Radioaerosol Scan Manifestations of Diffuse Panbronchiolitis

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=국문 초록=

미만성 세기관지염의 연무흡입 폐환기스캔 소견

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미만성 세기관지염은 기도와 폐실질부의 이행부(transitional zone)의 세기관지에 만성적이고 비특이적인 염증을 일으키는 질환으로 비교적 근래에 알려진 질환이다. 임상적으로 미만성 세기관지염은 만성 폐색성 폐질환과 유사하나, 이의 임상적경과와 치료방법이 전혀 다르기 때문에 두 질환의 감별은 매우 중요하다. 저자들은 미만성 세기관지염에서 연무흡입 폐환기스캔소견과 이의 진단적 유용성을 전향적으로 알아보고자 하였다.

총 4예의 미만성 세기관지염 환자를 대상으로 하였으며 이의 진단은 Homma등의 임상적 진단기준과 폐기능검사, 단순흉부사진, 고해상 CT와 임상추적검사로 확진하였으며 이중 1예는 조직생검을 시행하였다. 스캔상 연무침착의 기관지-폐분포는 비정상적 과도침착이 분포하는 부위별로 중심부(central), 중간부(intermediary), 이행부(transitional)의 기도와 말단 폐실질부(peripheral airspace)로 나누었다.

그 결과, 특징적으로 이행부와 중간부 기도에 비정상적 연무침착을 보였고 말단부 폐실질의 환기결손소견을 보였다. 이런 침착 경향은 만성 폐색성 폐질환에서 보이는 중심부기도의 연무침착양상과는 명백한 대조를 이루었다.

결론적으로 연무흡입 폐환기스캔은 미만성 세기관지염의 진단에 있어서 간편하고, 비침습적이며, 유용한 방법으로 사료된다.

Key Words: Diffuse panbronchiolitis, Lung, Aerosol scan

INTRODUCTION

Diffuse panbronchiolitis(DPB) is a relatively new, chronic, nonspecific, inflammatory disease of un- known etiology that primarily involves the respiratory bronchioles in the "transitional zone" of the lung that lies between the airways and lung pa- renchyma[1,2]. Histologically, DPB is characterized by chronic, inflammatory thickening of the respiratory

bronchiolar wall and peribronchiolar interstitia as well as the adjacent alveolar ducts and alveoli[1]. With chronicity respiratory bronchiolar narrowing may ensue, creating ectasia of the proximal terminal bronchioles and bronchi[4,5]. The main clinical symptoms include productive cough and progressively worsening exertional dyspnea, strongly resembling chronic obstructive pulmonary disease (COPD) in some stage of the disease. Frequently, however, DPB runs a relentless course with fatal outcome, needing different therapeutic strategies[1].

Radiographic manifestations include widely disseminated, fine, nodular densities and streaky and cystic shadows, especially in the lower lung fields with hyperinflation[1,2]. Recently, high resolution computed tomography (HRCT) has been shown to be extremely useful in making the diagnosis of DPB by delineating pathognomonic changes in the transitional airways[2,3]. To our knowledge radioaerosol scan (RAS) of the lung has not previously been used for the diagnosis of this new entity. During the past one year period we performed RAS in three patients with DPB diagnosed on the bases of classic symptoms, laboratory tests, radiography, and HRCT. This article describes characteristic RAS manifestations of DPB, which appear basically different from those of COPD.

METERIALS AND METHODS

The patients included two men (55 and 57 yr) and two women(55 and 43 yr). The diagnosis was based on the clinical diagnostic criteria of Homma, et al.[1], lung function tests, blood gas analysis, radiography, HRCT scan[2,3], and clinical follow up. One case was pathologically confirmed. All four had plain radiography, HRCT, and RAS. RAS was performed following the inhalation, in a resting tidal breathing state, of submicronic aerosol of Tc-99m phytate through a mask for 5 min in a sitting position[6]. The inhaled radioactivity was approximately 3mCi(111MBq). The aerosol was generated afresh each time by using a BARC nebulizer (Bhabha Atomic Research Centre, Bombay, India) after instillation of 15 mCi(555MBq) of Tc-99m phytate. After rinsing the esophagus, scanning was performed with the subject lying on a scan couch in the anterior, posterior, and both lateral positions. A total of 600K counts was accumulated over a period of 10min per view, which was twice as much total counts as the recommended count of 300K. This was to obtain images with improved quality by maximally eliminating the background noise. The sensitivity of detector was suppressed by setting the filter at the near baseline level. The gamma cameras used were Siemens Scintiview II (Model ZLC 7500S) and Orbiter(Model 6601).

