

Prestenotic Bronchial Radioaerosol Deposition: A New Lung Scan Sign of Bronchial Obstruction

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기관지 협착 근위부의 연무 침착: 페스캔에서 기관지 폐색의 특이한 지표

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기관지 폐색은 임상적으로 진단이 어려운 경우가 있는데 특히 대엽 이하나 소엽 기관지에 폐색이 일어날 경우엔 그 변화가 미미하기 때문에 더욱 그러하다. 저자들은 여러가지 원인에 의해 기관지 폐색과 협착을 일으킨 8예에서 연무흡입 폐환기스캔을 시행하여 폐환기스캔 소견을 분석하였고 진단적 유용성을 알아보려고 하였다.

8예중 7예는 기관지 폐색이었고 1예는 기관지 협착이었다. 연무흡입 폐환기스캔은 ^{99m}Tc -phytate를 BARC nebulizer를 이용하여 시행하였다. 스캔 소견을 단순 흉부X선, 기관지조영술, CT, 그리고 기관지경 소견과 비교하였다.

전예에서 특징적으로 기관지 폐색 또는 협착 근위부에 짧고 약간 확장된 기관지 분절에 강한 연무침착 소견을 보였다. 또한 원위부에서는 폐실질의 환기결손 소견을 보였다.

이러한 소견은 기관지 폐색과 협착의 감수적이고 특이한 소견이며, 연무흡입 폐환기스캔은 특히 폐색부가 대엽 이하나 소엽 기관지일 경우에 더욱 유용할 것으로 생각된다.

Key Words : Bronchus, Obstruction, Aerosol Scan

INTRODUCTION

Clinically and radiographically bronchial obstruction frequently imposes a diagnostic problem especially when it involves a small lobar or sublobar bronchus producing only subtle radiographic changes such as vascular crowding

which is often hard to detect with assurance. In such a situation CT diagnosis is not rewarding either unless slices accurately include small and short obstructed site. The detection of bronchial obstruction becomes harder still when it is incomplete with confusing air trap in the distal airspace.

In the course of recent lung scan studies on bronchial obstruction using ^{99m}Tc -phytate aerosol we have noted an interesting phenomenon of intense, short, segmental aerosol deposition in the immediate prestenotic bronchus, which precisely indicated obstruction or stenosis. Characteristi-

This study was supported in part by the Clinical research Fund of Catholic University Medical college and Center, Seoul, Korea. The BARC nebulizer was generously donated by the International Atomic Energy Agency, Vienna, under the provision of Coordinated Research Programme (Contract No. 302-E1-ROK-4819).

cally the segment was minimally dilated and clubbed, accompanying airspace deposition defect distally. The value of the ventilation scan using ^{133}Xe gas or $^{81\text{m}}\text{Kr}$ gas in obstructive pulmonary disease is well documented^{1,2)} and the test is felt to be superior to radiography in detecting bronchial obstruction because obstruction is indicated by a scan defect. But nevertheless the gas scan finding does not directly indicate the site of airway abnormality as in $^{99\text{m}}\text{Tc}$ -phytate aerosol scan. To our knowledge prestenotic aerosol position has not previously been reported in association with bronchial obstruction. This article describes the characteristic radioaerosol lung scan findings of bronchial obstruction and stenosis.

MATERIALS AND METHODS

Patients included five men (31-69 years) and two women (61 and 69 years) with eight lesions. In one male patient with pulmonary tuberculosis obstruction was bilateral in both upper lobe bronchi. The obstruction was complete in seven cases and incomplete with stenosis in one. The lesion was in the sublobar bronchus (n=3), the lobar bronchus (n=4), and the mainstem bronchus (n=1). The causes were chronic inflammation (n=2), tuberculosis (n=5), and small cell carcinoma with tuberculosis (n=1). In each patient the diagnosis was made on the bases of the radiographic evidence of bronchial obstruction and distal lung collapse, and, in addition, confirmatory evidences of the conventional X-ray tomography, bronchography and/or bronchoscopy.

Radioaerosol scan was performed following the inhalation, in a resting tidal breathing state, of submicronic aerosol of $^{99\text{m}}\text{Tc}$ -phytate through a mask for 5 min in a sitting position^{3,4)}. The inhaled radioactivity was approximately 3 mCi (111 MBq). The aerosol was generated afresh each time by using a BARC nebulizer (Bhabha Atomic Research Centre, Bombay, India) after

instillation of 15 mCi (555 MBq) of $^{99\text{m}}\text{Tc}$ -phytate. After rinsing the esophagus, scan was performed with the subject lying on a scan couch in the anterior, posterior, and both lateral positions. A total of 500K counts was accumulated over a period of 8 min per view, which was nearly 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).

