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A case of lung cancer associated with pneumoconiosis diagnosed by fluorine-18 fluorodeoxyglucose positron emission tomography

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We report a case of lung cancer arising from progressive massive fibrosis (PMF) associated with pneumoconiosis. In this case, fluorine-18 fluorodeoxyglucose positron emission tomography (FDG-PET) was able to clearly distinguish the lung cancer from PMF, suggesting a potential usefulness of FDG-PET in cancer screening in patients with pneumoconiosis. To our knowledge, this is the first description of an FDG-PET image of lung cancer arising from PMF.

Key words: pneumoconiosis, progressive massive fibrosis, lung cancer, FDG-PET

INTRODUCTION

PROGRESSIVE MASSIVE FIBROSIS (PMF) of the lung is a type of late-stage pneumoconiosis of an aggregation of silicotic nodules fused by connective tissue.[1] It appears rapidly and tends to increase in size.[2] The appearances of PMF on chest radiography and CT have been well discussed.[3–5] However, solitary PMF lesions are frequently confused with lung cancer, roentgenographically as well as clinically.[2] In addition, considering the high incidence of lung cancer in these patients,[6–9] a diagnostic approach would be valuable that could effectively differentiate a malignant lesion from pneumoconiosis-related benign lesion. Although CT scan has a high rate of sensitivity to detect pulmonary nodules,[10] it is difficult to characterize their nature, and observation or a more invasive diagnostic approach, such as biopsy, is needed to determine whether the lesions are malignant or benign.[11,12]

In the field of nuclear medicine, fluorine-18 fluorodeoxyglucose positron emission tomography (FDG-PET) has emerged as an important clinical tool for diagnosing, staging, and monitoring the therapy of cancer over the past several years,[13,14] FDG-PET is a whole-body imaging modality that allows one to noninvasively image biologic processes such as glucose use by tumors. Several studies have shown that FDG-PET is highly accurate for diagnosing and staging lung cancer[15] and that FDG-PET provides diagnostic information beyond that obtained through standard anatomic imaging modalities such as CT or MRI.

In this report, we present a case of lung cancer arising from PMF in a patient with pneumoconiosis. This case suggests the utility of FDG-PET assessments of pneumoconiosis-related pulmonary nodules.

CASE REPORT

A 79-year-old man was admitted to our hospital in October 2002 for further evaluation because of an abnormal chest radiograph and hemosputum. He had smoked 20 cigarettes daily for 50 years. He had been a tunnel worker for 15 years. He had been diagnosed with pneumoconiosis (silicosis), and PMF had been pointed out in bilateral upper lobes 26 years ago. Two months before admission to our hospital, he experienced hemosputum.

In our hospital, physical examination revealed wheeze on auscultation. In a laboratory examination, the white blood cell count was 5,500/μl with a normal differential. Hemoglobin and hematocrit levels were normal. CRP was 0.19 mg/d*l*. CEA (3.7 ng/m*l*) and SCC (2.2 ng/m*l*) were slightly elevated. Arterial blood gases while breathing room air showed an arterial oxygen tension of 68.7 mmHg and arterial carbon dioxide tension of 33.1 mmHg.

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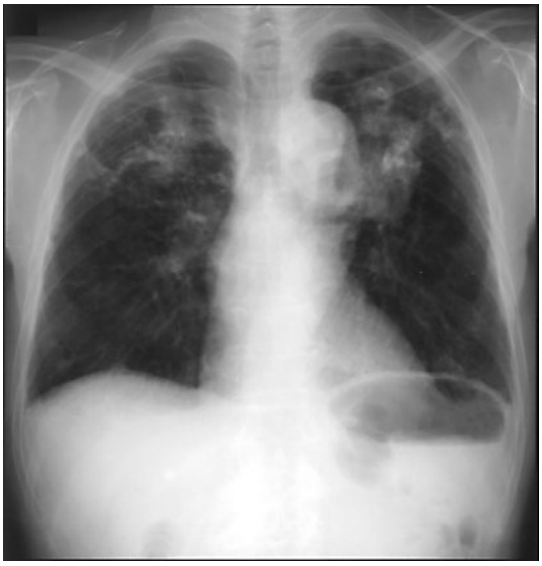