Abnormal aerosol deposition was assessed in terms of the intrapulmonary location, pattern, and intensity. The intrapulmonary location was divided into the central, intermediary, "transitional", and peripheral zones. The central zone included the major bronchi about the hila, the intermediary zone the medium-sized bronchi, the transitional zone the bronchiole, and the peripheral zone alveolar airspaces. The deposition pattern was either mottled or patchy and segmental or nonsegmental. The aerosol intensity was arbitrarily graded into mild, moderate, and marked. In addition the scintigraphically visualized bronchi were observed in terms of narrowing, dilatation, or obstruction.

CASE PRESENTATION

Case 1

A 55-year-old man was admitted because of sudden, cyanotic aggravation of dyspnea and productive cough of 5 years' duration. On physical examination peripheral and central cyanosis was noted. Coarse breathing sound was heard with inspiratory rales and expiratory wheezing in both lower lungs. Hemoglobin and hematocrit were 18.2g/dl and 57%, respectively. WBC count was 12,000/mm^3 with a normal differential. Vital capacity was 940ml(23% of predicted value), FEV1 530ml(18% of predicted value), and FEV1/FVC 76%. Arterial blood gas analysis revealed PaO$_2$ 32mmHg, PaCO$_2$ 59mmHg, and pH 7.32 during room air breathing.

