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The contribution of perfusion scintigraphy in the evaluation of children suffering from recurrent localized pneumonia

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Abstract. The value of perfusion scintigraphy as a screening test for children who have suffered from several episodes of recurrent localized pneumonia was evaluated in 32 patients aged 1–15 years. Perfusion studies were carried out using macroaggregated albumin (MAA) labeled with technetium 99m. In 9 patients (28%), large lobar or multisegmental perfusion defects were demonstrated. Their final diagnoses proved to be bronchiectasis (5 patients), bronchomalacia (2 cases), agenesis of a lobe (1 subject), and lobar sequestration (1 patient). In 23 children (72%), the perfusion scintigraphic patterns were normal or diffusely nonhomogeneous. All of these patients improved clinically on a 1- to 2.9-year follow-up. We conclude that a normal perfusion scintigraphy is a useful screening test for excluding structural lung abnormalities in pediatric patients with recurrent localized pneumonia. Children showing a pattern of lobar or multisegmental perfusion defects should be further investigated to rule out structural abnormalities as an underlying cause of disease.

Key words: Perfusion scintigraphy – Localized pneumonia – Differentiation of structural from functional disorders

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Introduction

A large proportion of children suffering from recurrent pneumonia have bronchial asthma and hyperreactive airways as an underlying problem. However, it is important to detect the relatively small group of patients who have structurally localized disease (Eigen et al. 1982; Fernald et al. 1986). Bronchoscopy with or without bronchography and computerized tomography (CT) are recommended techniques for the diagnosis of localized structural abnormalities. However, the former is invasive and the latter is insensitive to small lesions.

The objective of this study was to assess whether perfusion lung scintigraphy is a useful screening procedure for the differentiation of patients with primary or secondary structural abnormalities from those with functional problems such as hyperreactive airways.

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Patients and methods

During the period from June 1984 to November 1986, we studied 32 children who had suffered from at least two episodes of pneumonia (proven both clinically and radiographically) within a 1-year period. The patients were 1–15 years old (mean age, 7.2 years); 15 were boys and 17 were girls. Children with overt bronchial asthma, a history of a foreign-body inhalation, tracheo-esophageal fistula, or evidence of gastro-esophageal reflux were excluded. Therefore, the patient population consisted of children with repeated episodes of cough who could not be diagnosed as having bronchial asthma due to the atypical course of their illness, manifested by a lack of response to bronchodilators and persistent chest X-ray findings. The workup of these patients included a sweat test, fine mucosal nose-brush biopsy, and measurement of immunoglobulin levels, all of which were found to be normal. The scintigraphic studies were performed when the subjects had been asymptomatic for at least 8 weeks. The patients were examined by an experienced pediatric pulmunologist on the day of scintigraphy to exclude any acute illness.

Lung perfusion scintigraphy was carried out using 7.4–74 MBq (200 μCi–2 mCi) macroaggregated albumin labeled with technetium 99m (^{99m}Tc-MAA), of which 50×10^3–400×10^3 particles were given according to the patient's weight. Anterior, right and left lateral, posterior, and right and left posterior oblique views were obtained, with 500×10^3 counts/view. The radiation absorbed dose for the perfusion study was estimated to be 0.5–0.6 rad for the lung and 0.015–0.04 rad for the gonads (Treves and Harris

1985). The scintigrams were read by two experienced observers (R.H. and J.R.). The perfusion distribution patterns were classified either as being normal or diffusely nonhomogeneous or as demonstrating lobar, segmental, multisegmental, or subsegmental defects.

The patients were followed up for 1–2.9 years (mean, 1.4 years), and the definitive diagnosis was made either by bronchoscopy, bronchography, arteriography, or CT scan in patients suspected of having structural lesions or by clinical follow-up in the majority of cases. Repeat prefusion scintigraphy was performed in three patients with bronchiectasis.

Results

Nine patients (Table 1) demonstrated lobar or multisegmental perfusion defects on scintigraphy. All had persistently abnormal chest X-rays; four had a normal and one, an abnormal CT study. All nine patients in this group were found to have structural abnormalities on further radiological investigation or on bronchoscopy. These abnormalities comprised bronchiectasis (5 patients), bronchomalacia (2 cases), agenesis of a lobe (1 subject) and lung sequestration (1 patient). The children with bronchiectasis showed very mild, increased lung markings and peribronchial thickening on chest X-ray, which was initially overlooked in two cases (Fig. 1). Perfusion scintigraphy was repeated in three patients 1 year following conservative therapy including postural drainage and treatment with antimicrobial agents and showed marked improvement in the perfusion pattern (Figs. 2–4).

