

Foreign Bodies in the Aerodigestive Tract

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Aspirated and ingested foreign bodies continue to present challenges to otolaryngologists. The major issues involve obtaining an accurate diagnosis and speedy, safe retrieval of the foreign body. The accurate diagnosis may elude even the sophisticated physician because often the initial choking incidents are not witnessed and the delayed residual symptoms may mimic other common conditions, such as asthma, recurrent pneumonia, or upper respiratory infections. The retrieval of foreign bodies has been facilitated by technical improvements with the rod lens telescope, video endoscopy, a broad range of a variety of sized forceps and safer anesthesia. Otolaryngologists have always been in the forefront of the diagnosis and management of foreign body ingestion. In 1927, Dr. Chevalier Jackson was successful in lobbying for an increased awareness in handling and storing of certain products.¹ In spite of these advances, according to the National Safety Council, choking remained the fourth leading cause of unintentional injury death in the United States as of 2015.² In 2013, a total of 4,800 deaths (1.4 deaths per 100,000 population) from unintentional ingestion or inhalation of food or other objects resulting in airway obstruction was reported. The incidence rate was 0.6 deaths per 100,000 population aged 0-4 years or in other words, over 120 deaths. This chapter reviews the clinical presentation, diagnostic work-up, and appropriate management of foreign bodies in the aerodigestive tract.

FOREIGN BODIES IN THE AIRWAY

Clinical Presentation

Most commonly, foreign bodies are aspirated during the toddler years, ages 1 to 4. There is a bimodal age distribution, with a second peak between ages 10 and 11. Case series from the last decade reflect that children at age 1-3 years comprise the majority of patients (53.94%).^{3,4} The younger group, however, is most vulnerable because this population has a lack of adequate dentition and immature swallowing coordination. Young children chew their food incompletely with incisors before their molars erupt. Objects or fragments may be propelled posteriorly, triggering a reflex inhalation. Boys are affected more frequently than girls in a ratio of approximately 2:1⁵

Additionally, these children explore their world by introducing objects into their mouths. Because these children are ambulatory and may be out of parental view during the acute aspiration incident, there may not be a reliable witness to supply the incriminating clinical history. It has been reported that up to 50% of patients with foreign body aspirations do not have a contributing history available. In a review by Boufersaoui *et al* of 2624 children showed the delay between aspiration and removal was 2-8 days in 65.8% and within 24 hours in

9.2%.⁶ This consistent finding highlights the fact that the possibility of this diagnosis must be high in the clinician's mind in order to avoid delay in retrieval and prolonged erroneous treatment.

When the initial episode is witnessed, the clinical presentation of acute airway obstruction associated with a foreign body aspiration is quite straightforward. Initially, there is a brief period of choking, gagging, or wheezing. This may be associated with hoarseness, aphonia, or dysphonia. **The American Academy of Pediatrics has developed guidelines to assist in the management of acute choking episodes.⁷ For infants less than 1 year of age, back blows and abdominal thrusts are recommended. The Heimlich maneuver is reserved for older children or adults.**

As the foreign body passes through the vocal cords into the trachea and bronchi, these symptoms resolve and a relative asymptomatic period may begin. During this time, the diagnosis may be more difficult to ascertain. The most common clinical symptoms for patients with a bronchial foreign body includes cough, wheezing, and decreased breath sounds.⁸ The resulting symptoms may mimic intermittent tracheobronchitis, recurrent pneumonia, or asthma. These children may be treated with antibiotics and steroids, which may mask symptoms and delay further the diagnosis. Specifically for this reason, in children with atypical or prolonged pulmonary symptoms the possibility of a foreign body should be raised. Delayed complications associated with a retained foreign body include pneumonia, obstructive emphysema, and bronchiectasis.⁹

The most common objects aspirated by young children are food products. Most are peanuts, but seeds and other nuts are common as well. Beans and seeds absorb water over time and with subsequent swelling rapidly change from partial to complete bronchial obstruction.¹⁰ Organic foreign bodies, such as oily nuts (commonly peanuts), induce inflammation and edema. This may result in a condition known as *arachidic bronchitis*, a spidery pattern on chest radiograph. Inert foreign bodies cause less tissue reaction and may remain in one position for a long period without causing increased obstruction. The most common inert bronchial foreign bodies are pieces of toys. Inert bronchial foreign bodies such as school supplies, tacks, and pins are more common in older children.¹¹

In a review by Bamber *et al* of 2165 autopsies, ten cases were identified and all but one case involved aspiration of food, with grapes being a feature of four cases.¹²

The angles of the takeoff mainstem bronchi are identical until age 15 years, and therefore foreign bodies are found on the right and the left with equal frequency in persons in this age group. With normal growth and development, the adult right and left mainstem bronchi diverge from the trachea with very different angles, with the right mainstem bronchus being more acute and therefore making a relatively straight path from larynx to bronchus. Objects that descend beyond the trachea therefore are more often found in the right endobronchial tree than in the left.