Posteroanterior chest showed numerous, small, nodular densities scattered rather heavily throughout both lungs, especially in the lower lung(Fig. 1a). There were mottled densities intermingled with
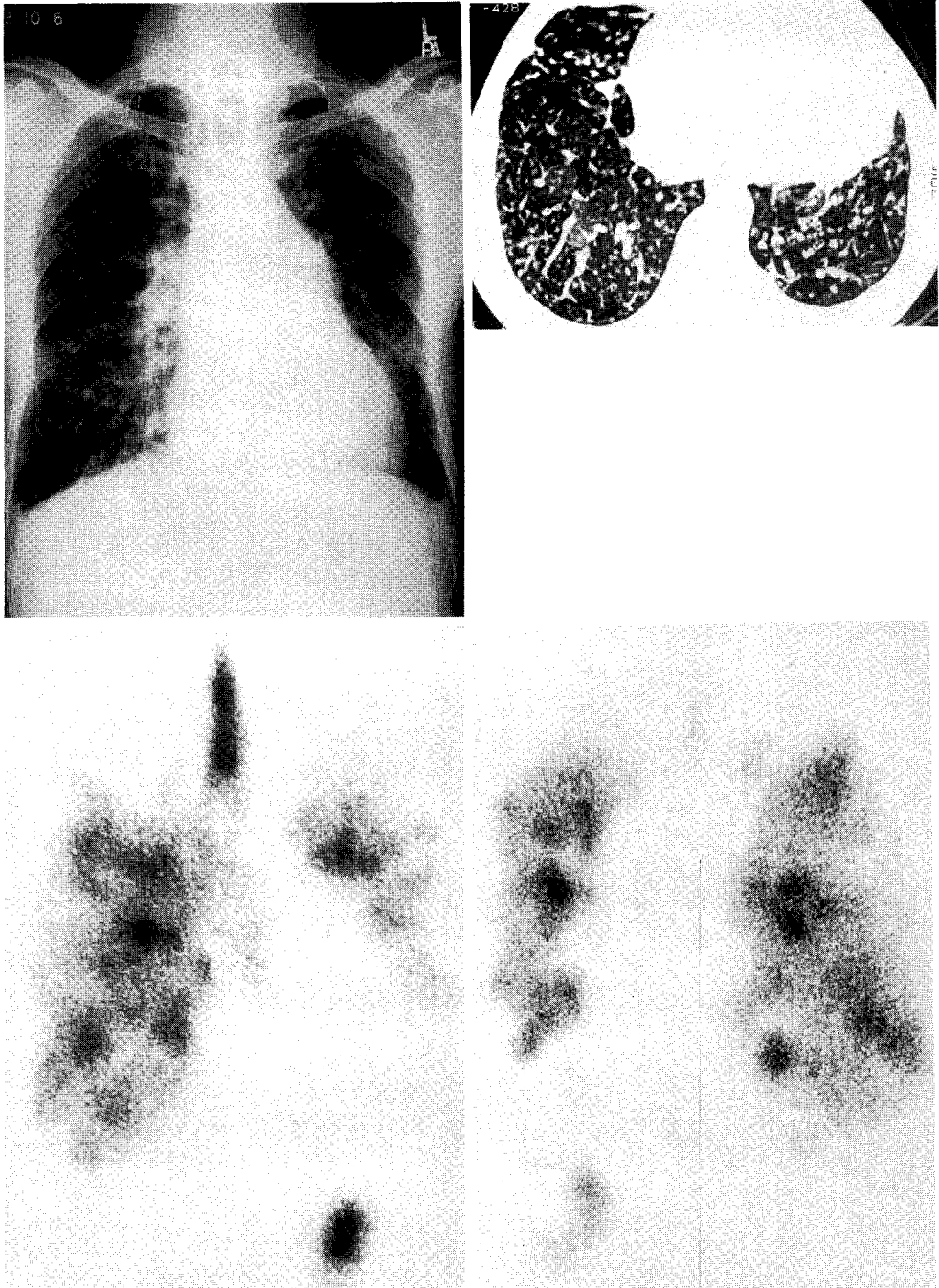
Fig. 1. DPB in a 55-year-old man(Case 1). (A) Posteroanterior chest shows hyperlucent lung with evidences of cor pulmonale. Multiple small nodules are scattered throughout both lungs, especially in lower lungs, with tramline and ring-shaped shadows. (B) HRCT shows ring-shaped and ductal opacities and ring-shaped shadows. (B) HRCT shows ring-shaped and ductal opacities and small nodules in both lungs. (C, D) Anterior and posterior aerosol scans portray mottled aerosol deposits in the transitional and intermediary airways along with patchy, nonsegmental airspace defects.
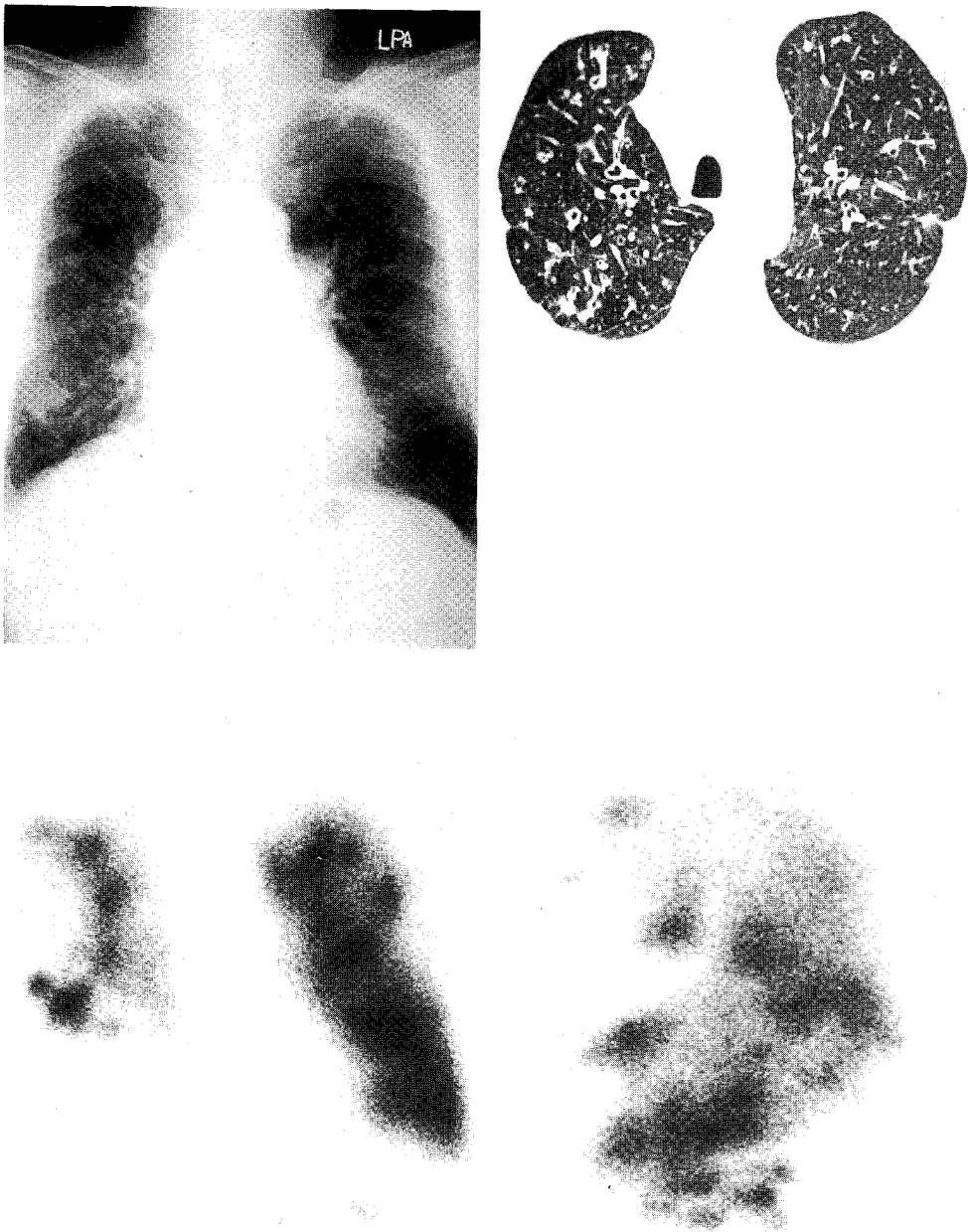
Fig. 2. DPB in a 57-year-old man(Case 2). (A) Posteroanterior chest shows diffuse, small nodules and extensive cystic and ringlike shadows with marked air trapping and cor pulmonale change. (B) HRCT reveals ringlike and ductal opacities, large cystic lesions, and peripheral air trapping. The airways appear irregularly dilated with more prominent change in the peripheral airways. (C, D) Anterior and left lateral aerosol scans portray large airspace defects with marked aerosol deposition in transitional and intermediary zones.

