Ventilation-Perfusion Scan in the Acutely Ill Patient with Unilateral Hyperlucent Lung

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A patient with a unilateral hyperlucent lung with acute respiratory complaints is presented. A ventilation-perfusion scan was performed to rule out pulmonary embolism. The perfusion scan ([^{99m}TC]MAA) showed peripheral perfusion defects in the hyperlucent lung. The ventilation study (^{133}Xe) demonstrated peripheral ventilatory defects on the single breath image in the hyperlucent lung, the filling in of these on the equilibrium view, and diffusely delayed washout in the affected lung. These findings were suggestive of the Swyer-James syndrome and critical in excluding the numerous other causes of unilateral hyperlucent lung, which are discussed. The importance of the ventilation-perfusion study (and particularly the ventilation scan) in the patient with unilateral hyperlucent lung and acute respiratory symptoms is stressed. In addition, a discussion of the Swyer-James syndrome is included.

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When a patient with acute respiratory symptoms presents with a chest x-ray consistent with unilateral hyperlucent lung, it may be difficult to determine whether the finding is chronic or related to the patient's clinical presentation, as this entity has a varied etiology. Ventilatory abnormalities, pulmonary artery defects, and extrapulmonary changes can yield this radiographic picture (*1–3*). A ventilation-perfusion study and, primarily the ventilation scan, can be invaluable in sorting out the cause for the unilateral hyperlucent lung and, in doing so, obviate the need for more invasive diagnostic procedures (*1,4,5–8*). We describe a case of unilateral hyperlucent lung in a patient who presents with a clinical picture suggestive of pulmonary embolism. The ventilation-perfusion scan was suggestive of the Swyer-James syndrome and helped to exclude other causes of unilateral hyperlucent lung.

CASE REPORT

A 65-yr-old woman, 1-wk post percutaneous transluminal coronary angioplasty (PTCA), developed acute onset of right sided pleuritic back pain. Physical exam revealed decreased breath sounds at the right base and in the right mid lung field. A ventilation-perfusion study was requested to rule out a pulmonary embolism.

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The patient's past medical history was remarkable for aspiration of a carpet tack into the right bronchial tree at the age of 10. The tack was removed bronchoscopically when she was 12 yr old, but the patient noted the development of "colds" and a productive cough each winter. At the age of 29 yr, she presented with hemoptysis and bronchoscopy revealed stenosis of the right bronchus intermedius of a moderate degree. Bronchography demonstrated stenosis of the bronchus intermedius and middle lobe bronchi and bronchiectasis of the right middle and lower lobes. At 30 yr old, the patient was admitted for resection of her bronchiectatic right middle and lower lobes. Preoperative chest x-ray showed a flattened right hemidiaphragm, a blunted right costophrenic angle, and an emphysematous right upper lobe. There was some shift of the mediastinum to the right. Pathologically, the resected lobe had moderately large saccular dilatations of each segmental bronchus. There was considerable fibrosis about the bronchial spaces with thickening of the bronchial walls. There was also some hypertrophy of the muscular layers of the bronchial arteries.

The ventilation study (Fig. 1) was performed with 15 mCi of xenon-133 (^{133}Xe). An initial single breath view was obtained, followed by an equilibrium view at 3 min, and washout images every 30 sec for 5 min. There was no ventilation at the right lung base and there were nonsegmental ventilatory defects in the periphery of the right lung on the single breath image. The equilibrium view showed some filling in of the peripheral ventilatory defects. There was delayed washout of xenon uniformly throughout the right lung.

There was slightly diminished ventilation to the left apex on the single breath image. The equilibrium phase in the left lung was normal. There was mild retention of xenon at the left apex and lung base. The left lung was larger than the right.

