Pediatric Airway and Esophageal Foreign Bodies

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INTRODUCTION

Aerodigestive foreign bodies (FBs) in children are commonly encountered clinical problems with the potential for life-threatening complications. FB aspiration into the tracheobronchial tree or ingestion with esophageal retention requires prompt surgical diagnosis and management. The identification of a foreign object lodged in the trachea or esophagus can be difficult owing to a delay in presentation and nonspecific symptoms. This article focuses on the clinical presentation, treatment approach, and risks associated with pediatric aerodigestive FBs.

Gustav Killian performed the first bronchoscopic removal of a FB in a farmer in 1897. Decades later, Chevalier Jackson developed the lighted bronchoscope and several specialized instruments for removal of FBs. Contemporary management of airway or esophageal FBs is characterized by evaluation and stabilization of the physiologic status of the child with the performance of appropriate diagnostic and therapeutic procedures designed to achieve safe, successful removal. These procedures mandate

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KEYWORDS

- Aerodigestive foreign bodies
- Bronchoscopy
- Button battery
- Esophageal bougienage

KEY POINTS

- Common airway foreign bodies include peanuts, seeds, and vegetable matter.
- Many children with airway foreign bodies initially have normal chest radiographs.
- Suspicion of an airway foreign body mandates bronchoscopy.
- The most commonly retained esophageal foreign bodies are coins.
- Lithium button battery ingestion must be distinguished from coins. Button batteries require emergent diagnosis and removal to prevent life-threatening injury.

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coordinated efforts between the primary care provider, emergency room, pediatric surgeon, anesthesiologist, and the operating room team.

AIRWAY FOREIGN BODIES: CLINICAL PRESENTATION

Aspiration is common for infants and children, and, in particular, between 1 and 4 years of age. Many FBs are either partially or completely expelled by coughing and spitting reflexes. Frequently inhaled FBs include organic materials such as nuts, seeds, vegetable matter, or dried fruits, and inorganic material such as toy pieces and pins. Most aspirated objects lodge in the bronchial tree, with the right main stem bronchus being the most common location because of its straighter trajectory relative to the trachea. The diagnostic difficulty is increased by the observation that the FB is visible on radiograph in only 10% to 20% of cases. Clinically, this is made more complex by an initially normal chest radiograph appearance in many infants and children who have aspirated a FB. A positive history or even a plausible history of witnessed aspiration of a FB should prompt evaluation and management for definitive diagnosis, because a delay in diagnosis increases the rate and severity of complications.

FB aspiration typically presents with at least 1 symptom of coughing, choking, stridor, and/or wheezing at the time of aspiration. On physical examination, the character of persistent stridor may reflect the anatomic location of partial airway obstruction. High-pitched inspiratory stridor is usually a result of supraglottic obstruction or physiologic collapse. Biphasic stridor indicates an obstruction in the glottis or subglottic region. Expiratory stridor is generally characteristic of tracheal or bronchial obstruction. The presence of decreased breath sounds and wheezing is highly correlated with an aspirated FB. The aspiration or ingestion event is often not witnessed, making the clinical history less clear in infants and preverbal children.

A high index of suspicion should be maintained for any infant, child, or adolescent who has a history consistent with aspiration. The degree of respiratory distress determines the urgency of intervention. Tachypnea, nasal flaring, retractions, or cyanosis requires immediate intervention, and acute respiratory distress necessitates emergent establishment of a secure airway. In a physiologically normal child, the urgency of intervention may change precipitously based on the location of the FB. Delay in diagnosis is common, and many children do not present acutely following FB aspiration. Subacute or chronic airway FB in the bronchi may cause chronic pulmonary infection, bronchiectasis, asthma, lung collapse, or lung abscess.

AIRWAY ASPIRATION: DIAGNOSTIC AND THERAPEUTIC PROCEDURES

Simulation courses can provide the foundation for trainees to become familiar with the assembly and utility of a ventilating bronchoscope, as well as how to address laryngospasm and other potential intraoperative issues. Most importantly, a simulated setting is an excellent way to provide experience to trainees and the team in the technical and communication aspects of the procedure.

Radiographic findings of an aspirated FB include asymmetric air trapping with hyperinflation; unilateral atelectasis; and, later, pneumonia with distal chronic parenchymal infection. In children older than 3 years of age, inspiratory and expiratory radiographs may be attempted. Bilateral decubitus radiographs may also be helpful. The sensitivity and specificity of chest radiography in identifying an aspirated FB are 61% and 77%, respectively. For this reason, children with characteristic history and symptoms of FB aspiration should undergo prompt bronchoscopy regardless of radiographic findings.