Gang *et al* reviewed 953 cases of foreign bodies, 98 were lodged in the main bronchus and/or bilateral bronchi, 506 in the right main bronchus, and 349 in the left main bronchus.⁵ Once aspirated, objects may subsequently change position or

migrate distally, particularly after rigorous coughing or unsuccessful attempts to remove the object or if the object fragments. Vegetable material may swell over hours or days, worsening the obstruction. Cough, wheeze, stridor, dyspnea, cyanosis, and even asphyxia might ensue.

Chest auscultation most commonly will reveal decreased breath signs on the obstructed side with wheezing and decreased localized air entry. The chest findings are frequently misinterpreted as asthma or pneumonia. In patients with prolonged or unusual symptoms which do not respond to routine pharmacologic management, bronchoscopy should not be delayed.

Acute Management

Clinical management of an aspirated foreign body includes early recognition, acute emergency interventions, supportive care, and preventive anticipatory guidance. The current guidelines for pediatric basic life support recommend that when airway obstruction from a foreign body is mild, no intervention is required. The patient should be allowed to clear his or her airway by coughing while the clinician watches for signs of impending severe airway obstruction.

In infants with severe obstruction, 5 back blows followed by 5 chest thrusts should be administered repeatedly until the object is expelled or the victim becomes unresponsive. Abdominal thrusts should not be delivered to infants because they may damage the relatively large and unprotected liver.⁷

For children older than 1 year, subdiaphragmatic abdominal thrusts (the Heimlich maneuver) should be administered. These maneuvers force the diaphragm upward, thereby increasing the intrathoracic and intratracheal pressure that expels the foreign body. These maneuvers should be performed only if the child is responsive.

Cardiopulmonary resuscitation should be performed if a child becomes unresponsive. Rescuers should always look into the mouth before giving breaths. Keep in mind that a blind oropharyngeal finger sweep in a choking infant or child can dislodge the foreign body to the more distal and smaller airways. A finger sweep should be done only if the object can be seen in the posterior pharynx. Ventilation followed by chest compressions should follow. Parents and caregivers should learn these techniques to prevent accidental deaths from foreign-body aspiration.

Diagnostic Imaging

Diagnostic imaging plays a variable role in identifying a foreign body. Many foreign bodies are not radiopaque and small foreign bodies may cause symptoms but not radiographic changes. Plain films may be inadequate to document a nonradiopaque foreign body unless they are obtained in the expiratory phase. (See **Figure 1**) On expiration air trapping, obstructive emphysema, and a mediastinal shift may be demonstrated. These characteristic findings also may be demonstrated on fluoroscopy or right and left lateral decubitus film. Using the right and left lateral decubitus film demonstrates the physiologic fact that the down side lung should be deflated unless it is obstructed with a foreign body. In a study by Parida et al, common radiographic signs were unilateral hyperinflation (64.9%), mediastinal shift (45.9%), and collapse (21.6%) and in 13.5% the chest

X-rays were normal.¹³ It has been reported that 20% of patients with an aspirated foreign body have a negative history and a negative radiographic work-up. Even in view of a negative clinical history and a normal chest radiograph, a child still may have an aspirated foreign body. Additionally, it is important to remember that other pulmonary conditions such as asthma and mucus plugging can mimic the radiographic findings also associated with foreign body aspiration. Over time, several chest radiographs of a patient with a retained foreign body may change, and even include films that are read as normal. Because chest films can have false positives and false negatives, a high degree of clinical suspicion is the most important element in the diagnostic work-up.

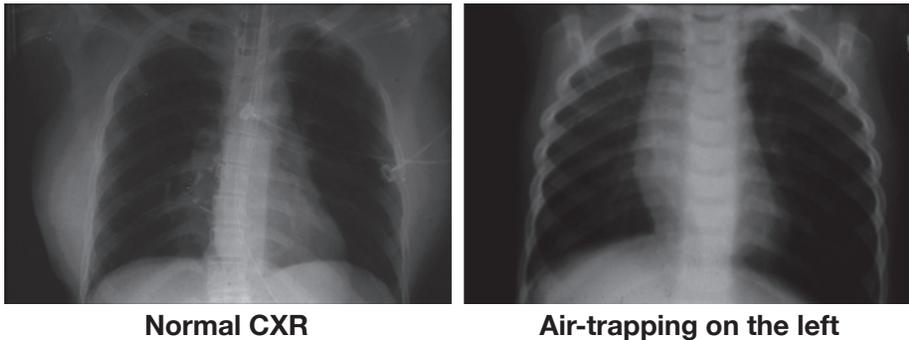


Figure 1. Chest x-ray showing airtrapping.

