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Lobar Pneumonia with Bronchial Narrowing: A Typical Sign of Primary Tuberculosis in Children

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Abstract
Purpose of Review Community-acquired pneumonia is most prevalent in children with less than 5 years of age, and this age group is also at the highest risk for pulmonary tuberculosis.
Objective Our objective is to describe bronchial narrowing in chest X-rays, with patients with image of pneumonia, as a typical radiographic sign of primary tuberculosis in children.
Materials and Methods Chest radiographic findings of nine patients (five boys and four girls; age range 9–30 months; mean age 17.6 months) treated for community-acquired pneumonia with no clinical improvement were studied retrospectively.
Recent Finding Chest radiographs, in all cases, showed lobar pneumonia with bronchial narrowing. Bronchial narrowing was found either in the main right or left bronchi and was ipsilateral to the lobar consolidation in all cases. Positive tests or epidemiology for tuberculosis was obtained, and patient was treated for tuberculosis with improvement. At the end of treatment, follow-up radiographs were normal, including resolution of bronchial narrowing.
Summary In the setting of community-acquired pneumonia in children under 3 years of age with no clinical improvement after empiric treatment, a chest radiograph showing bronchial narrowing should raise suspicion for a tuberculosis etiology and elicit change to both diagnostic and therapeutic management.

Keywords Lobar pneumonia · Pulmonary tuberculosis · Chest radiograph · Bronchial narrowing

Introduction

Community-acquired pneumonia (CAP) is the leading cause of childhood morbidity and mortality in developing as well as in developed countries. The disease is most prevalent in children younger than 5 years of age [1•, 2]. The diagnosis of pneumonia is based primarily on an algorithm built on the patient's history, clinical signs and symptoms, laboratory tests, and chest radiograph findings. As a practical matter, however, the cause of pneumonia can usually be surmised on the basis of clinical and epidemiologic data, findings on chest radiograph, and a few laboratory tests [1•].

The most common causes of CAP in otherwise healthy children are viruses, including respiratory syncytial virus, influenza A or B, parainfluenza viruses 1, 2, and 3, adenovirus, rhinovirus, and the measles virus; *Mycoplasma pneumoniae*; *Chlamydia* (*trachomatis* and *pneumoniae*); and bacteria, such as *Streptococcus pneumoniae*, *Mycobacterium tuberculosis*, *Staphylococcus aureus*, *Haemophilus influenza*e type b and nontypable *H. influenzae* [1•].

Determining the cause of an individual case may be difficult [3]. Blood cultures are not routinely performed and have little value in areas where antibiotic use prior to the search of proper medical care is common. The lung itself is rarely sampled directly, and sputum representing lower-airway secretions can rarely be obtained from children [4].

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Although it is difficult to determine the accuracy of such nonmicrobiologic diagnostic approaches because of the lack of an etiologic gold standard, there have been many attempts to correlate them with microbiologic causes [1•].

Currently, chest radiograph is the most common investigation modality used to diagnose pneumonia. Some findings are thought to be strongly associated with bacterial pneumonia, like the typical appearance of severe lobar consolidation, while others are more often associated with viral infections or asthma, like mild interstitial and perihilar changes [5, 6]. In pediatric practice, it seems acceptable to consider a febrile child as having bacterial pneumonia if the clinical picture is associated with lobar or segmental consolidation on the chest radiograph [4].

Community-acquired pneumonia is most prevalent in children with less than 5 years of age [1•, 2], and this age group is also at the highest risk for pulmonary tuberculosis [7••]. Given the difficulties of clinical diagnosis in pneumonia, empiric antibiotic treatment often is used. Inherent to the use of empiric therapy is the assumption that a favorable clinical response indicates both that pneumonia is present and that the empiric treatment is adequate [8]. Patients with no resolving or slowly resolving CAP are at risk for increased morbidity and mortality [9].

In the setting of no resolving pneumonia, the differential diagnosis includes noninfectious causes as well as a variety of atypical infectious agents, specifically, mycobacterial and fungal agents, which have overlapping but distinctive clinical and radiographic presentations [10••].

Most cases of tuberculosis resembling pneumonia in children are related to primary infection [11–14].

We will present nine cases of patients with lobar tuberculosis pneumonia and bronchial narrowing in chest radiographs. The objective of this study is to describe this finding as a typical radiographic sign of primary tuberculosis in children. We review the literature to explain the relationship between the typical presentation of primary pulmonary tuberculosis in children and the presence of bronchial narrowing, which is observed in all reported cases.

