermedius (arrow) and consolidation in the superior segment of the right lower lobe.
D. Photomicrography of pathologic specimen depicts an endobronchial nodule (arrows) and invasion of the full thickness of the bronchial wall (arrowhead) by the carcinoma (original magnification, ×100; hematoxylin-eosin staining).

made in Table 3. At CT, five of the histopathologically diagnosed endobronchial nodules were correctly interpreted (Fig. 2), three were identified as bronchial obstruction (right upper lobar bronchus, anterior segmental bronchus of the left upper lobe, lateral basal segmental bronchus of the left lower lobe) (Fig. 3), two as bronchial wall thickening and stenosis (anterior segmental bronchus of the right upper lobe and superior segmental bronchus of the right lower lobe), and one as completely normal (left upper lobar bronchus). Of the six lesions in which irregular bronchial wall thickening was identified histopathologically, two were missed at CT; these were located in the right upper lobar bronchus (Fig. 4) and the superior segmental bronchus of the left lower lobe.

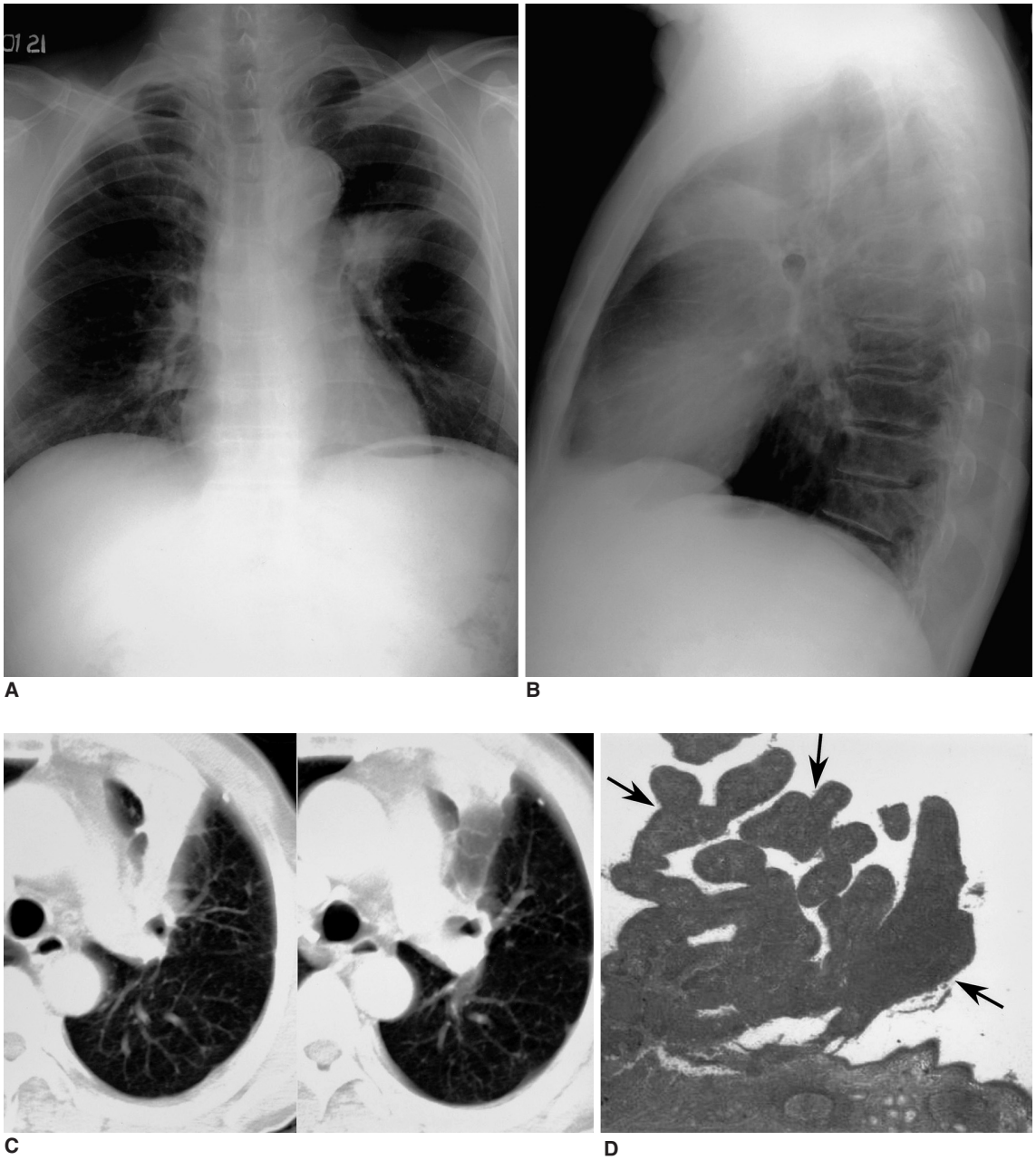
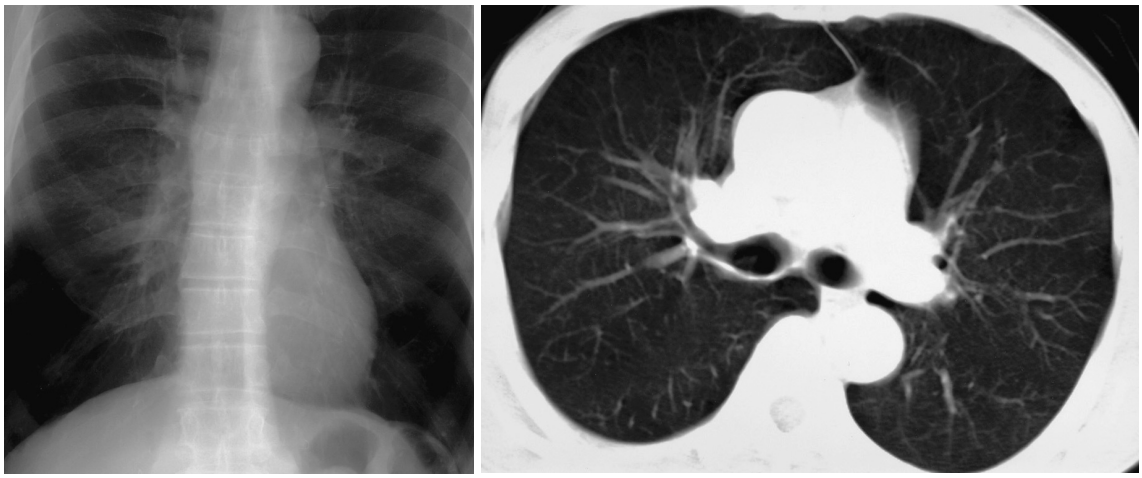