"tramline" and "ring"shadows thickened bronchi. In addition, moderate air trapping and cor pulmonale changes were noted. HRCT showed numerous, small, nodular opacities along with branching shadows and ringlike and ductal opacities(Fig. 1b). RAS portrayed moderately intense, irregular, mottled aerosol deposition in the transitional and intermediary airways in the middle and lower lungs. There were many intermingled, nonsegmental, patchy airspace defects(Fig. 1c&d). Aerosol deposition was inconspicuous in the central or perihilar zone. The right lung appeared overdistended, but the left was smaller than normal.

Case 2

A 57-year-old man was referred to us becuase of severe dyspnea and cough for 1 month. Previously, he had been treated under the diagnosis of COPD. On auscultation coarse breathing sound with inspiratory rales were heard in both lungs. Hemogram was within normal limits. Vital capacity was 1950ml(49% of predictive value), FEV1 1340ml(46% of predictive value), and RV 202%. Arterial blood gas analysis showed PaO_2 being 46 mmHg, $PaCO_2$ 25 mmHg, and pH 7.48.

Posteroanterior chest revealed extensive, small, cystic shadows distributed throughout both lungs with intermingled nodular, mottled densities and linear shadows in both lower lungs(Fig. 2a). Diffuse air trapping was seen. The heart was moderately enlarged with a prominent pulmonic conus, the typical sign of cor pulmonale. HRCT showed multiple, small, ringlike shadows and fine, ductal opacities as well as generalized peripheral air-trapping(Fig. 2b). Prominent airway dilatation was seen in the lung periphery and the branching shadows typical of DPB were seen. RAS portrayed irregular, mottled aerosol deposition in the intermediary and transitional airways in the left lower lobe. The right lower lobe was photopenic and the perihilar deposition was not conspicuous in this case, too(Fig. 2c&d).