Materials and methods

We retrospectively reviewed chest radiographs of nine children who had been treated for CAP and in whom clinical improvement did not occur. Moreover, all of these patients were subsequently diagnosed with tuberculosis pneumonia.

Initial chest radiographs were available for all patients and no changes in the appearance of the lobar pneumonia itself were noted after treatment with regular antibiotics, until the specific treatment for *M. tuberculosis* was instituted. Follow-up chest radiographs were also available for all patients. The radiographic follow-up was not uniform in all cases, and the mean follow-up time span was 6 months (range 4 months–1 year). The last examination showed normal appearance of the lungs, without scarring, in all nine patients.

The diagnosis of tuberculosis was established by positive culture (staining of sputum or gastric aspirates for acid-fast bacilli in four patients); positive results of polymerase chain reaction for *M. tuberculosis* in two patients and the other three patients, as the six mentioned previously, presented more than two of the following three criteria [12]: tuberculin skin test (Mantoux test) with five tuberculin units of purified protein derivative that resulted in an area of induration of 10 mm or greater; ruling out other causes of disease and finding that subsequent clinical course of the disease was consistent with tuberculosis (clinical or radiologic improvement from antituberculous medications); discovery of at least one family member with contagious tuberculosis.

The study group included five boys and four girls ranging in age from 9 months to 2.5 years (mean age, 17.6 months). None of the children were immunocompromised, and none were HIV positive. All patients were vaccinated with BCG (*bacille Calmette-Guérin*) at the age of 4 weeks. Physical examination of the BCG site and the regional lymph nodes revealed no abnormalities. Symptoms of the patients were fever, cough, and secretion.

The median duration of symptoms before the diagnosis of tuberculosis and start of antituberculous medication was 45 days (range, 30–70 days).

In the chest radiographs, particular attention was given to the pattern of pulmonary parenchymal lesions (consolidation, with or without cavities, and focal or multifocal disease); bronchial narrowing; and lymph nodes (hilar and mediastinal adenopathy): atelectasis and pleural effusion. Consolidation was classified as involving the upper or lower lung zone; multi-focal consolidation if both upper and lower lung zones were involved, in the same lung.

Results

Chest radiographs, in all cases, showed lobar pneumonia with bronchial narrowing. Air-space consolidation was more common in the upper lung zones (78%) and no significant difference between right (44%) and left (56%) side involvement was noted. All lesions were focal. No multifocal lesions were found. No pleural effusions were found.

Mediastinal bulging, suggesting mediastinal or hilar lymphadenopathy, was difficult to identify due to the lung involvement.

Bronchial narrowing was found either in the main right or left bronchi and was ipsilateral to the lobar consolidation in all cases (Figs. 1, 2, 3, 4). Parenchymal scarring, characterized by one or more areas of persistent linear opacities, bronchial stenosis, and both parenchymal and nodal calcifications were not observed at the end of follow-up.

Discussion

Mycobacterium tuberculosis is a strictly aerobic, acid-fast, Gram-positive bacillus [15], transmitted via airborne droplet nuclei, laden with a few organisms, and produced when persons with pulmonary or laryngeal TB cough, sneeze, or speak [16]. These particles, being 1–5 μm in diameter, can remain airborne for long periods of time [17], and infection occurs when a susceptible person inhales those droplet nuclei, which in turn deposit most commonly in the middle and lower lobes of the lung [18]. Most pulmonary tuberculosis cases seen in infants are primary tuberculosis. Infection with tubercle bacilli does not usually result in disease but in a minority of individuals disease follows some weeks or months after primary infection.