A total of 23 patients (Table 2) demonstrated either a normal pattern (12 cases) or nonhomogeneity (11 children) on perfusion scintigraphy. Chest X-rays performed prior to scintigraphy were normal in only three cases; the remainder showed peribronchial thickening, hyperlucent segments, and lung infiltrates. No additional radiological studies were done, as the perfusion pattern did not indicate gross pathology. In the follow-up period of 1–2.9 years, 20 patients were diagnosed as having hyperreactive airway disease and 3 patients with a normal perfusion scintigram were well. We did not perform

Table 2. Data of patients presenting with normal or nonhomogeneous patterns on perfusion scintigraphy

Patient number	Perfusion	Chest X-rays		Diagnosis	
		Normal	Abnormal[a]	HA	N
12	Normal	1	11	9	3
11	Diffusely nonhomogeneous	2	9	11	–

[a] Abnormalities included peribronchial thickening, hyperlucent segment, and lung infiltrates
HA, hyperreactive airways; *N*, normal

Table 1. Data of patients presenting with lobar or multisegmental defects on perfusion scintigraphy

Patient number	Perfusion	Chest X-ray	Additional radiological studies	Diagnoses
7	Lobar and multisegmental defects	Increased lung markings, peribronchial thickening (7)	CT, normal (2) CT, abnormal (1) Bronchography, abnormal (5)	Bronchiectasis (5)
			CT, normal (2)	Bronchomalacia (2)
2	Lobar and multisegmental defects	Hyperlucent lung Lung infiltrate (1)	Bronchography (1) Angiography (1)	Agenesis of lobe (1) Lung sequestration (1)

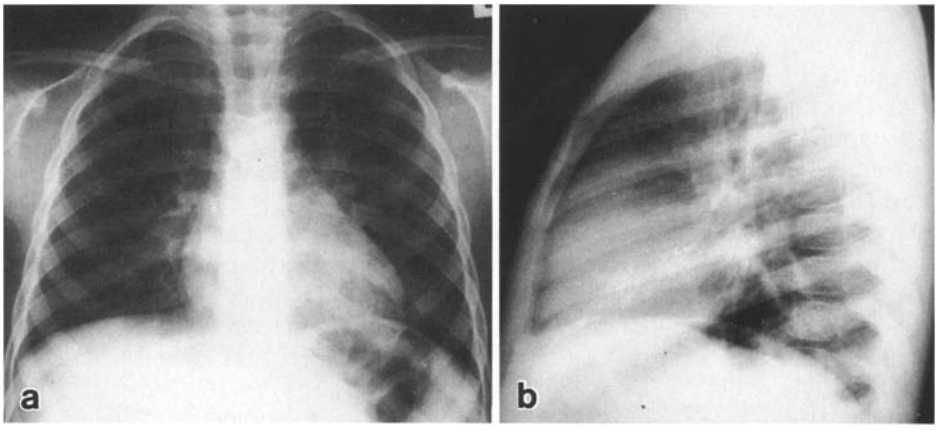

Fig. 1A, B. A 7-year-old boy suffering from chronic suppurative lung disease, with several episodes of left lower-lobe pneumonia. Chest X-ray from the **A** (AP) and **B** left lateral views, demonstrating mild, increased lung markings behind the heart

