

PediatricsⁱⁿReview[®]

Pediatric Foreign Body Aspiration
Joshua D. Rovin and Bradley M. Rodgers
Pediatrics in Review 2000;21;86
DOI: 10.1542/pir.21-3-86

The online version of this article, along with updated information and services, is located on the World Wide Web at:
<http://pedsinreview.aappublications.org/content/21/3/86>

Pediatrics in Review is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1979. Pediatrics in Review is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2000 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0191-9601.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



Pediatric Foreign Body Aspiration

Joshua D. Rovin, MD,* and Bradley M. Rodgers, MD†

OBJECTIVES

After completing this article, readers should be able to:

1. Delineate the signs and symptoms of foreign body aspiration.
2. Explain the process of evaluating for suspected foreign body aspiration.
3. Describe the possible radiographic manifestations of foreign body aspiration.
4. Explain the management of foreign body aspiration in children.
5. Delineate the potential late complications of foreign body aspiration.

Epidemiology

Aspiration of foreign bodies by children can lead to serious illness and sometimes even death. According to National Safety Council statistics, in 1995, mechanical suffocation accounted for 5% (167) of all unintentional deaths among children in the United States younger than 4 years of age. Most of these deaths occurred in children younger than 1 year of age (81 deaths, accounting for 10% of all unintentional deaths in children younger than 1 year of age). Fortunately, the number of deaths has decreased over the past decade, which has been attributed to better education of the public and stricter guidelines for toy manufacturers. Nevertheless, foreign body aspiration continues to account for a significant number of preventable childhood deaths.

Younger children are at the highest risk for accidental foreign body aspiration. This increased incidence has been attributed to several factors among younger children, including that they: 1) have the tendency to put small objects into their mouths; 2) often cry, shout, run, and play with objects in their mouths; and 3) do not have molars to chew certain foods adequately. Most studies show that fewer than 15% of foreign body aspirations occur among children older than 5 years of age. Boys comprise more than 50% of all cases of foreign body aspiration. By

far, the objects aspirated most frequently are organic or food matter. In North America, peanuts are most common (Table 1).

Unlike aspiration in adults, there is only a slight propensity for objects to lodge on the right side in children. Some studies even demonstrate a higher incidence of foreign bodies on the left side. This observation may be explained by children having symmetric bronchial angles until about 15 years of age. It is not until that age that the aortic knob fully develops, displacing the left mainstem bronchus and creating a more obtuse angle at the carina.

Diagnosis

The most important piece of data for a clinician to have when evaluating a child who possibly has aspirated a foreign body is an accurate history provided by a witness to the event. Unfortunately, a reliable witness is not always available. Even with a good history for aspiration provided by a witness, children sometimes are asymptomatic at presentation. Therefore, it is important to evaluate the child who presents with a reliable history of aspiration thoroughly, even in the absence of physical findings.

The classic history can include an acute choking episode followed by coughing, wheezing, and even stridor. A history of one or more of these symptoms is present in greater than 90% of children who aspirate foreign bodies. Often temporary perioral cyanosis can follow these initial symptoms. A fever may be present. If the child has been febrile,

it is important to consider the possibility that the object may be contaminated or chemically irritating. Alternatively, the aspiration may have occurred weeks or even months earlier, causing the child to develop an obstructive pneumonia or lung abscess. It is important to entertain the diagnosis of chronic foreign body aspiration in children who present with unexplained recurrent pneumonia or lung abscesses.

Physical findings include cough, tachypnea, diminished breath sounds, wheezing, stridor, dyspnea, cyanosis, and suprasternal retractions. However, the absence of any of these findings does not preclude the possibility of foreign body aspiration. Absence of breath sounds on auscultation of the chest occurs in 30% to 60% of affected children and is suggestive of total airway obstruction. However, the presence of normal bilateral breath sounds does not exclude the diagnosis. Some authors have advocated use of the two-headed stethoscope to help in assessing breath sounds. Although this device can assist in making the diagnosis, it never should be used to exclude the diagnosis of foreign body aspiration. As stated earlier, if there is a reliable history for aspira-

TABLE 1. Commonly Aspirated Foreign Bodies

Organic

- Food
 - Peanuts
 - Popcorn
 - Seeds
 - Hot dogs
 - Vegetable matter
- Nonfood
 - Bones

Inorganic

- Toy parts
- Crayons
- Pen tops
- Tacks
- Pins
- Nails
- Screws
- Bullets and casings

*Division of Pediatric Surgery, Children's Medical Center, University of Virginia Health Sciences Center, Charlottesville, VA.