RESULTS

In all seven bronchial obstructions and one stenosis pathology was clearly indicated by a short-segmental, intense aerosol deposition in the immediate, prestenotic bronchus (Fig. 1, 2). Characteristically, the segment was minimally dilated and clubbed in appearance. It was accompanied by photopenic airspace deposition defect of collapsed lung distally. In the case with mainstem bronchial obstruction, intense deposition occurred in the trachea and contralateral mainstem bronchus which were dilated (Fig. 3). In this particular case the trachea and left mainstem bronchus constituted the prestenotic airways. In all cases the radioaerosol scan could clearly indicate bronchial obstruction, the radiographic diagnosis of which was either indirect or obscure due to the overlying heart, mediastinum, or lung consolidation except in one case with main-stem bronchial obstruction (Fig. 4). For example, the chest radiograph of one patient with chronic inflammatory obstruction of the medial segment of the right middle lobe showed no evidence of pathology, but the aerosol scan showed the characteristic, prestenotic aerosol deposition, clearly indicating bronchial obstruction (Fig. 5).

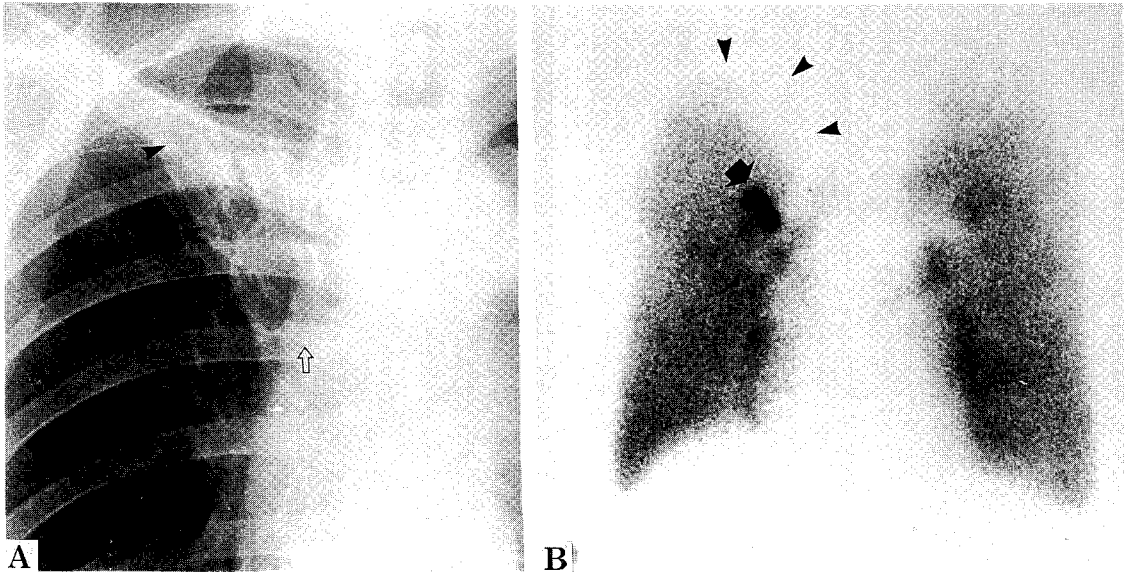


Fig. 1. Classic prestenotic aerosol deposition in bronchial obstruction. (A) Posteroanterior chest in a 57-year-old man with chronic fibroatelectatic tuberculosis in the right upper lobe shows moderate lung collapse (arrowheads) with cranial dislocation of the ipsilateral hilum (arrow). (B) Anterior aerosol lung scan reveals a large airspace deposition defect in the right upper lobe that is reduced in size (arrowheads). An intense aerosol deposition is seen in the first branch of the right mainstem bronchus which is occluded, clubbed, slightly dilated, and retracted superolaterally (arrow). The presence of a small aerated lung with aerosol deposition above the occluded bronchus is due to overinflated middle and lower lobes.