Case 3

A 55-year-old woman was admitted due to chronic cough and dyspnea with purulent expectoration and worsened dyspnea. On auscultation inspiratory rales were heard in both lungs. WBC count was

$11800/mm^3$ with a normal differential. Vital capacity was 2070ml(67% of predictive value), $FEV_1$1480ml (64% of predictive value), and RV 188%. Arterial blood gas analysis revealed PaO_2 being 62 mmHg, $PaCO_2$ 33 mmHg, and pH 7.

Posteroanterior chest showed multiple, small, nodular densities scattered throughout both lungs(Fig. 3a). Mottled densities were seen in the left lower lung and air trapping in both upper lungs. The radiographic changes were less prominent in this case. HRCT revealed small, roundish opacities along with linear shadows arising from bronchovascular branches(Fig. 3b). RAS portrayed irregular, mottled aerosol deposition in the transitional zone of the right lung with patchy airspace defects(Fig. 3c). RAS changes in the left lung was minimal.

Case 4

A 43-year-old woman was admitted because of chronic cough and exertional dyspnea with purulent expectoration. On auscultation inspiratory rales were heard in both lungs. WBC count was $17100/mm^3$ with left shift. Vital capacity was 2090ml(62% of predictive value), FEV_1 1050ml(40% of predictive value), and RV 200%. Arterial blood gas analysis revealed PaO_2 being 66 mmHg, $PaCO_2$ 40mmHg, and pH 7.39. Transbronchial lung biopsy was revealed chronic bronchiolitis.

Posteroanterior chest showed multiple, small, nodular densities scattered throughout both lungs(Fig. 4a). Lobar consolidation was seen in the right middle lobe and air trapping in peripheral portion of both lungs. HRCT revealed small, roundish opacities along with linear shadows arising from bronchovascular branches with mild tubular bronchiectatic change in middle and peripheral zone of the both lungs(Fig. 4b). RAS portrayed irregular, mottled aerosol deposition in the transitional zone of the left lung with patchy airspace defects(Fig. 4c).

DISCUSSION

DPB is a relatively new disease entity known since 1969[7]. It is not rare in Japan[1,7] and cases are reported recently also from Korea[3] and Italy[8]. It may occur in association with ulcerative colitis[9]. Although
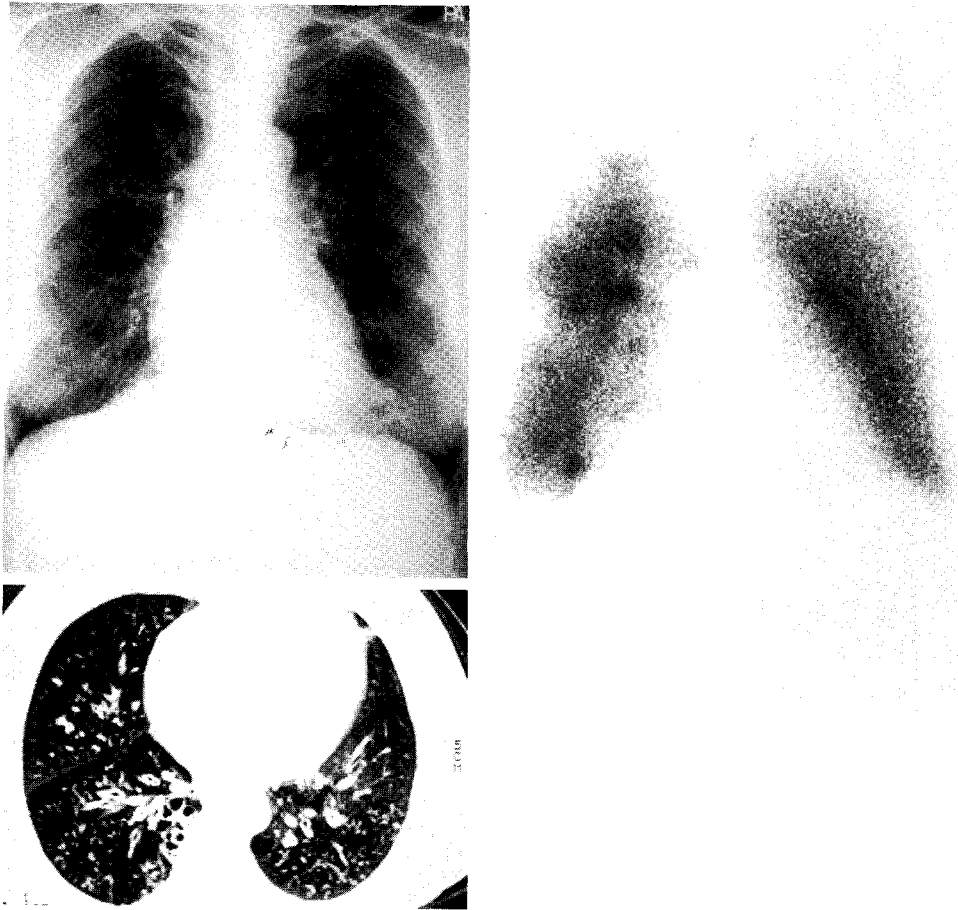
Fig. 3. DPB in 55-year-old woman(Case 3). (A) Posteroanterior chest shows small nodules with cystic shadows in both lower lungs. Vascular markings are irregularly thickened and lungs appear overdistended. (B) HRCT reveals small nodules and linear opacities arising from bronchovascular branches in the periphery, denoting bronchiolitis with peribronchiolar alterations. Modest ectasia is seen in the lower lobes. (C) Anterior aerosol scan shows minimal aerosol deposition in the transitional zone with patchy airspace defects. Note that, unlike bronchiectasis in COPD, the ectasia in DPB retains little aerosol.

