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Tracheobronchial Foreign Bodies in Children: Imaging Assessment

Shilpa V. Hegde, MD,* Peter K.T. Hui, MBBS, FRCR,† and Edward Y. Lee, MD, MPH‡,§

Tracheobronchial foreign-body aspiration is a relatively frequent pediatric emergency and a cause of substantial morbidity and mortality especially in preschool children. Although foreign-body aspiration may cause sudden airway obstruction and subsequent death, quite often symptoms are mild and nonspecific; therefore, the correct diagnosis may be delayed particularly in the pediatric population. A delay in diagnosis increases the rate of complications and can cause substantial morbidity. Early and accurate diagnosis combined with intervention through foreign-body retrieval is critical for proper patient management. For evaluation of both radiopaque and non-radiopaque airway foreign bodies in pediatric patients, imaging plays an important role in initial detection and follow-up evaluation. In this article, we discuss the currently available imaging modalities and techniques for evaluating tracheobronchial foreign bodies in infants and children. Imaging findings of various tracheobronchial foreign bodies and mimics of foreign bodies are also discussed. In addition, information regarding management of tracheobronchial foreign-body aspiration is included.
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Introduction

Foreign-body aspiration is a common pediatric emergency and is the sixth most common cause of accidental deaths in children.[1] More than 300 deaths occur in the United Sates per year as a result of foreign-body aspiration.[2] Majority of cases occur in preschool children with a peak incidence in second year.[1] Young children, owing to their poor chewing ability, are prone to aspiration while eating, crying, or playing.[1] Symptoms of foreign-body aspiration are related to size, shape, and nature of foreign body. An organic foreign body causes more airway inflammation, whereas an inorganic foreign body may go undetected for a long time.[1] Radiopaque foreign bodies are more easily diagnosed on imaging studies, whereas non-radiopaque foreign bodies may not be suspected owing to nonspecific symptoms. A large foreign body may cause complete airway obstruction and sudden subsequent death. A sharp object may cause direct injury to the airway. However, in most cases, the symptoms of tracheobronchial foreign-body aspiration are nonspecific and constitute cough, wheeze, dyspnea, fever, and pneumonia.[1] For evaluation of both radiopaque and non-radiopaque airway foreign bodies in pediatric patients, imaging plays an important role in initial detection and follow-up evaluation. This article describes the currently available imaging modalities and techniques as well as imaging findings of tracheobronchial foreign-body aspiration in the pediatric population. The differential diagnostic considerations and mimickers of tracheobronchial foreign bodies in pediatric patients are also reviewed. Additionally, management of tracheobronchial foreign-body aspiration is discussed.

Imaging Techniques

Currently, the 3 most commonly used imaging modalities for assessing tracheobronchial foreign-body aspiration in children are plain radiographs, airway fluoroscopy, and computed tomography (CT). The current role and imaging technique of these modalities are briefly reviewed and addressed in the following section.

*Department of Radiology, University of Arkansas for Medical Sciences, Little Rock, AR.
†Department of Radiology, Queen Mary Hospital, Hong Kong SAR, China.
‡Department of Radiology, Boston Children's Hospital and Harvard Medical School, Boston, MA.
§Department of Medicine, Boston Children's Hospital and Harvard Medical School, Boston, MA.
Address reprint requests to Edward Y. Lee, MD, MPH, Division of Thoracic Imaging, Boston Children's Hospital and Harvard Medical School, 300 Longwood Ave, Boston, MA 02115. E-mail: Edward.Lee@Childrens.Harvard.Edu

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Plain Radiographs

Plain radiographs are usually the first line of imaging study in a child who presents with respiratory distress including suspected tracheobronchial foreign-body aspiration. Plain radiographs are frequently used as the first-line imaging modality, because they are relatively inexpensive and widely available. Radiographs are very sensitive in directly showing radiopaque foreign bodies (Fig. 1). However, 90% of foreign bodies are non-radiopaque and the indirect signs of air trapping, atelectasis, and consolidation are not always present in these cases.[3] Hence a normal appearing radiograph does not exclude a foreign body. Up to 80% of children with laryngotracheal foreign bodies and 30%-50% of children with bronchial foreign bodies have been reported with a normal chest radiograph.[4] Although frontal and lateral views are the most commonly recommended views in the setting of evaluating children suspected of having tracheobronchial foreign-body aspiration, additional views such as decubitus views that can demonstrate air trapping may be also obtained in selected equivocal cases and in noncooperative young children ($\leq$5 years old)[5] (Fig. 2). In cooperative older pediatric patients (>5 years old), end inspiratory and end expiratory radiographs can be performed (Fig. 3). The technical parameters for chest radiographs in children are summarized in Tables 1 and 2.