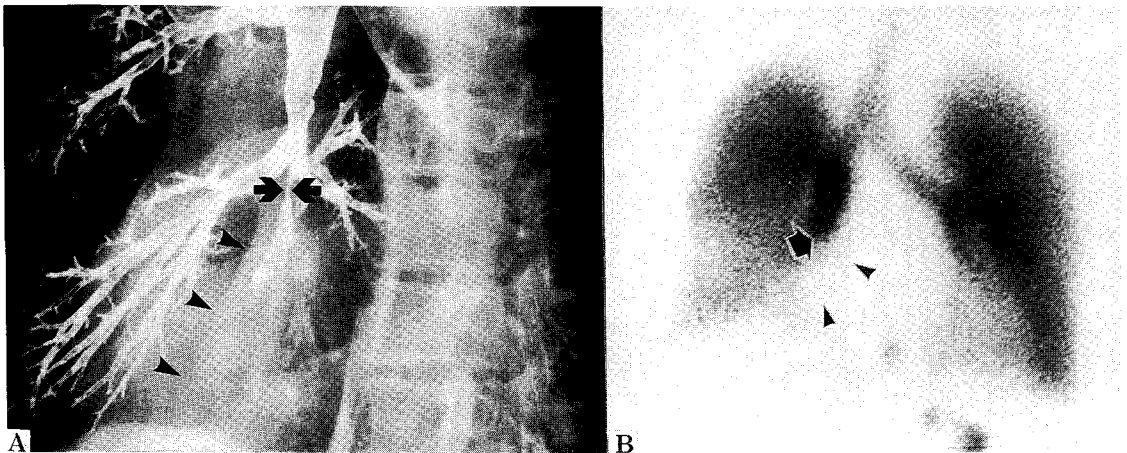


Fig. 2. Prestenotic aerosol deposition in bronchial stenosis. (A) Left anterior oblique view of right bronchography shows marked narrowing of the very proximal segment of the right lower lobe bronchus due to bronchial tuberculosis (arrows) with associated lung collapse (arrowheads). (B) Anterior aerosol lung scan reveals intense aerosol deposition in a short, dilated segment of the intermediate bronchus due to bronchial tuberculosis (arrow) and associated airspace deposition defect in the collapsed lung (arrowheads).

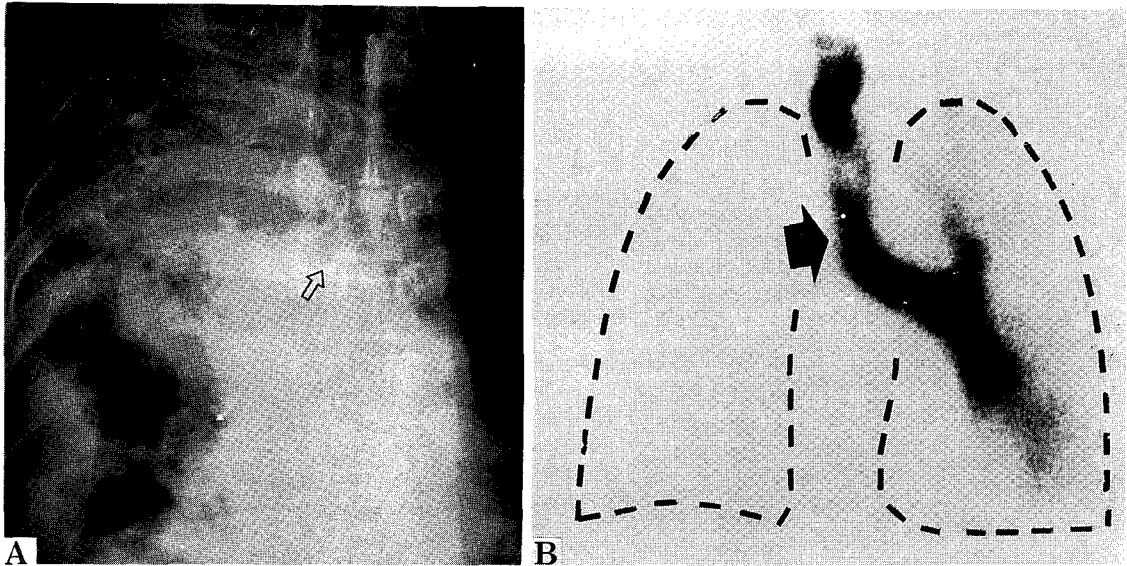


Fig. 3. Modified prestenotic aerosol deposition in mainstem bronchus obstruction. (A) Heavy penetration posteroanterior chest in a 69-year-man with advanced tuberculosis and intercurrent right mainstem bronchial carcinoma shows an abrupt termination of the tracheobronchial air column at the right mainstem bronchus (open arrow). (B) Anterior aerosol lung scan reveals complete obstruction of the right mainstem bronchus with an intense aerosol deposition in the trachea above and left mainstem bronchus (arrow). This is a modified manifestation of the prestenotic aerosol deposition sign.