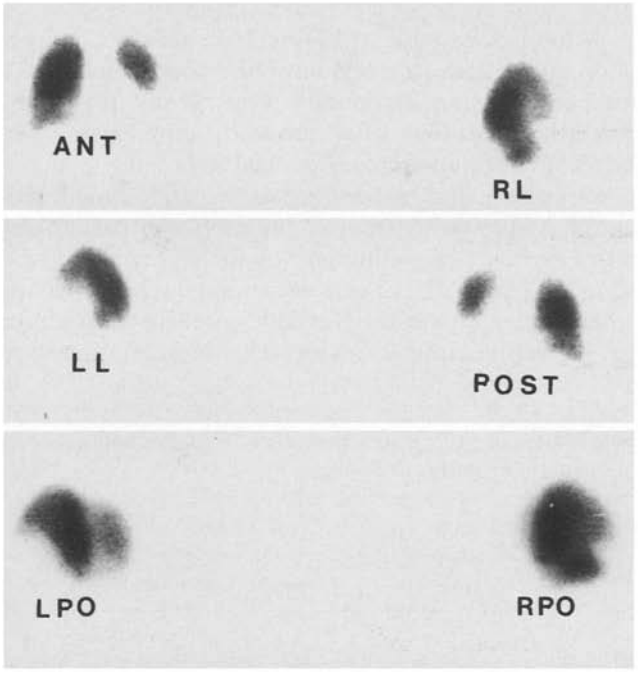

Fig. 2. ^{99m}Tc-MAA perfusion scintigram demonstrating a lobar defect involving the left lower lobe as well as subsegmental defects in the right lung. *ANT*, anterior; *POST*, posterior; *RL*, right lateral; *LL*, left lateral; *RPO*, right posterior oblique; *LPO*, left posterior oblique

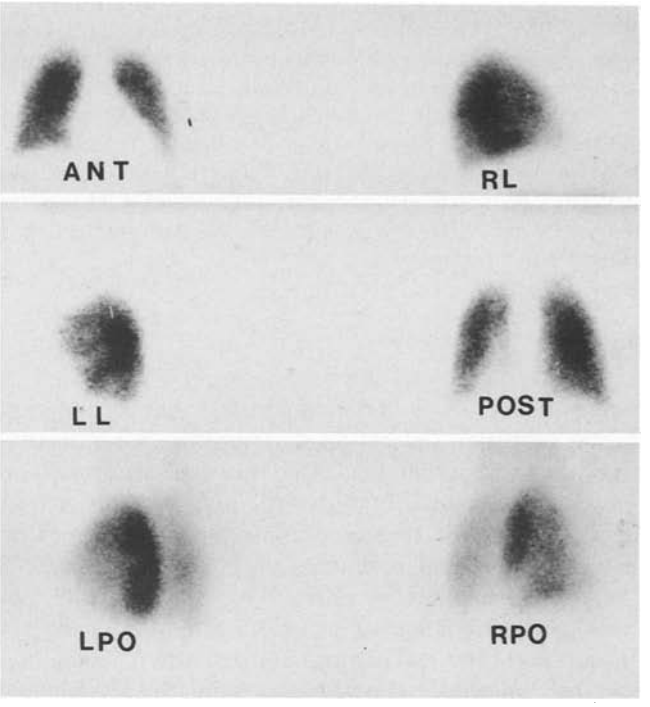

Fig. 4. ^{99m}Tc-MAA scintigram obtained 1 year after conservative treatment, demonstrating improved perfusion. Segmental and subsegmental perfusion defects are still visible in both the left and the right lower lobes. *ANT*, anterior; *POST*, posterior; *RL*, right lateral; *LL*, left lateral; *RPO*, right posterior oblique; *LPO*, left posterior oblique

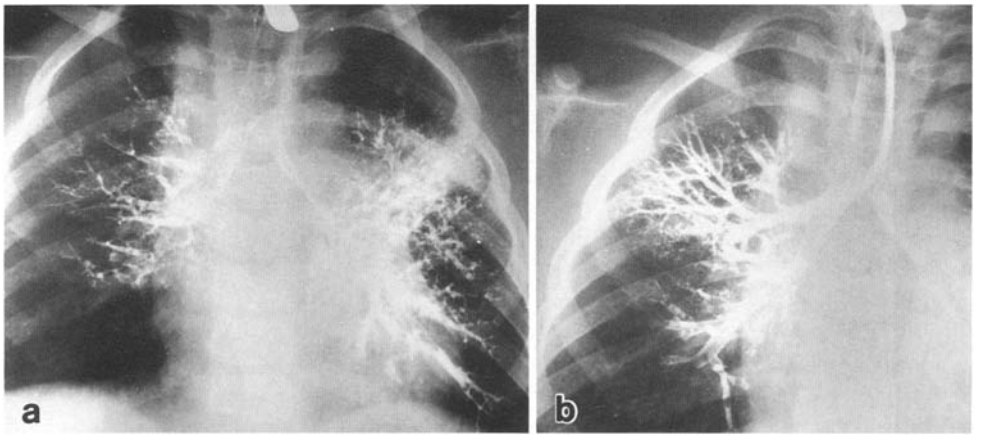

Fig. 3A, B. Bronchogram showing cylindrical bronchiectasis involving the **A** left and **B** right lower lobes

repeat perfusion scintigraphy in the 11 patients who showed nonhomogeneity, since the diagnosis of hyperreactive airways became obvious during the clinical follow-up period. Three patients in this group had normal chest X-rays and only one was well, with no underlying disease. The other two patients with normal chest X-rays were diagnosed as having hyperreactive airways disease.