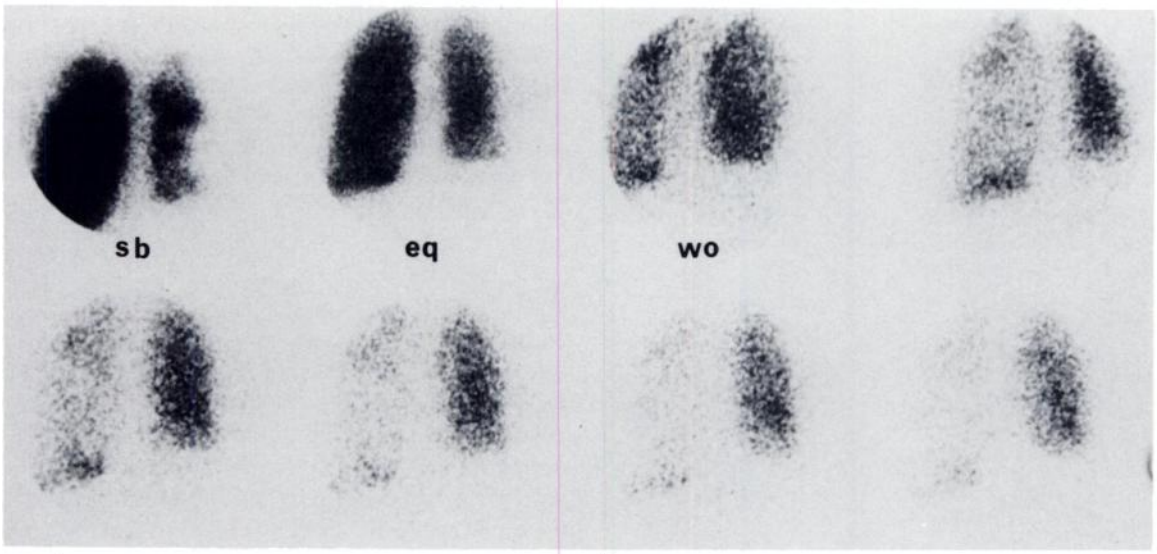

FIGURE 1
Ventilation scan (posterior views)—single breath image (sb) shows no ventilation at the right lung base and nonsegmental defects in the periphery of the right lung. There is partial filling in of these defects on the equilibrium view (eq) and diffuse Xenon trapping in the right lung during washout (wo). Washout images are taken every 30 sec. At maximum inspiration (sb), part of the left lung base is outside the field of view. The left lung is larger than the right and shows slightly diminished ventilation to the apex on the single breath image, as well as mild retention of xenon at the apex and base.

The perfusion scan (Fig. 2) was performed with 4 mCi of technetium-99m macroaggregated albumin ([^{99m}Tc]). Multiple views were obtained. The scans showed perfusion defects at the base and periphery of the right lung, matching the ventilatory defects. There was diffusely diminished perfusion to the right lung in comparison to the left, and the left lung was again noted to be much larger than the right.

Chest x-ray (Fig. 3) showed a small, hyperlucent right lung with blunting of the right costophrenic angle, which had been noted on prior chest x-rays. The right hilum was small.

The ventilation-perfusion scan was reported as suggestive of the Swyer-James syndrome, given the patient's past history and radiologic picture.

DISCUSSION

The Swyer-James syndrome was first described in 1953 (*9*), and the description was further expanded by Macleod in 1954 (*10*). A number of inciting stimuli thought to generally occur in childhood have been implicated in the pathogenesis of this syndrome. These include radiation therapy, measles, pertussis, hydrocarbon ingestion, tuberculosis (*6,11,12*), and frequently an adenoviral infection (7). In addition, a number of reports have described the Swyer-James syndrome following aspiration of a foreign body (*11,13*). These pulmonary insults initiate a bronchitis and bronchiolitis which proceeds to bronchiolitis obliterans and, eventually, destruction of the lung parenchyma. There is often scarring and stenosis of the bronchi and larger bronchioles. Fibrosis of the interalveolar septae results in obliteration of the pulmonary capillary bed, reduction in blood flow to the major pulmonary arteries, and, ultimately, hypoplastic vasculature (*14–16*). These pathologic changes result in the classic radiologic picture of a small, hyperlucent lung with an ipsilateral small hilum, diffuse air trapping, and segmental bronchiectasis.

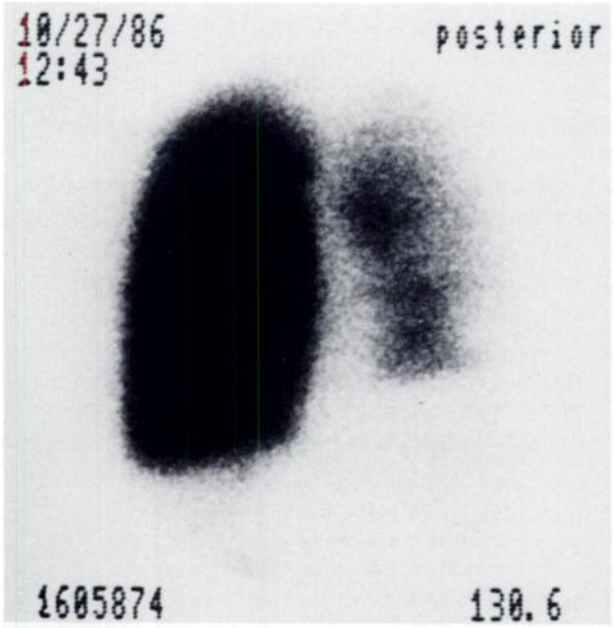

FIGURE 2
Perfusion scan (posterior view). There are perfusion defects at the base and periphery of the right lung, which match the ventilatory defects.