DISCUSSION

Bronchial obstruction is one of the most common airway conditions caused by a number of diseases including inflammation, tuberculosis and tumor. Bronchial obstruction may be either complete or incomplete. Clinically and radiographically the diagnosis may not be difficult when obstruction is at the lobar bronchus or higher level (Fig. 1, 3). However it is difficult indeed to detect the obstruction in a small lobar or sublobar bronchus because the radiographic manifestations are subclinical or too subtle at best. Frequently it is not possible to radiographically visualize obstruction directly even in a large bronchus because the accompanied lung collapse obscures the pathology. Furthermore, when obstruction is incomplete, a check-valve mechanism may develop, regionally creating emphysema that may also mask the pathology. Occasionally the

lung consolidation produced by bronchial obstruction disguise pneumonia (Fig. 5), and when such a consolidation hides in the cardiac or mediastinal shadow diagnosis becomes even more difficult. It is under these circumstances that the radio-aerosol scan plays a decisive diagnostic role in bronchial obstruction or stenosis.

The value of ventilation scan using ^{133}Xe gas or 81mKr gas in obstructive pulmonary disease has been well established^{1,2}. The methods were reported to be superior to radiography in detecting bronchial obstruction by demonstrating air-space scan defect. But nevertheless ^{133}Xe and 81mKr scans usually do not specifically point to the site of obstruction as aerosol scan does. Our series clearly indicates that the aerosol lung scan has a definite place in detecting bronchial obstruction or stenosis, especially when it is at the sublobar level (Fig. 2). Thus the site was indicated by an intense, short, segmental aerosol

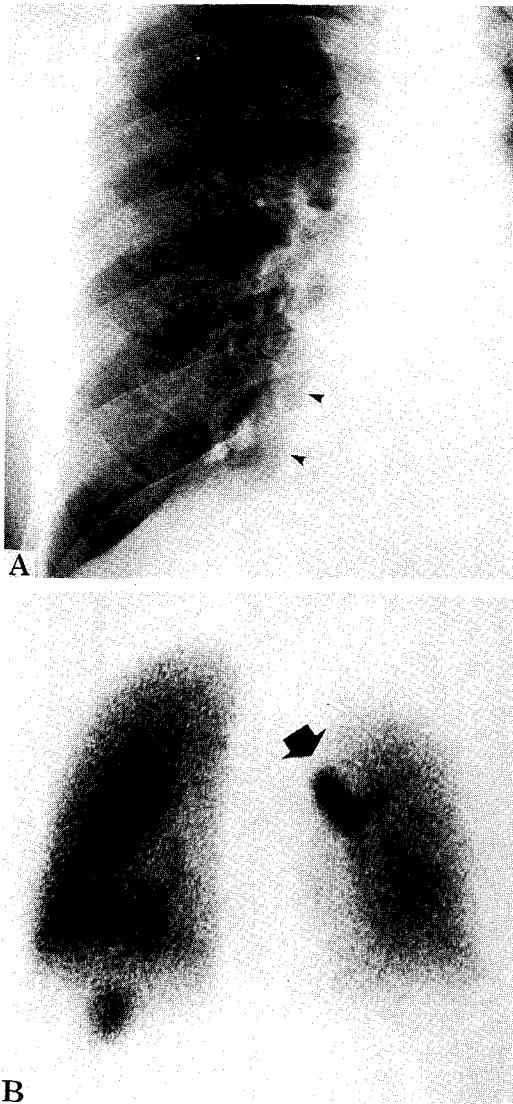


Fig. 4. Prominent prestenotic aerosol deposition sign in radiographically obscure bronchial obstruction. (A) Posteroanterior chest in a 31-year-old man with chronic bronchial inflammation shows marked collapse of the right middle and lower lobes with resultant double triangular opacities along the right cardiac border (lower arrowheads). The outer triangle denotes lower-lobe collapse and the inner one middle-lobe collapse, obliterating the cardiac silhouette. Also observe typical upper mediastinal sign (upper arrowheads) indicating massive lower-lung collapse. (B) Posterior aerosol lung scan reveals classic prestenotic aerosol deposition sign in the intermediate bronchus that is occluded, dilated, and clubbed (arrow).