Though air trapping was suggested in 77% of the expiratory radiographs in one series of pediatric patients with airway foreign-body aspiration, other studies have questioned their usefulness.[4,6] In a recent study of 328 pediatric patients with suspected foreign-body aspiration, the addition of expiratory radiograph was found to increase the number of true positives; however, the accuracy was low and the clinical benefit of the expiratory radiographs remains unclear.[6] The same study also reported that the decubitus radiographs increased the false positive rate and had no clear clinical benefit.[6]

Airway Fluoroscopy

Traditionally, this technique was used to demonstrate mediastinal shift or decreased excursion of the diaphragm in cases of air trapping owing to foreign-body aspiration in the absence of findings on the chest radiograph in noncooperative young pediatric patients with high clinical suspicion of having tracheobronchial foreign-body aspiration. However, this operator-dependent technique now has a limited role because of the wide availability and recent advances in CT, although it can still be valuable in areas where CT is not readily available.[7]

With the child in the supine position on the fluoroscopic table, the lower extremities and upper extremities are stabilized by the radiologist who is performing the procedure or trainees, technologists, or nurses who are assisting the radiologist. After adjusting the fluoroscopic field that covers both hemithoraces sufficiently, the chest is then carefully observed fluoroscopically during quiet and deep breathing (or crying) in real time to detect abnormal side-to-side shifting of the mediastinum or decreased excursion of the diaphragm produced by the imbalance of air flow between the 2 hemithoraces because of the presence of the foreign body.

Computed Tomography

There has been an increase in the use of CT in investigating large airway abnormalities in children. Though CT is fast to perform and easily available, the associated radiation risk should be carefully considered and its usage made judiciously. Direct demonstration of foreign body and indirect evidences

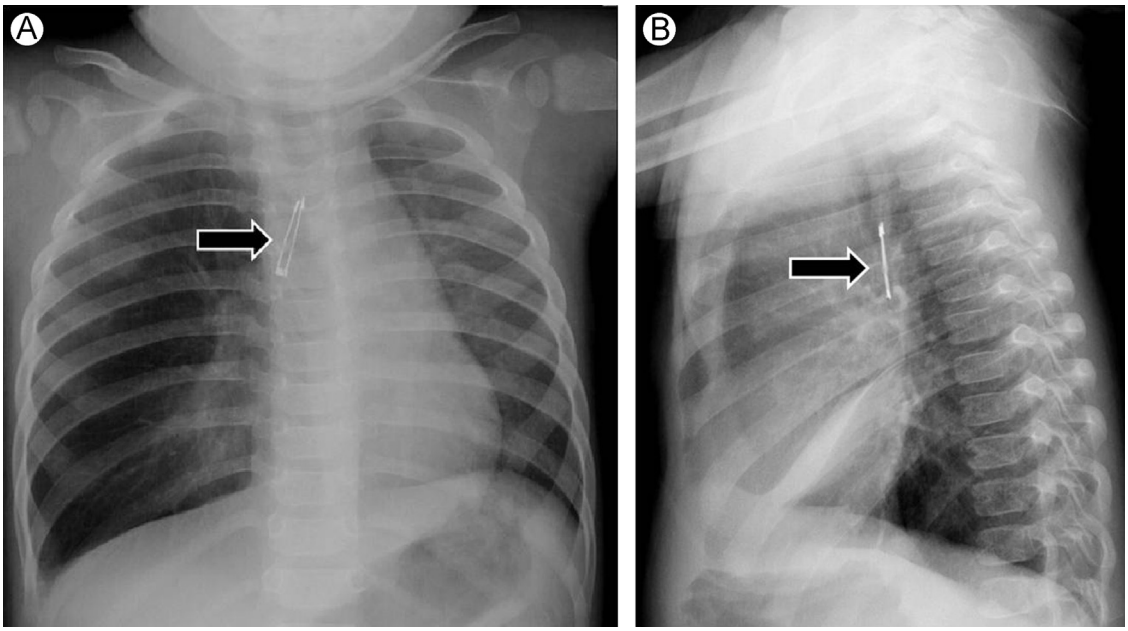

Figure 1 A 13-month-old girl who presented with persistent cough for 2 weeks with an aspirated metallic pin lodged in the right main stem bronchus. (A) A frontal chest radiograph shows a metallic pin (arrow) projecting over the right hilar region. (B) A lateral chest radiograph demonstrates a metallic pin (arrow) located in the right main stem bronchus. Case courtesy of Chan Hau Yee, MD, Department of Surgery, Queen Mary Hospital, 102 Pokfulam Road, Hong Kong SAR.