Fig. 3. A 59-year-old man with blood-tinged sputum.
A, B. Chest radiographs show segmental collapse in the anterior segment of the left upper lobe.
C. CT scans (10-mm-thickness) depict bronchial obstruction and segmental atelectasis of the anterior segment of the left upper lobe.
D. Photomicrography of pathologic specimen shows a polypoid mass in the anterior segmental bronchus of the left upper lobe (arrows), its invasive component extending through the full thickness of the bronchial wall (not shown here) (original magnification, ×400; hematoxylin-eosin staining).



A B

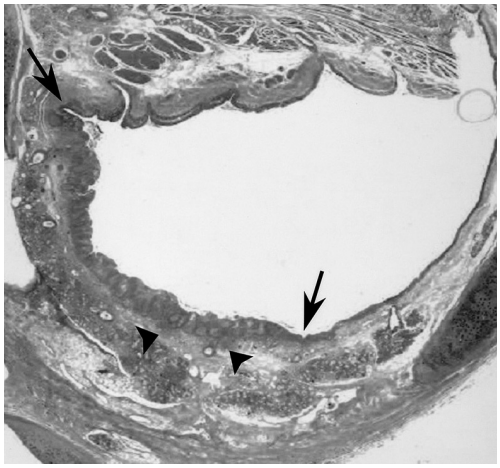


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Fig. 4. A 61-year-old man with blood-tinged sputum and weight loss.
A. Chest radiograph reveals no abnormality.
B. CT scan demonstrates patent right upper lobar bronchus with no endobronchial abnormality.
C. Pathologic specimen depicts mucosal irregularity in the right upper lobar bronchus (arrows), and intramucosal invasion (arrowheads) (original magnification, ×40; hematoxylin-eosin staining).

