Open Bronchial Stump Post-Pneumonectomy: Findings on Xenon-133 Ventilation Imaging

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A 67-yr-old male status post right pneumonectomy for non-small cell lung cancer who later developed an open right bronchial stump underwent a ventilation-perfusion lung scan because of episodes of recurrent dyspnea suspected to be due to pulmonary embolism. Xenon-133 ventilation images showed both rapid entry into and later washout of activity from the air-filled portion of the right thoracic cavity. A wide-open bronchial stump, documented both at bronchoscopy and later autopsy, allowed the xenon gas to freely wash out from the thoracic cavity, resulting in a different imaging pattern than for a typical bronchopleural fistula, which is usually characterized by prolonged trapping of radioactive gas within the pleural space.

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Estimates of the frequency of failure of bronchial stump closure following pneumonectomy range from 3% to 12.5% (*1–3*). The severity of this failure can range from a small air leak which seals spontaneously with no sequelae to a wide open bronchial stump with fatal complications due to pulmonary insufficiency or sepsis (*4*). The characteristic finding on chest radiography in a patient with a bronchial air leak is a lowering of the air-fluid level in the thoracic cavity (*4*). Ventilation scintigraphy with radioactive gas has been used to identify the presence of a bronchial leak, with the typical finding being entrance of gas into the thoracic cavity on single breath and equilibrium views, followed by prolonged retention during washout (*5–8*). We present an unusual case in which ventilation scintigraphy showed both free entrance and egress of gas from the thoracic cavity.

CASE REPORT

A 67-yr-old male who had undergone a right pneumonectomy 8 mo earlier for non-small cell lung carcinoma was evaluated because of recurrent episodes of paroxysmal dyspnea. The patient's original postoperative course was complicated by development of a right hydropneumothorax (Fig. 1) which was determined at bronchoscopy to be due to failure of the right bronchial stump closure. Because of the close proximity of the original surgery to the carina, surgical intervention to close the open right bronchial stump was not attempted. Since pulmonary embolism was considered a possible cause for the patient's current dyspneic episodes, ventilation-perfusion lung scintigraphy was performed.

On posterior ventilation imaging with ^{133}Xe gas, xenon entered into the upper half of the right thoracic cavity similar to the left lung, which showed relatively normal first-breath and equilibrium ventilation (Fig. 2). On washout images, there was no significant retention of the radioxenon in either the left lung or the upper right hemithorax. Perfusion imaging with ^{99m}Tc-MAA (Fig. 3) showed absent uptake in the right chest consistent with previous surgical history and relatively normal perfusion to the left lung, essentially excluding the possibility of significant pulmonary embolism.

The patient had progressive deterioration in clinical symptoms and expired 2 wk following the lung scan. Autopsy reconfirmed patency of the right bronchial stump.

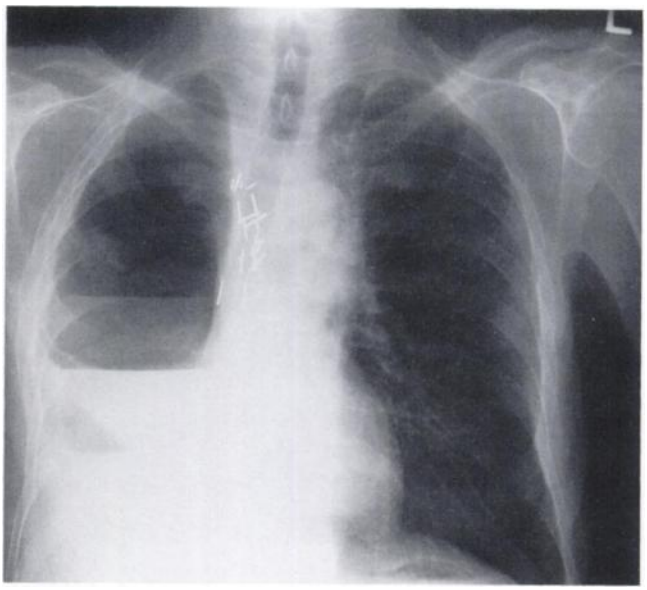

FIGURE 1. Chest x-ray demonstrates absence of right lung in patient status post-pneumonectomy and the right thoracic cavity is partially filled with fluid.