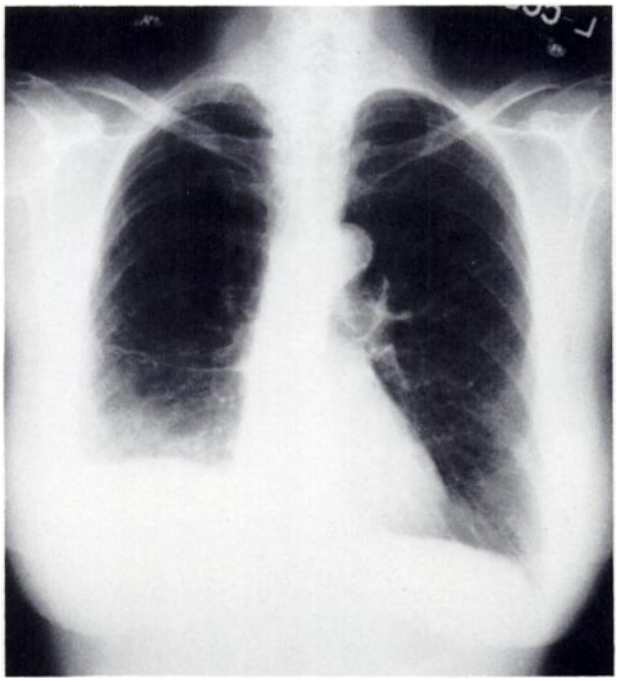

FIGURE 3
Chest x-ray. The right lung is small with diminished vascular markings, resulting in its hyperlucency. The right pulmonary hilum is small. The blunting of the right costophrenic angle had been noted on previous chest x-rays.

In our case, the patient presented with symptoms consistent with pulmonary embolism and a chest x-ray consistent with the Swyer-James syndrome as well as a number of other entities which would yield a unilateral hyperlucent lung (Table 1). The causes of unilateral hyperlucent lung with a vascular etiology would all be expected to yield an abnormal perfusion scan but, unlike the Sywer-James syndrome would produce a normal ventilatory study (*4*).

Careful assessment of the ventilation scan can reliably differentiate primary ventilatory causes of unilateral hyperlucent lung from the Swyer-James syndrome. Lee and Granada, in 1977 (*5*), and others (*1,6,7,8*), have commented upon delayed washin and washout of Xenon in the lung affected by this syndrome. Our case shows this as well, and more specifically, demonstrates on the single breath image diffuse peripheral ventilatory defects, suggesting obliteration of small airways, a pathologic change found in the Swyer-James syndrome (*6*). These defects filled in during equilibrium by collateral air drift and trapped xenon during the washout phase.

TABLE 1
Causes of Unilateral Hyperlucency of the Lung

A.	Compensatory or obstructive emphysema (including bronchial obstruction secondary to foreign body, intrabronchial neoplasm, and mucous plug)
B.	Pulmonary artery defects
	1. Congenital
	a. Pulmonary artery hypoplasia
	2. Acquired
	a. Pulmonary artery stenosis
	b. Pulmonary arteritis
	c. Pulmonary embolism
C.	Swyer-James (Macleod's) syndrome
D.	Post lobectomy lung
E.	Extrapulmonary causes
	1. Mastectomy
	2. Congenital absence or atrophy of the pectoral muscles

Unilateral hyperlucent lung, secondary to bronchial obstruction from a foreign body, intrabronchial neoplasm, or mucous plug would result, on the single breath image, in nearly complete absence of ventilation to the whole lung in a proximal lesion or diminished ventilation to a select segment or lobe in a more peripheral lesion (*17–19*). None of these entities would produce the diffuse, peripheral ventilatory defects on the single breath image that the Swyer-James syndrome does. Extrapulmonary causes of our patient's unilateral hyperlucent lung were excluded because these causes would not affect the ventilation scan or the posterior view of the perfusion scan. An added complicating factor was this patient's right middle and lower lobectomy, which confused the radiologic picture. A hyperexpanded post lobectomy lung would not, however, trap xenon gas (*2,20*).

The pathologic changes occurring in the Swyer-James syndrome would result in diminished perfusion and would be expected to yield the specific ventilatory abnormalities as described above (*1,4,5–8*), suggesting the diagnosis of Swyer-James syndrome and excluding other causes of unilateral hyperlucent lung.

Careful assessment of the ventilation-perfusion scan, then, may be critical in determining the etiology of a unilateral hyperlucent lung. This becomes particularly important in patients presenting acutely, where the study can preclude more invasive diagnostic procedures.

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