†Editorial Board.

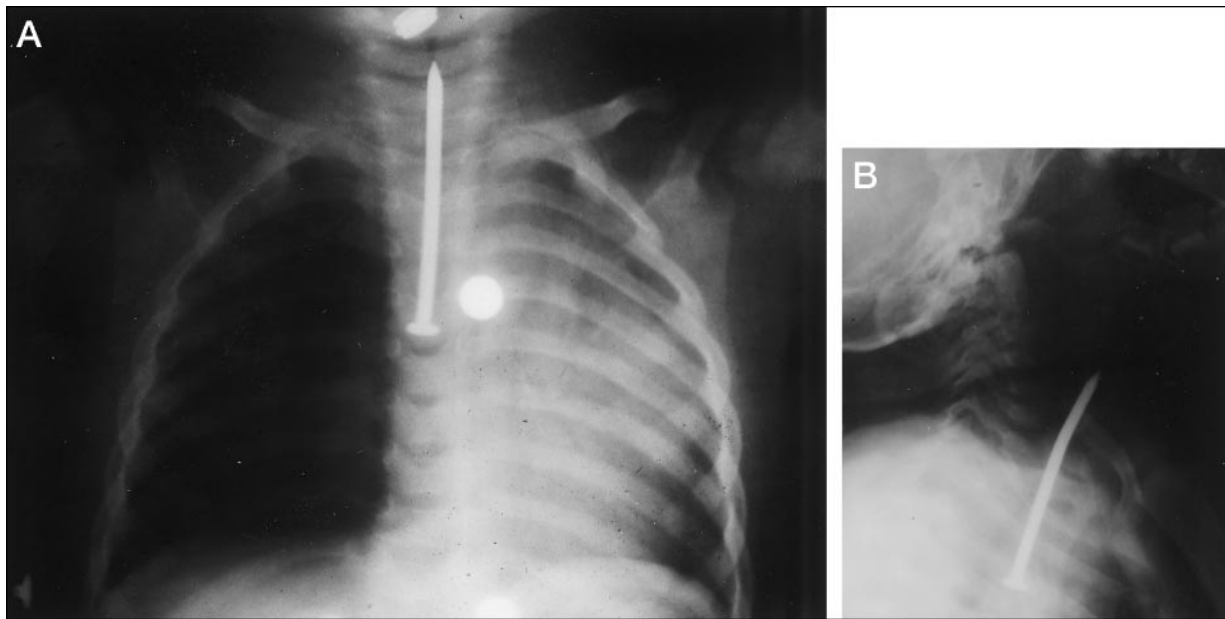


FIGURE 1. Anteroposterior (A) and lateral (B) radiographs demonstrating a radiopaque tracheal foreign body. This ten penny nail, extending from the larynx to the carina, was removed successfully under general anesthesia with a laryngoscope.

tion, the child should be evaluated further.

Most foreign bodies aspirated by children are radiolucent. Therefore, radiographs primarily are useful for detecting only the indirect signs of foreign body aspiration, such as air trapping or atelectasis. Common radiographic findings are listed in Table 2. Routine diagnostic imaging consists of anteroposterior and lateral chest radiographs (Fig. 1). It is important to include the entire neck in these studies or specific neck radiographs should be obtained. The use of inspiratory and expiratory anteroposterior chest radiographs often will help lateralize the foreign body by emphasizing air trapping (Fig. 2). Left and right lateral decubitus films can be helpful in infants and younger children who cannot cooperate with inspiratory and expiratory films. The side with the foreign body usually will not deflate when placed in the dependent position.