deposition in the prestenotic bronchus which was slightly dilated and clubbed (Fig. 1-5). The dilated bronchus is probably due to true dilatation and/or pseudodilatation due to intense deposition of radioaerosol. In each case the clubbed segment was accompanied by an airspace aerosol deposition defect in the collapsed distal lung. It was of interest to note that while the characteristic scan sign was observed in all eight lesions studied with the aerosol scan, the radiographic alterations were either inconclusive or indirect at best in all but one case with carcinomatous obstruction of the right mainstem bronchus (Fig. 3). The mechanism with which such a peculiar aerosol deposition takes place in the prestenotic bronchus, which is slightly dilated and clubbed, is probably related with turbulent bronchial air flow⁵⁾. In this connection it is also to be noted that Boxen and Zhang⁶⁾ ascribed the occurrence of diffuse radioaerosol deposition in the major airways in tracheobronchitis to the similar mechanism. Such an aerosol deposition in obstruction site of the lung was also associated with chronic bronchial wall damage and hindered mucociliary movement with resultant hold-up of aerosol migration⁷⁾.

SUMMARY

The present study has been carried out to assess the diagnostic usefulness of radioaerosol lung scan in complete bronchial obstruction (n=7) and bronchial narrowing (n=1) of varying causes.

^{99m}Tc-phytate lung scan was performed using the aerosol generated by a BARC nebulizer. Scan alterations were correlated with those of chest radiography, bronchography, lung CT and/or bronchoscopy.

In every case scan showed characteristic, intense deposition of radioaerosol in a short, slightly dilated, bronchial segment immediately proximal to obstruction or stenosis. Characteristi-

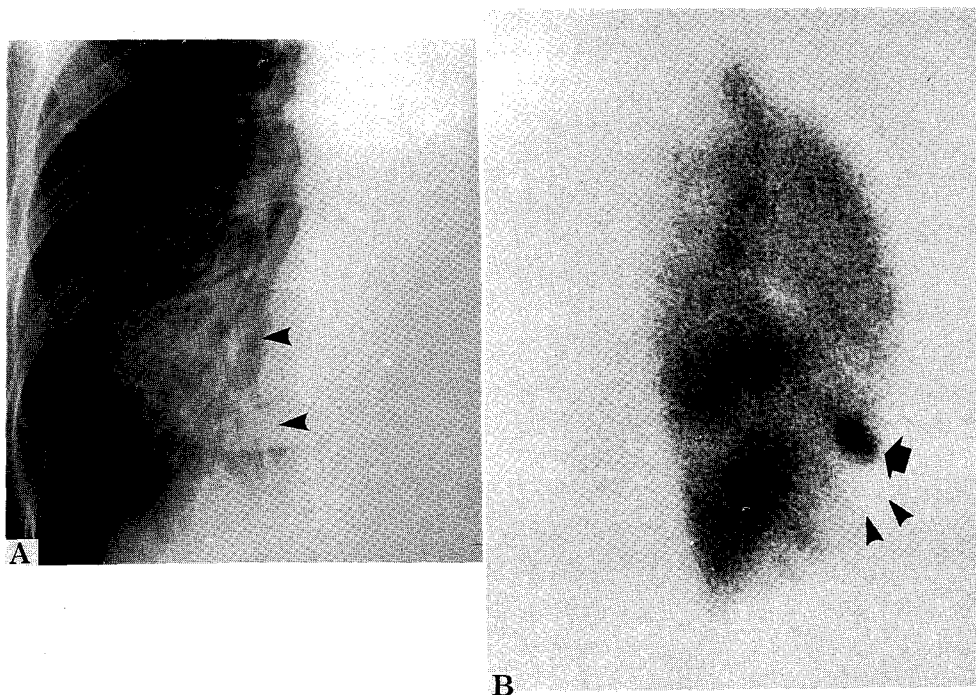


Fig. 5. Classic prestenotic aerosol deposition sign in segmental bronchial obstruction. (A) Posteroanterior chest in a 61-year-old woman with chronic pneumonia in the medial segment of the right middle lobe shows an ill-defined homogeneous opacity in the right paracardiac lung, producing cardiac silhouette sign (arrowheads). (B) Right lateral aerosol lung scan reveals an intense aerosol deposition in the intermediate bronchus, immediately proximal to the middle lobe bronchus (arrows). An airspace deposition defect is seen in the collapsed lung segment in anteroinferior aspect (arrowheads).

cally it was accompanied by an airspace aerosol deposition defect distally.

The finding of a short, clubbed, bronchial radioaerosol deposition with distal airspace defect is a sensitive, specific indicator of bronchial obstruction or stenosis. It was especially useful in the detection of the obstruction of a small bronchus at the lobar and sublobar levels. We propose to name it the prestenotic aerosol deposition sign.

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