Discussion

Children who suffer from recurrent localized pneumonia present a diagnostic challenge, whereby those whose disease has an underlying cause must be identified. These causes comprise primary and secondary bronchiectasis, lobar sequestration, agenesis of a lung segment, and tracheobronchomalacia.

The conventional chest X-ray provides anatomic information and is routine as an initial step in the evaluation of these patients. The CT scan may add detailed information about lesions seen on the chest X-ray, but its use in bronchiectasis is controversial (Grenier et al. 1986; Muller et al. 1984; Phillips et al. 1986): several studies have shown that it is inaccurate and insensitive, particularly when the bronchiectasis is cylindrical or varicose and located in the lower lobes (Cooke et al. 1985; Grenier et al. 1986; Muller et al. 1984).

Bronchoscopy, bronchography, and arteriography are considered to be the definitive diagnostic procedures, but all are invasive. Scintigraphic lung assessment provides information on both global and regional perfusion and ventilation and is widely used in adults, mainly for the diagnosis of pulmonary embolism. Its use in children has been evaluated in several series (Godfrey and McKenzie 1977; Gordon et al. 1981; Treves and Harris 1985). These series investigated a large variety of patients, including those with congenital heart disease, musculoskeletal abnormalities, cystic fibrosis, and vascular abnormalities, whose diagnosis had been established and in whom scintigraphy was performed to assess treatment.

Gordon et al. (1981) used lung scintigraphy mainly for the assessment of the extent of a known lung disease and for evaluation of surgical procedures in the heart and lungs. These authors also found that in a small number of their patients, the lung scan was essential for either establishing or refuting a diagnosis of bronchiectasis or foreign-body inhalation. Godfrey and McKenzie (1977) investigated the usefulness of the radionuclide lung scan by comparing it with multiple different tests in 123 children, 20% of whom had cardiac lesions and 21%, hyperlucent lung. Thus, in their group the most common indication for performing the test was the estimation of the severity of a known lung disease rather than the establishment of a diagnosis. The overall usefulness was found to be 53%, being higher in the 6-month to 6-year age group and lower in older children. Using lung scintigraphy combined with bronchography, Vandevivere et al. (1980) studied children suspected of having bronchiectasis. They found that 40% of the bronchograms could have been avoided on the basis of a normal chest X-ray and normal lung scintigraphy, thus stressing the usefulness of lung scintigraphy as a screening procedure.

In our group of patients with recurrent localized pneumonia, perfusion scintigraphy, was found to be contributory in dividing patients into two groups. The first group, with normal or nonhomogeneous perfusion patterns, comprised patients in whom the probability for structural lesions was low and who proved to have either no chronic disease or hyperreactive airway disease but showed no structural lung disease on follow-up. The second group of patients, whose lung scintigrams were grossly abnormal, were all found to have significant structural lesions when further diagnostic procedures were performed. As large perfusion defects can be detected in the post-pneumonia period (Treves and Harris 1985), it should be stressed that our patients were imaged when they were clinically symptom-free and after several weeks had elapsed since the acute illness. It is conceivable that patients with hyperreactive airways may have prominent perfusion defects when they are symptomatic (or even asymptomatic) and therefore be included in the group with large perfusion defects. We did not encounter such a case, probably due to the long symptom-free period and the nearly normal physical examination of the patients on the day of scintigraphy. In this small group, therefore, all subjects with structural lesions were identified by perfusion scintigraphy, and none of the patients with normal or minimal changes on scintigraphy were subsequently found to have a structural basis for their recurrent pneumonia.

Perfusion scintigraphy proved to be a more reliable indicator than the chest X-ray for the presence of structural abnormalities, as the chest X-ray showed peribronchial thickening, hyperlucent segments, or lung infiltrates in all but three patients. The severity of changes on chest X-ray did not correlate with the severity of the disease. As mentioned above, two patients suffering from bronchiectasis had mild peribronchial thickening and their chest X-rays were initially read as being normal. Four patients with mild, increased lung markings had a normal CT scan (Table 1); by bronchography, two were subsequently diagnosed as having bronchiectasis and two, bronchomalacia.

This study suggests that children with a history of recurrent localized pneumonia and a normal or nearly normal perfusion scintigram can be clinically followed without the use of invasive procedures such as bronchoscopy or bronchography. Patients with lobar or multisegmental perfusion defects require further investigations.

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