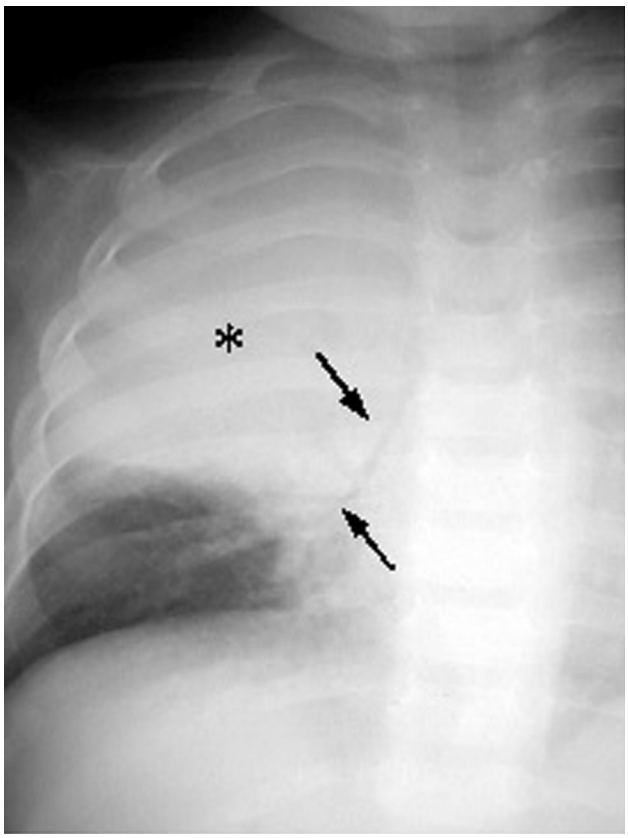

Fig. 1 Chest radiograph of a 9-month-old boy with pulmonary tuberculosis shows consolidation in the right upper lung zone (*asterisk*) and bronchial narrowing of right main bronchus (*arrows*)

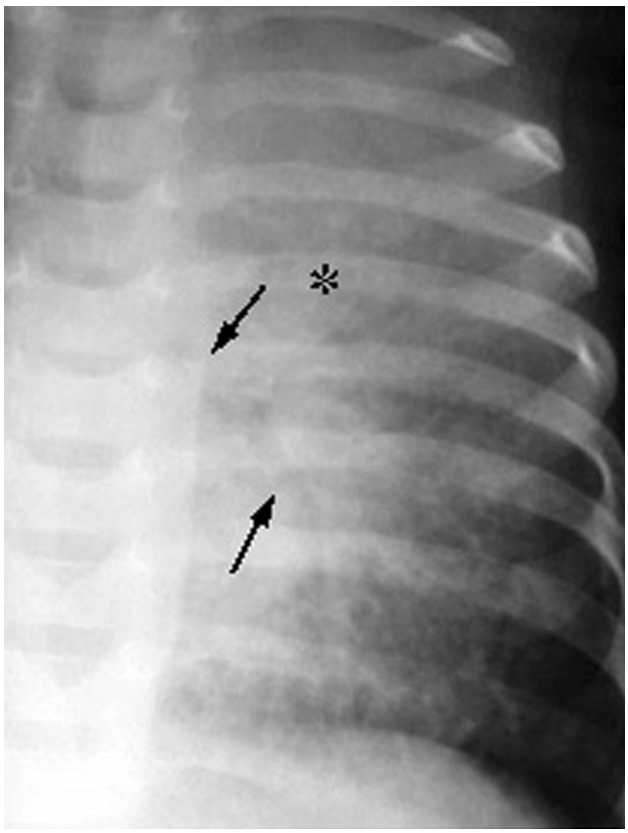

Fig. 2 Chest radiograph of a 15-month-old girl with pulmonary tuberculosis. Close-up of the left chest showing consolidation in the left upper lung (*asterisk*) and bronchial narrowing (*arrows*)

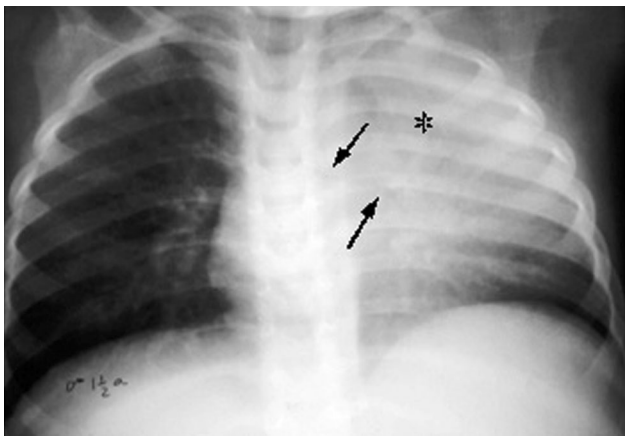

Fig. 3 Chest radiograph of a 18-month-old boy with pulmonary tuberculosis shows consolidation in the left upper lung zone (*asterisk*) and bronchial narrowing of the left main bronchus (*arrows*)

The primary infection begins with deposition of infected droplets in the lung alveoli, followed by parenchymal inflammation [14, 19]. The initial inflammation produces localized alveolar consolidation, which is the primary focus, also called a Ghon focus. This may, although rarely, progress to involve a segment or an entire lobe [15, 19].