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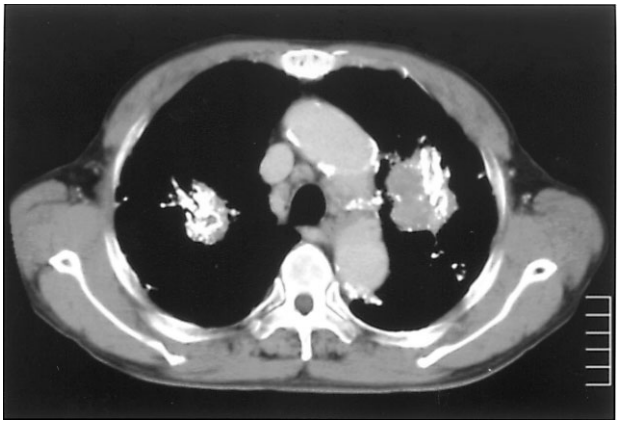

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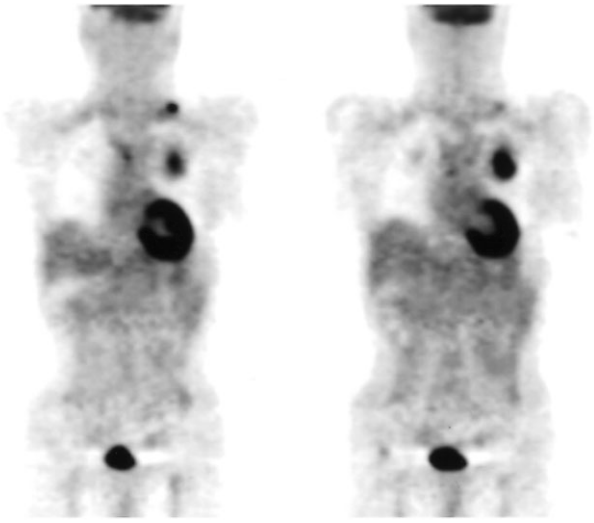
Fig. 1 Chest x-ray and CT findings. (A) Chest radiograph on admission shows two pulmonary nodules, one in the left upper lung field and the other in the right upper lobe. (B) CT scan shows mass-like shadows in bilateral upper lobes with irregular contour and scattered calcifications. These findings are consistent with PMF in pneumoconiosis. The medial part of the PMF in the left upper lobe does not contain the scattered calcifications.



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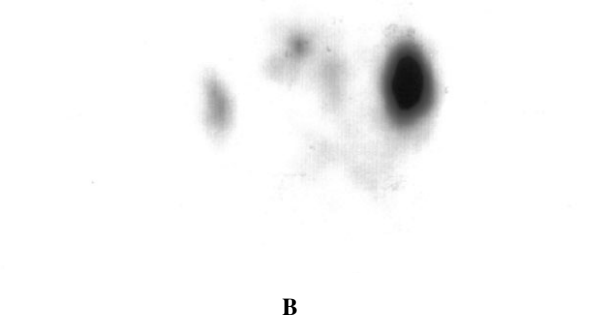

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Fig. 2 FDG-PET findings. FDG-PET scan shows significant increased uptake in the medial part of PMF in the left upper lobe, and no significant uptake in the PMF in the right upper lobe. Increased uptake of FDG is also observed in left supraclavicula suggesting the existence of metastatic lymph node. (A) Coronal image. (B) Axial image shows intense uptake of FDG that corresponding to the medial part of the left PMF, demonstrated by CT scan in Figure 1B.

Lung function studies showed a vital capacity of 68.2% and revealed that a forced expiratory volume (FEV_1) in 1 second was 59.7%. Although repeated analyses of sputum were negative for *Mycobacterium tuberculosis*, cytological analysis was positive for adenocarcinoma.

Chest radiograph and a computed tomography (CT) scan of the thorax revealed a 5 × 5 × 6-cm mass-like shadow in the left upper lobe with irregular contour and scattered calcifications (Fig. 1). Another mass, 4 × 3 × 4-cm, in the right upper lobe also contained scattered calcifications and was surrounded by small nodules as well as the lesion in the left upper lobe. These findings were consistent with PMF in pneumoconiosis. However, the medial part of the PMF in left upper lobe did not contain scattered calcifications suggesting the development of lung cancer. It was difficult to differentiate the pure PMF from lung cancer combined PMF by judging from the chest x-ray and chest CT findings.