Fluoroscopy has been advocated as a more sensitive modality to evaluate movement of the mediastinum and diaphragms. Mu and colleagues (see Suggested Reading) reviewed 343 cases that were evaluated with fluoroscopy, plain chest radiography, or both prior to bronchoscopic removal of the foreign body. Positive radiographic findings were seen

in 213 (62%) of the cases. The most common findings were obstructive emphysema (62%), mediastinal shift (55%), pneumonia (26%), atelectasis (18%), and radiopaque objects (3%). The authors noted that 56% of the chest radiographs obtained within 24 hours of the aspiration appeared normal. In contrast, only 33% of the chest radiographs were normal if more than 24 hours had passed since the aspiration.

Most studies report normal radiographic findings in 10% to 30% of children who have documented foreign body aspiration. As many as 50% of those who have foreign bodies in the trachea can have normal findings on radiography. Therefore,

the presence of normal findings on chest radiography should not exclude the diagnosis of aspiration. Other diagnostic imaging modalities, such as computed tomography, magnetic resonance imaging, and ventilation perfusion scans have a limited role in the diagnosis of foreign body aspiration.

Management

Acute management usually occurs before the child arrives in the hospital. Most children manifest forceful coughing as a reflex to clear the airway. As long as the child is able to cough, cry, or speak, no further immediate measures should be undertaken. Complete occlusion of the airway presents as the inability to make sounds or exchange air and requires immediate action. The current American Academy of Pediatrics guidelines for a choking infant and child suggest that, unlike the treatment for adults, the clinician should *not* perform a blind oropharyngeal finger sweep in children. Only if the object can be seen in the posterior pharynx should an attempt be made to remove it. For children younger than 1 year of age, back slaps and chest thrusts with the infant in a head-down position are the treatment of choice. For children older than 1 year, abdominal thrusts

TABLE 2. Radiographic Findings of Aspirated Foreign Bodies

- Normal findings
- Air trapping
- Mediastinal shift
- Atelectasis
- Pneumonia
- Lobar collapse
- Consolidation
- Radiopaque foreign body