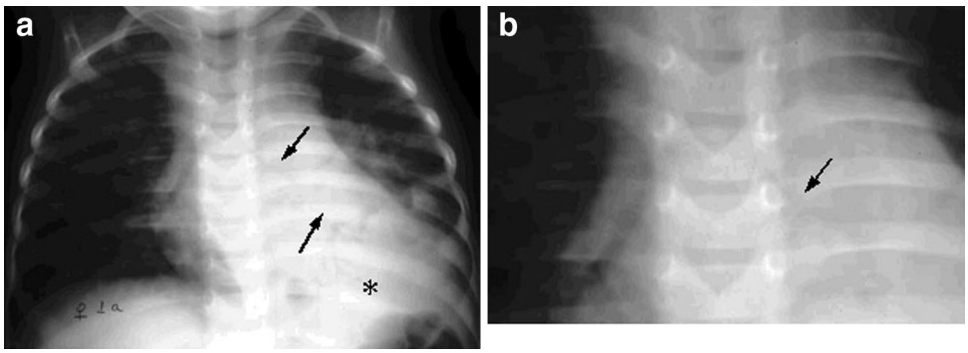

Fig. 4 **a** Chest radiograph of a 12-month-old girl with pulmonary tuberculosis shows consolidation in the left lower lobe (*asterisk*) and bronchial narrowing of the left main bronchus (*arrows*). **b** Close-up of the involved bronchus (*arrow*)

Infection then spreads to the central lymph nodes from the primary focus via draining lymphatic vessels (appearing as a linear interstitial pattern on chest radiographs) and results in regional lymphadenopathy. Together, the primary focus and the enlarged or calcified lymph nodes that drain it are called the Ranke complex [13, 15, 19, 20]. In most cases, the mild parenchymal lesions and lymphadenopathy resolve spontaneously. In some cases, however, especially in young infants, the parenchymal lesion may progress to a lobar pneumonia and the involved lymph nodes continue to enlarge [14]. The parenchymal lesion is most often homogeneous, ill-defined, and may involve an entire lobe [21].

Bronchial narrowing may occur because of extrinsic compression, intrinsic narrowing secondary to thickening of the bronchi, or endoluminal material filling the bronchi [22, 23].

Bronchial narrowing was reported by Kim et al. [7••] in 16% of infants on chest radiograph and 65% on CT scans. This airway complication was more common than in childhood tuberculosis, reported as 24% on chest radiograph and 37% on CT scans [24]. CT scans detect airway complications better than chest radiographs [25•], especially distal to the lobar bronchus. However, CT scans are not always performed and it is only indicated to evaluate unusual findings on radiographs, to find or confirm lymphadenopathy, and to detect or evaluate complications [7]. Chest radiograph is the initial image modality used in investigation of pneumonia, including tuberculosis.

There are no reports describing bronchial narrowing in the setting of community-acquired pneumonia. This is supported by the fact that lymphadenopathy determining extrinsic airway compression does not usually occur with the usual pathogens involved in these infections. Chest radiographs, on the other hand, are widely used to help differentiate bacterial from viral infections in order to determine if an antibiotic treatment regimen will be established. The use of empiric antibiotic therapy is based on the frequency of CAP agents at given age groups, and clinical observation is more often than not the most widely used parameter for confirming treatment adequacy. Management of nonresponding patients requires reevaluation of epidemiologic data, a complete microbiologic investigation, with conventional and sometimes invasive respiratory samples, and performance of a new radiographic study [26]. No microbiologic approaches, such as a chest radiograph, are usually not accurate in determining the nature of the infection.

Therefore, the existence of a single, well-established radiological sign with adequate statistical power to suggest a specific etiology, in this case tuberculosis, for CAP in children would be invaluable. We noticed that bronchial narrowing, especially when observed in children younger than 3 years, is a sign highly associated with infection by *M. tuberculosis* and could hence be used to guide therapy or at least specific diagnostic pathogen-seeking measures. Early diagnosis and prompt treatment are of utmost importance for children with tuberculosis, since infants and younger children are at high risk of severe and life-threatening complications such as tuberculous meningitis or miliary tuberculosis.

Conclusion

In summary, in the setting of CAP in children, especially in those under 3 years of age and in whom clinical improvement after empiric treatment is not observed, a chest radiograph showing bronchial narrowing should raise suspicion for a tuberculosis etiology and elicit change to both diagnostic and therapeutic management.

Compliance with Ethical Guidelines

Conflict of interest Rodrigo Regacini and Jose Luiz Schiavon each declare no potential conflicts of interest. Henrique M. Lederman is a section editor for *Current Radiology Reports*.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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