clinical symptoms resemble COPD, often strongly, DPB belongs to a distinctly different category of disease[1, 7]. The basic pathology is characterized by diffuse bronchiolitis and peribronchiolitis localized mainly and peculiarly in the transitional zone of the lung, especially in the lower lobes. The essential features of pathophysiology is respiratory impairments of expiratory nature, causing exertional dyspnea, cough, wheezing, and expectoration that may occasionally become purulent. The clinical course of the disease is typically progressive and frequently outcome fatal[1, 7].

The radiographic manifestations include small nodular and mottled densities diffusely scattered throughout both lungs with air trapping and occasional cor pulmonale. Cystic and streaky shadows of various intensities may be seen. Clearly, however, these findings are not specific, being seen in many other lung diseases such as COPD, infections, and pneumoconiosis. It is also true that the plain chest is of limited use in demonstrating the characteristic site of affection in the transitional airways[2, 3]. Recently, HRCT has been shown to be extremely useful in delineating such anatomical feaures[2, 3]. Thus, HRCT can precisely indicate the presence of the main pathology in the bronchiolar wall and peribronchiolar interstitia, producing small nodules, branching sha-
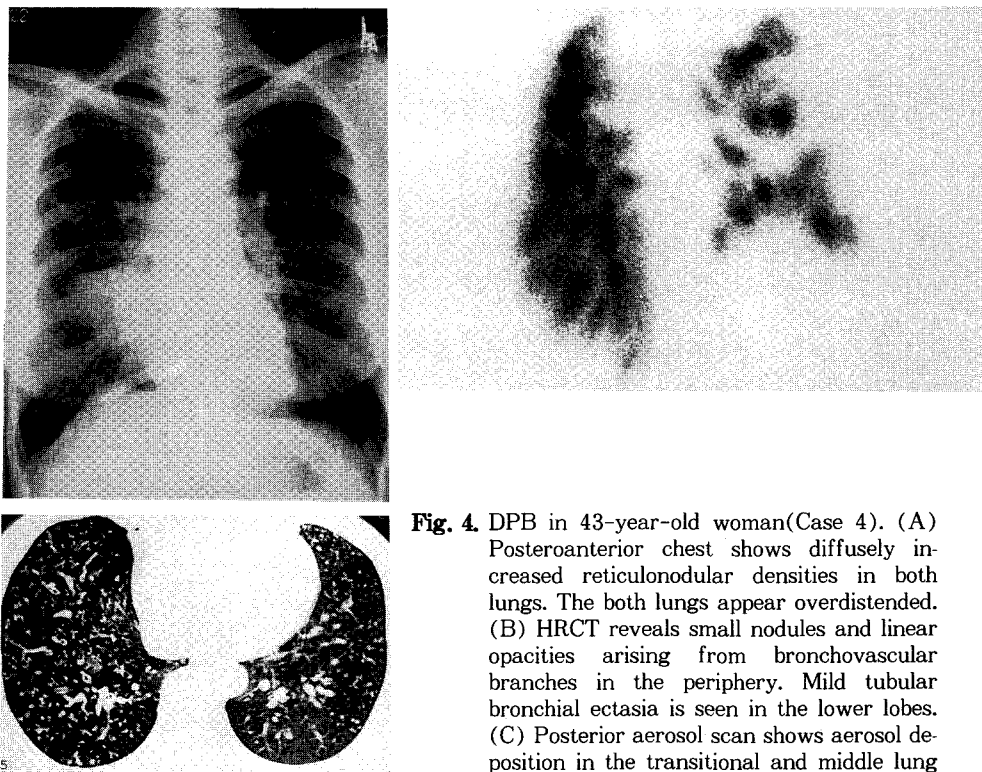
Fig. 4. DPB in 43-year-old woman(Case 4). (A) Posteroanterior chest shows diffusely increased reticulonodular densities in both lungs. The both lungs appear overdistended. (B) HRCT reveals small nodules and linear opacities arising from bronchovascular branches in the periphery. Mild tubular bronchial ectasia is seen in the lower lobes. (C) Posterior aerosol scan shows aerosol deposition in the transitional and middle lung zone with peripheral airspace defects.