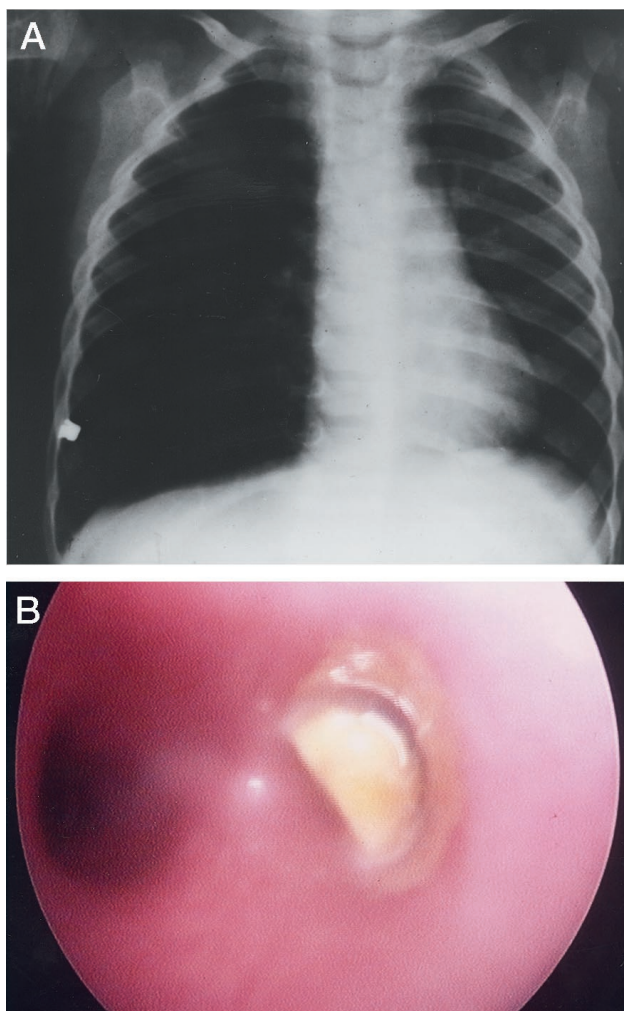


FIGURE 2. A. Frontal radiograph of a 2-year-old boy who experienced a sudden onset of coughing. Air trapping in the right hemithorax is evident, with shift of the mediastinum to the left. B. Rigid bronchoscopy under general anesthesia revealed a peanut lodged in the right mainstem bronchus, which was removed successfully with a peanut grasper.

(Heimlich maneuver) are recommended. These maneuvers are designed to force the diaphragm upward, which generates increased intrathoracic pressure and results in increased intratracheal pressure that expels the foreign body. Unfortunately, these techniques are not without complication. However, it is believed that with proper application (brought about through public education), these techniques can save many more children than can be injured.

Before the advent of bronchoscopy in the early 1900s, the mortality rate for foreign body aspiration approached 50%. Today, successful treatment with bronchoscopy has reduced this to less than 1%.

Improvements in surgical techniques, instruments, and modern anesthesia have allowed bronchoscopy to be effective in greater than 95% of the patients, with a complication rate of less than 1%. In 2000, the standard of care for children who have aspirated foreign bodies is extraction by rigid bronchoscopy, performed under general anesthesia. Once the decision has been made to evaluate the child via bronchoscopy, he or she should be taken to the operating room quickly. Coordination with a skilled pediatric anesthesiologist is critical to the success of the procedure. It is important not to use positive pressure ventilation, which could wedge the foreign body further into the airway or cause pulmonary hyperexpansion. After inducing general anesthesia and obtaining intravenous access, the patient's head is placed into the "sniffing" position. The surgeon then can insert the rigid, open-channel bronchoscope through which high-resolution optical telescopes and instruments may be passed. Use of the rigid bronchoscope allows the patient to be ventilated throughout the procedure and provides a larger working area through which various instruments can be passed. We believe that there is no role for flexible bronchoscopy to remove foreign bodies from the airway. On the other hand, flexible

bronchoscopy occasionally can be useful for diagnostic purposes in patients who have more chronic symptoms. Following removal of the aspirated foreign body, patients are admitted for observation, aggressive pulmonary toilet, and possible antibiotic and bronchodilator treatment. Most children are discharged within 24 hours of the procedure.

Rarely, some foreign bodies cannot be removed by bronchoscopy. In these instances, open thoracotomy is required. Such cases usually necessitate a bronchotomy to remove the object or resection of the lung parenchyma along with the foreign body.

It should be mentioned that there is *no role* for "inhalation and postural drainage," a technique of postural drainage, percussion, and isoproterenol inhalation that was introduced in the early 1970s by Burrington and Cotton. This technique was fraught with complications, including airway obstruction and cardiac arrest. Subsequent to publication of the original articles, several retraction articles were published advocating the use of rigid bronchoscopy as the treatment of choice for airway foreign bodies.

Complications from airway foreign bodies are related directly to the timeliness of the diagnosis and treatment. If sudden complete airway obstruction occurs and the child does not receive immediate medical attention, cardiac arrest and death will follow shortly. However, the foreign body usually does not obstruct the airway completely; rather, it lodges in one or the other mainstem bronchus or a distal bronchus.

The most common complication associated with foreign body aspiration is pulmonary infection, the pathogenesis of which is related to either partial or complete obstruction of the airway that results in retained secretions and subsequent bacterial overgrowth. There are many cases in the literature of children who have been treated for recurrent pneumonia or lung abscess for many months before the correct diagnosis of airway foreign body was entertained.

Complications

The most common complication associated with foreign body aspiration is pulmonary infection, the pathogenesis of which is related to either partial or complete obstruction of the airway that results in retained secretions and subsequent bacterial overgrowth. There are many cases in the literature of children who have been treated for recurrent pneumonia or lung abscess for many months before the correct diagnosis of airway foreign body was entertained.