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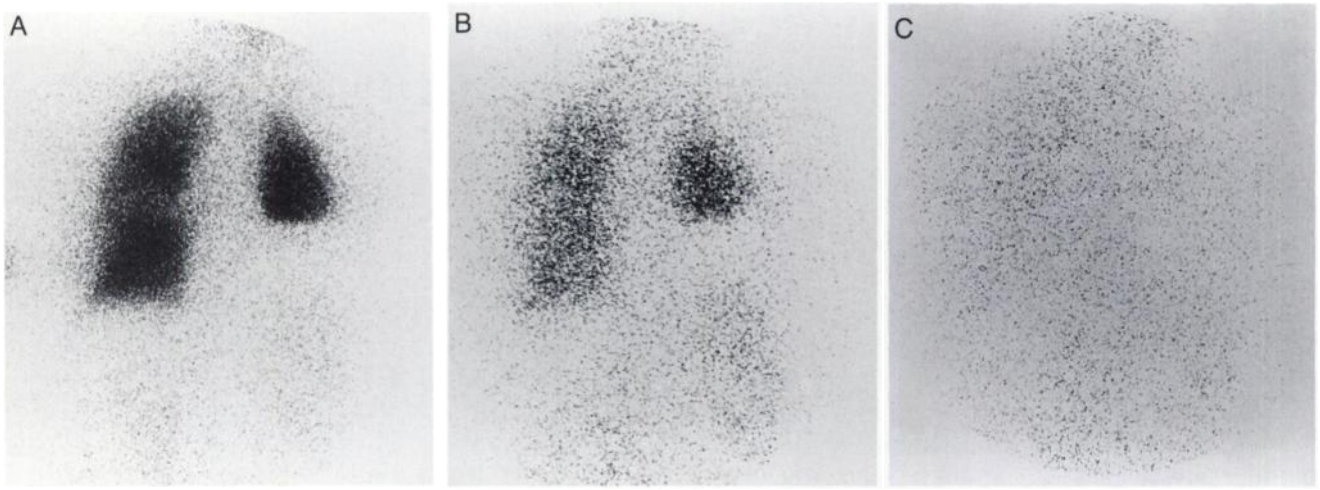

FIGURE 2. Posterior equilibrium ^{133}Xe ventilation image (A) shows accumulation of radiotracer in the upper right thoracic cavity. Washout images at 1 min (B) and 4 min (C) show relatively normal clearance of xenon from both the native left lung and the right thoracic cavity.

DISCUSSION

Following a pneumonectomy, the thoracic cavity fills with fluid, with total opacification usually occurring over a period of 3 wk to 7 mo (*4*). If the bronchial stump develops an air leak, the amount of fluid in the thoracic cavity typically decreases either due to increased absorption by the parietal pleura or loss through the patent bronchus. This results in a reduction in the height of the fluid level in the postpneumonectomy space commonly observed on chest x-ray. Infection of the postpneumonectomy fluid and respiratory insufficiency are important causes of morbidity and mortality in patients with failure of bronchial stump closure (*2–4*).

A number of previous reports have described the utility of radionuclide ventilation imaging in the diagnosis and localization of bronchopleural fistulae and bronchial air leaks (*5–13*). In the postpneumonectomy patient, this diagnosis is usually less in doubt than in patients with empyema, localized lung resection, or pneumothoraces, in that typical changes in the chest radiograph usually suggest the diagnosis. In our patient, the patent bronchial stump had been identified on prior bronchoscopy, and the lung scan was performed for suspicion of pulmonary embolism, a case similar to that described by Roswig (*7*).

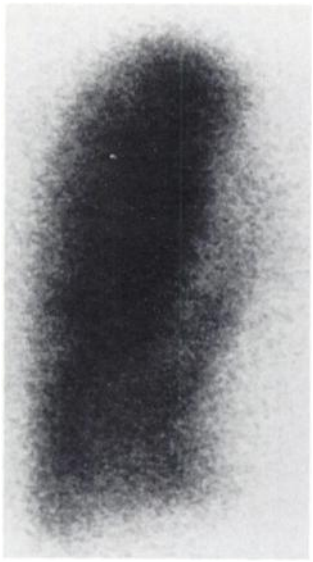

FIGURE 3. Posterior ^{99m}Tc-MAA lung perfusion image demonstrates absence of activity in the right chest, which is consistent with prior pneumonectomy.

Although prior reports have demonstrated various amounts of radioactive gas or radiolabeled aerosol entering into the affected lung or thoracic cavity on inhalation imaging, our case employs radioactive gas to show rapid washout of activity from the thoracic space comparable to that observed in the native lung. It is understandable why trapping occurs in a patient with a communication between a bronchus and the visceral pleura, with both parietal and visceral pleura present, in that there is no ready mechanism for clearance of this gas once it has diffused throughout the available pleural space. In contrast, with an open bronchial stump postpneumonectomy, the communication is between the bronchus and the parietal pleura, or more specifically the thoracic cavity, and, assuming there is sufficient air exchange in the cavity, clearance of the radioactive gas on washout imaging should occur without significant impediment. Possible explanations for previously observed trapping of radioactive gas in patients with postpneumonectomy bronchial fistulae include the presence of only a relatively small opening which behaved similar to a ball valve, allowing free entrance but minimal exit of radioactive gas, or paralysis of the hemidiaphragm on the side in question, with tracer diffusing into the thoracic cavity but clearing only slowly in the absence of significant inspiratory or expiratory forces. The quantity of ^{133}Xe entering into the thoracic cavity in our patient appears significantly greater than that shown in images from several

previous case reports (*5–7*), suggesting that there was a larger communication between the bronchus and thoracic cavity in our patient than in those previously described.

The lung scan in our patient showed the features described as a "pseudoventilation-perfusion mismatch" (*7*) with the additional feature of normal washout from the thoracic cavity that was not seen in the previous report. Observation of the scan pattern seen in the present case should alert the interpreting physician of the likelihood of a large leak, suggesting complete failure of bronchial stump closure.

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