dows, airway dilatation, and regional differences between CT attenuation. But in the early stage of the disease centrilobular nodules may appear, simulating interstitial lung diseases such as sarcoidosis and silicosis and in the late stage ectasia of the proximal bronchioli and bronchi may result from bronchiolar narrowing, disguising as bronchiectasis.

Theoretically, unlike in COPD which produce aerosol scan abnormalities predominantly in the central airways and peripheral airspaces[10,11], the main aerosol scan changes in DPB were expected to occur in the transitional zone of the lung and it was clearly borne out. Thus, RAS showed aerosol to deposit characteristically in the transitional zone of the lung located between the intermediary airways and periphery airspaces. Such a finding clearly denotes the site of the main pathological change in DPB in the respiratory bronchioli. In addition, it was observed that when the disease is relatively mild aerosol deposition tends to be minimal in the transitional zone

(Case 3) and vice versa with aerosol deposition spreading proximally to the central airways(Cases 1 and 2). For the differential consideration it is to be noted that the aerosol deposition in COPD occurs typically in the central airways with patchy defects in the periphery[10,11]. In bronchiectasis and bronchial asthma with limited tidal flow and impaired mucociliary clearance, aerosol particles are retained in the central and middle airways and airspaces are not penetrated producing photopenic defects[10]. In conclusion the aerosol deposition in the transitional zone of the lung appears to be characteristic of DPB.

SUMMARY

Diffuse panbronchiolitis(DPB) is a relatively new, chronic, nonspecific, inflammatory disease of the lung that typically involves the airways in the "transitional" zone of the lung. Clinically, DPB strongly resembles chronic obstructive pulmonary disease

(COPD) and the distinction between the two is cru-
cial because the former is often fatal, requiring dif-
ferent therapeutic strategies. This study was prospec-
tively carried out ot assess diagnostic usefulness of
radioaerosol scan(RAS) in DPB. RAS findings were
analyzed with respect to the location and extent of
abnormal aerosol deposition in the lung divided into
the central, intermediary, and transitional airways
and the peripheral airspaces. RAS showed mottled
aerosol deposits characteristically in the transitional
and intermediary airways with peripheral airspace
defects. Such a deposition pattern contrasted sharply
with central aerosol deposition of COPD. In conclu-
sion, RAS appears to be a convenient, noninvasive,
and useful diagnostic method of DPB.

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