Therefore, it is important to consider the diagnosis of foreign body aspiration in all children who have unexplainable pulmonary pathology, such as persistent lung infections, bronchiectasis, or new-onset asthmatic symptoms. In these instances, the use of flexible bronchoscopy may aid in the diagnosis. Acute expansion of a lung caused by a ball-valve foreign body may lead to respiratory symptoms or pneumothorax. Less common complications of chronic aspiration of a foreign body include perforation of the bronchial tree and fistula formation. In a recent multicenter study, Reilly and colleagues (see Suggested Reading) retrospectively reviewed the charts of 507 children evaluated for foreign body aspiration. The most common complications among children in whom the diagnosis was delayed were croup, pneumonia, pneumothorax, atelectasis, stricture, and perforation.

In an attempt to reduce these preventable complications associated with delayed diagnosis, many advocate the aggressive use of bronchoscopy in children in whom foreign body aspiration is suspected. Mantor and colleagues (see Suggested Reading) retrospectively evaluated the diagnosis and treatment of 76 patients in whom foreign body aspiration was suspected during the 1980s. Nine of the 76 patients had a delay in diagnosis prior to arrival at the institution and required longer hospital stays due to complications resulting from the retained foreign body. No foreign body was found in 9% of the 73 patients who underwent rigid bronchoscopy. There was no morbidity or mortality associated with the procedure. These authors concluded that a negative bronchoscopy rate of 10% to 15% appears to be acceptable to prevent the morbidity associated with the missed diagnosis of foreign body aspiration.

Prevention

As long as children have mouths and their world contains objects that fit into those mouths, foreign body aspiration will occur. The only way to reduce the number of associated deaths is through public education and legislation. As discussed previously, many of the objects commonly aspirated are foods, such as peanuts. Therefore, parents and caretakers should be educated by clinicians to withhold such foods until the child is old enough to chew them adequately. Additionally, they should be reminded to keep small objects such as pins and tacks out of their child's reach.

Further attempts to prevent aspiration injuries during childhood have been stimulated by federal regulations, led by the Consumer Products Safety Commission. The Small Parts Test Fixture, a federally mandated test to screen toy parts for potential ingestion by children younger than 3 years of age, is an example of recent legislation attempting to reduce aspiration injuries. This law defines specific dimensions of objects that pose potential aspiration risks. It requires that toy manufacturers clearly label their products when they contain small parts that may be aspirated. Only through such legislation and public education can aspiration injuries and deaths be prevented.

Summary

Foreign body aspiration accounts for a significant number of preventable childhood deaths each year in the United States. Fortunately, the number of deaths has declined over the past decade, but morbidity remains significant. This decrease has been attributed to better education of the public and stricter guidelines for toy manufacturers. Primary care physicians must help to educate parents

of small children about the potential for foreign body aspiration and ways to prevent it.

SUGGESTED READING

- American Academy of Pediatrics Committee on Pediatric Emergency Medicine. First aid for the choking child. *Pediatrics*. 1993; 92:477-479
- Black RE, Johnson DG, Matlak ME. Bronchoscopic removal of aspirated foreign bodies in children. *J Pediatr Surg*. 1994; 29:682-684
- Burton EM, Brick WG, Hall WD, Riggs W, Houston CS. Tracheobronchial foreign body aspiration in children. *South Med J*. 1996;89:195-198
- Cataneo AJM, Reibschied SM, Ruiz RL, Ferrari GF. Foreign body in the tracheobronchial tree. *Clin Pediatr*. 1997;36:701-706
- Causey AL, Talton DS, Miller RC, Warren ET. Aspirated safety pin requiring thoracotomy: report of a case and review of the literature. *Pediatr Emerg Care*. 1997;13: 397-400
- Deskin R, Young G, Hoffman R. Management of pediatric foreign bodies. *Laryngoscope*. 1997;107:540-543
- Johnson DG, Condon VR. Foreign bodies in the pediatric patient. *Curr Probl Surg*. 1998;34:271-278
- Kosloske AM. Tracheobronchial foreign bodies in children: back to the bronchoscope and balloon. *Pediatrics*. 1980;66:321-323
- Mantor PC, Tuggle DW, Tunnell WP. An appropriate negative bronchoscopy rate in suspected foreign body aspiration. *Am J Surg*. 1989;158:622-624
- Mu L, HE P, Sun D. Inhalation of foreign bodies in Chinese children: a review of 400 cases. *Laryngoscope*. 1991;101: 657-660
- National Safety Council. *Accident Facts*. Itasca, Ill: National Safety Council; 1998: 10-32
- Reilly J, Thompson J, MacArthur C, et al. Pediatric aerodigestive foreign body injuries are complications related to timeliness of diagnosis. *Laryngoscope*. 1997;107: 17-20
- Steen KH, Zimmerman T. Tracheobronchial aspiration of foreign bodies in children: a study of 94 cases. *Laryngoscope*. 1990;100:525-530