Table 3. CT-Pathologic Correlation of Superficial Endobronchial Lung Cancer in 19 Patients

Pathologic Findings	CT Findings			
	Endobronchial Nodule	Bronchial Obstruction	Bronchial Wall Thickening and Stenosis	Normal
Endobronchial nodule	5	3	2	1
Bronchial wall thickening	2	1	1	2
Elevated mucosa	0	1	0	0
Carcinoma in situ	0	0	0	1

DISCUSSION

Superficial endobronchial lung cancer may be defined as 'a tumor of any size with its invasive component limited to the bronchial wall and perhaps extending to the proximal bronchus', and is also classified as T1 at TNM staging (1). Because of its intraluminal growth, airway obstruction is an almost invariable feature of this cancer, and in most patients, initial radiologic presentation thus includes distal atelectasis, bronchiectasis, and obstructive pneumonia (10). These secondary findings make it difficult to differentiate between superficial endobronchial lung cancer and segmental or lobar pneumonia of bacterial origin, endobronchial tuberculosis, or other causes of bronchial obstruction or stenosis. Lung cancer which is missed at CT scanning manifests in 67% of cases as a central endobronchial lesion (11), and this is difficult to distinguish from surrounding structures and sticky mucus.

Even though the two radiologists involved in our retrospective study were aware of the fact each examination involved a case of superficial endobronchial lung cancer, 4 of

19 lesions were not detected at CT. One of these was a carcinoma *in situ*; of the other three, identified histopathologically, one was an endobronchial nodule, located in the left upper lobar bronchus, and two involved irregular bronchial wall thickening and had developed, respectively, in the right upper lobar bronchus and superior segmental bronchus of the left lower lobe. Because these bronchi ran transversely in the axial CT plane, the partial volume averaging effect might have played a major role in this failure to detect the tumors. One case of superficial endobronchial lung cancer showed no endobronchial abnormality at CT, and the microscopic finding was carcinoma *in situ*. The five endobronchial nodules, averaging 18 (range, 10–24) mm in size, were interpreted as bronchial obstruction in three cases and bronchial stenosis in two; it was impossible to separate an endobronchial nodule from associated parenchymal consolidation or atelectasis.

Anatomical and technical factors might also be associated with these missed or misinterpreted nodules. CT is relatively inaccurate in evaluating left bronchial trees and bronchi that lie cephalocaudally, though by detecting their origin and proximal portion, it can depict the full length of every major bronchus that runs horizontally. This is probably a consequence of the oblique orientation of both the left mainstem and lingular bronchi. Although axial CT can demonstrate the full length of horizontally oriented lobar or segmental bronchi, the partial volume averaging effect might prevent the visualization of small endobronchial abnormalities located at either their superior or inferior wall. Where such abnormalities occur at vertically oriented bronchi such as the bronchus intermedius, however, the partial volume averaging effect is minimized (12). In patients with a strong clinical suspicion of endobronchial disease but a negative scan, it cannot be assumed that disease is in fact absent. In such cases, other techniques must be used to evaluate the bronchi, and for this purpose bronchoscopy has usually been recommended. A recently introduced multi-detector row spiral CT scanner which offers retrospective reconstruction through the use of thinner collimation and multiplanar reformation may be able to improve the detection rate.

Our study has several limitations. First, the number of patients was rather small for statistical analysis. Second, although blind to the actual location of the superficial endobronchial lung cancer, the radiologists involved in our study were biased by the knowledge that in each case they studied, this condition had occurred. Third, because histopathologic specimens were opened along the direction of the bronchial tree rather than in axial plane, in which CT scans were obtained, accurate and elaborate one-to-one CT-pathologic correlation was not possible.

In summary, CT helped detect superficial endobronchial lung cancer in 79% of cases, though there was some disagreement between the CT findings and pathologic patterns of bronchial abnormality. At CT, 8 of 19 pathologically proven cases showed nonspecific findings such as bronchial obstruction and bronchial wall thickening and stenosis. These non-specific findings should not, therefore, be overlooked, and if clinically necessary, bronchoscopy should be performed. Care must be taken to show the full length of a lobar or segmental bronchi by using thinner collimation scans. To determine whether the use of recently introduced multi-detector row spiral CT with multiplanar reformation can help increase the detectability of superficial endobronchial lung cancer, further study is needed.

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