Friedman *et al* reviewed 145 patients who underwent bronchoscopy in a 5 year period. The overall rate of negative bronchoscopy was 37%. A subset of 20 patients had CT scans.¹⁴ All 20 of the scans were of clinical significance and accurate, either identifying or excluding a bronchial foreign body. They suggest low dose protocol chest CT scans may be useful to decrease the number of negative bronchoscopies in stable and asymptomatic patients. Other authors also suggest the use of low dose CT scans and virtual bronchoscopy.¹⁵ (**Figure 2**)

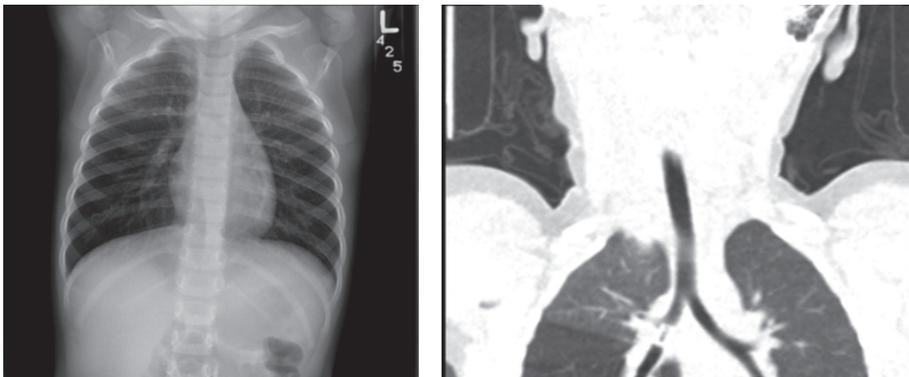


Figure 2. Radiolucent Airway Foreign body (right bronchus)

In a series of cases from Adaletli, false positives from CT scans from obstructive pathologies thought to be foreign bodies on MDCT (Modified Dose Computer Tomography) and VB (Virtual Bronchoscopy) were actually due to purulent secretions and an intrabronchial soft-tissue mass.¹⁶

Retrieval Techniques

Airway foreign bodies are removed most safely under general anesthesia using the ventilating rigid bronchoscope. The anesthetic has not changed drastically over the years nor has the critical role of meticulous communication between the surgeon and the anesthesiologist. The use of the bronchoscopic video camera has enhanced the coordination of efforts between the endoscopist and the anesthesiologist, but nothing can replace the preoperative and intraoperative discussion. Usually spontaneous respiration is preferred. When the endolarynx is visualized, 2% or 4% lidocaine is sprayed topically to decrease laryngospasm. The patient inhales 100% oxygen before the introduction of the bronchoscope. Selection of the most appropriate size of endoscope depends upon the age of the patient. Age appropriate equipment decreases postinstrumentation edema. Surgeon familiarity and experience with the wide variety of forceps available facilitates safe and smooth retrieval. A major distinction among forceps is whether they are single or dual action; each has its own role in different situations. The optical forceps markedly have improved visualization, providing excellent illumination as well as magnification. In spite of these advantages, the addition of the telescopic rod into the bronchoscope lumen decreases the space available for ventilation. This may be a serious consideration in very small children and may be alleviated by using a smaller diameter telescope or resorting to the nonoptical forceps. It is imperative that the surgeon personally review the instruments pulled for foreign body retrieval to be assured that the appropriate size and variety of forceps are available. The elective retrieval of an aspirated foreign body should not be initiated without an available full range of sizes and variety of instrumentation.¹⁷

When the foreign body is visualized, forceps are used to gently grasp the object for retrieval. Excessive pressure or biting motions may lead to fragmentation of the foreign body. When the object is too large to withdraw through the lumen of the bronchoscope, the bronchoscope, forceps, and object must be removed as a single unit, which requires coordination with the anesthesiologist. If the object is sharp, it is removed most safely when it is sheathed within the lumen of the scope, decreasing the risks of mucosa injury. It is important to keep in mind that the incidence of a second foreign body in the airway is 5%.

In cases where it is not possible to perform a rigid bronchoscopy due to a child's unstable respiratory status or if there is an airway foreign body lodged in the trachea that cannot be removed without potential loss of airway support, extracorporeal membrane oxygenation (ECMO) may be a useful adjunct.¹⁸

Complications

The possibility of complications is increased when removing a retained foreign body. The possibility of granulation tissue and post-obstruction infection exists. Removal may be hampered by poor visualization associated with swelling, granulation, or bleeding. These added challenges further reinforce the need for an

earlier examination, when the removal of a foreign body is less difficult. Postinstrumentation edema may result, which usually responds to intravenous steroids and inhaled vaponephrine treatments. Postural drainage should be avoided because it is uncommon for this to result in the successful removal of a foreign body and more likely may dislodge the foreign body to another more distal location. Atelectasis is the most common complication following foreign body retrieval.^{9,10,19}

Conclusion

Foreign body aspiration accounts for substantial morbidity and mortality. Toddlers are consistently the most common age group involved. This chapter highlights the challenges in establishing the correct diagnosis and initiating the appropriate intervention. Actual cases are used to illustrate teaching points concerning the clinical presentation, the role of diagnostic imaging, and the technique of rigid bronchoscopy.

*Images courtesy of Brandy Bales Brandy Bales RPA/RA (CBRPA), RT(R)(M)(ARRT) Radiology Clinical Educator, Dr. Edward B. Singleton Dept. of Pediatric Radiology, Texas Children's Hospital

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