To characterize the PMF in the left upper lobe, we attempted to perform FDG-PET because it might be able to differentiate between lung cancer and PMF on the basis of hypermetabolism of cancer cells. PET scan in our hospital was obtained on a high-resolution dedicated system (ECAT EXACT HR +; Siemens/CTI, Knoxville, TN) with a 65.9-cm axial field of view and a resolution of 4.6 mm (axial) × 3.4 mm (in-plane) in full width at half maximum and a 3-dimensional acquisition mode. The patient fasted for at least 5 hours before receiving an

intravenous injection of 159 MBq F-18-FDG. Forty-five minutes after injection, two-min transmission scans and 3-min emission scans were obtained from neck to pelvis. Image data sets were obtained using iterative reconstruction (the ordered subset expectation maximization method). In consequence, FDG-PET scan revealed significant increased uptake in the corresponding areas in the medial part of PMF in the left upper lobe, and no significant uptake in the PMF in the right upper lobe (Fig. 2A, B). Bronchoscopic examination revealed no endobronchial lesions. However, selective bronchial washing obtained from left B^3 revealed adenocarcinoma. Therefore, the medial part of the PMF in the left upper lobe was thought to be the primary lung cancer. Increased uptake of FDG was also observed in left supraclavicula suggesting the existence of metastatic lymph node. Although FDG accumulation was slightly observed in mediastinal lymph nodes, it seemed to be insignificant because of its low SUV.

The staging of lung cancer was consistent with stage IIIB (T2N3M0) and the patient was treated with radiotherapy.

DISCUSSION

PMF of the lung occurs on a background of pneumoconiosis and is defined by the National Coal Workers Autopsy Study[2] as a fibrotic lesion greater than 1 cm in diameter. Pathologically, PMF consists of massive fibrosis and occurs most commonly in the upper and posterior portions of the lung.[1,2] Vascular abnormalities are usually found in PMF.[2] It has been shown that the thickness of the small pulmonary arterial wall increases as the vessel traverses PMF. They primarily involve the small pulmonary arteries, but pulmonary veins and bronchial arteries are also affected. The affected vessels show an arteritis involving all layers of the wall. The media is progressively replaced by fibrous tissue, sometimes in segmental fashion. Therefore, unprepared biopsy or surgery of PMF sometimes leads to massive hemorrhage. To avoid such a complication, non-invasive method that could differentiate a malignant tumor from PMF is required.

The chest x-ray and chest CT findings of PMF have been well described.[3–5] The CT features of PMF are characterized mostly by an irregular mass with calcifications, and surrounding areas of emphysematous lung tissue. However, in situations where a mass lacks the typical radiographic findings of PMF, or increases in size, it is impossible to distinguish PMF from lung cancer on chest x-ray or chest CT. Matsumoto et al. have reported that PMF and fibrous tissue usually have low signal intensity that is similar to muscle on both T1-weighted and T2-weighted images on MRI.[16] In addition, lung cancer usually shows high signal intensity on T2-weighted images. They have concluded that MRI is potentially useful in distinguishing lung cancer from PMF in patients with pneumoconiosis. However, necrotic cavitations containing fluid, which are frequently seen within PMF pathologically, may appear as areas of high signal intensity on T2-weighted images. Furthermore, Matsumoto et al. have reported that small pulmonary lesions (<2 cm) were not visible on MRI.[16] Therefore, FDG-PET may have some advantage in such cases.

On the other hand, Shuke et al. have reported the utility of Tl-201 scintigraphic assessments of pneumoconiosis-related pulmonary nodules when lung cancer was suspected.[17] Although Tl-201 has been used successfully to determine whether a thoracic lesion is malignant or benign in the field of nuclear medicine,[18,19] sensitivity and specificity of these methods to lung cancer are considered to be low compared with FDG-PET.[20,21]

It is generally accepted that benign fibrous lesion exhibits a lower glucose metabolic rate than aggressive, rapidly growing tumor. Therefore, FDG-PET scanning could be a sensitive screening test for lung cancer among patients with pneumoconiosis. In the present case described here, the pulmonary mass in the left upper lobe had the characteristic FDG accumulation of rapidly growing tumor. On the other hand, fibrous tissue of PMF in the right upper lobe showed no significant accumulation of FDG. Although Alavi et al. have reported that pneumoconiosis with active fibrosis shows variable degrees of FDG uptake,[22] the difference in glucose metabolic rate between lung cancer and PMF was clearly demonstrated by PET image in the present case. To our knowledge, the FDG-PET appearances of lung cancer arising from PMF have not been reported in the literature so far.

While further work needs to be done, this case emphasizes the use of FDG-PET scanning in establishing the potential usefulness to detect lung cancer in patients with pneumoconiosis.

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