PIR QUIZ

Quiz also available online at www.pedsinreview.org.

9. Which of the following statements regarding foreign body aspiration in children is *true*?
- A. Boys aspirate foreign bodies more frequently than do girls.
 - B. In most cases, a history of choking can be elicited.
 - C. Most cases of aspiration occur in children older than the age of 5 years.
 - D. Plastic toys are the most commonly aspirated objects.
 - E. The incidence of aspiration is higher down the right mainstem bronchus than the left.
10. A 2-year-old child is brought to your office with a history of choking after playing with her brother. She is in mild respiratory distress. You suspect foreign body aspiration. If you are correct, which of the following would you be *least* likely to see on a chest radiograph?
- A. A mediastinal shift.
 - B. A radiopaque object.
 - C. Air trapping.
 - D. Atelectasis.
 - E. Normal findings.
11. You are working in the emergency department one night when a worried mother brings in her 11-month-old son with a complaint of acute onset of "breathing hard." There is no history of choking. He is in moderate respiratory distress with nasal flaring and subcostal retractions. There is no stridor, but bilateral faint wheezes are present. Air movement is fair, and oxygen saturation is 96% on room air. Administration of albuterol by inhalation provides minimal relief. Your *next* step would be to:
- A. Continue albuterol and add oral steroids.
 - B. Obtain chest radiography with bilateral decubitus views.
 - C. Obtain inspiratory and expiratory films.
 - D. Place the patient on 2 L of oxygen and admit him for observation.
 - E. Take the patient to the operating room for immediate bronchoscopy.
12. Which of the following treatments has been shown to be *most* effective in reducing morbidity and mortality associated with foreign body aspiration?
- A. Immediate flexible bronchoscopy followed by antibiotic therapy.
 - B. Inhalation and postural drainage.
 - C. Positive pressure ventilation.
 - D. Rapid administration of bronchodilators.
 - E. Timely use of rigid bronchoscopy followed by aggressive pulmonary toilet.
13. Which of the following is the *most* common complication of foreign body aspiration?
- A. Bronchial perforation.
 - B. Bronchial stricture.
 - C. Pneumothorax.
 - D. Pulmonary infection.
 - E. Reactive airway disease.

Pediatric Foreign Body Aspiration
Joshua D. Rovin and Bradley M. Rodgers
Pediatrics in Review 2000;21;86
DOI: 10.1542/pir.21-3-86

Updated Information & Services

including high resolution figures, can be found at:
<http://pedsinreview.aappublications.org/content/21/3/86>

References

This article cites 12 articles, 3 of which you can access for free at:

<http://pedsinreview.aappublications.org/content/21/3/86#BIBL>

Subspecialty Collections

This article, along with others on similar topics, appears in the following collection(s):

Ear, Nose and Throat Disorders

http://pedsinreview.aappublications.org/cgi/collection/ear_nose_throat_disorders

Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:

</site/misc/Permissions.xhtml>

Reprints

Information about ordering reprints can be found online:

</site/misc/reprints.xhtml>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