Extraction of airway FB is performed under general anesthesia. The team should have the necessary equipment, personnel, and experience before attempting airway FB
removal in an infant or child; this includes resources, infrastructure, and experience with complicated pediatric airway management. Preoperative communication between the pediatric anesthesiologist, surgeon, and operating room team are essential to establish a plan of action. Spontaneous respiration is generally safer than an apneic technique with positive pressure ventilation to prevent distal displacement of the FB in the airway.

Rigid bronchoscopy is the mostly commonly used technique for airway FB removal. The ability to control the airway, the excellent telescopic visualization, various sizes of bronchoscopes, and the array of available extraction instruments make rigid bronchoscopy the technique of choice; however, this does not allow for evaluation of the most distal peripheral airways. Flexible bronchoscopy may be used for objects in the smaller, peripheral airways. The limiting factor for flexible bronchoscopy is the 2-mm instrument channel, which requires specialized extraction equipment that is not readily available.

For airway FB removal, appropriate instruments should be assembled and the child well oxygenated before induction of anesthesia. Once a suitable plane of anesthesia is achieved, direct laryngoscopy is performed with insertion of the bronchoscope into the airway with the child in supine position. Contemporary ventilating bronchoscopes allow for adequate gas exchange during the procedure. A systematic approach to the inspection of the trachea and bronchi is essential. The FB is identified and suction performed as needed to aspirate secretions. The FB is typically removed with optical forceps; rarely, impacted debris in the distal bronchi can be carefully extracted into the trachea with a Fogarty catheter and subsequently removed with forceps. Following successful extraction, bronchoscopy should be repeated to evaluate for retained FB or secretions, and an endotracheal tube placed for emergence from anesthesia. Complicated FBs include pins, teeth, and thin flexible material that can occlude the airway. Should symptomatic tracheal occlusion occur during attempts to extract an airway FB, the FB can be temporarily pushed into the right or left bronchus, allowing for single lung ventilation for further attempts at removal. Passage of catheters for distal airway ventilation; tracheostomy instruments; and, in rare cases, cardiopulmonary bypass should be available resources for complicated airway management.

ESOPHAGEAL FOREIGN BODIES: CLINICAL PRESENTATION

Symptoms of FB ingestion vary with the age of the patient and the location and size of the FB. Infants may show nonspecific symptoms such as drooling, gagging, or poor feeding. Larger objects in the esophagus may rarely cause obstruction of the airway if lodged proximal to the upper esophageal sphincter. Some children present immediately following witnessed ingestion of a coin or other FB; other children are found to have an incidental retained FB from a chest radiograph taken for other symptoms. Older children may report odynophagia, dysphagia, and chest pain. The physical examination includes airway and oropharyngeal evaluation, palpation of the neck and upper thorax to assess for crepitus, and auscultation of the lungs. Symptomatic patients with retained esophageal FB who are unable to swallow or in acute respiratory distress require prompt evaluation based on physiologic status. For most infants and children, symptoms and physical signs of a retained esophageal FB are not dramatic.

ESOPHAGEAL FOREIGN BODIES: DIAGNOSTIC AND THERAPEUTIC PROCEDURES

Essential diagnostic procedures for a retained esophageal FB include frontal and lateral radiograph imaging for radiopaque items such as coins and metal FBs. The images should include the neck and chest. If a retained esophageal object is suspected by history, examination, or symptoms, and plain radiographs of the neck are normal, an esophagram may be helpful, particularly for food impaction. The most commonly
retained object in the esophagus in infants and children is a coin. Some esophageal coins spontaneously pass within 24 hours. Persistent esophageal coins may be removed by rigid endoscopy. Alternatively, esophageal coin removal using a balloon catheter passed into the esophagus under fluoroscopy may be used.\textsuperscript{16,17} The balloon of the catheter is passed distal to the coin, inflated with contrast, and the coin is brought into the oropharynx under fluoroscopic guidance. In addition, the authors have reported our experience using bougienage for the management of uncomplicated esophageal coins in children.\textsuperscript{18}

If the retained esophageal FB is a suspected button battery, it must be emergently removed given the potential for clinically significant esophageal injury within 2 hours.\textsuperscript{19} Button batteries, and in particular the 3-V, 20-mm lithium button batteries that are approximately the size of a United States penny, are particularly dangerous and can lead to rapid, serious injury and death. Once in contact with a wet mucosal surface, the electrical current from the battery generates hydroxide alkaline injury that can rapidly proceed to full-thickness oropharyngeal or esophageal injury, which can lead to esophageal perforation with mediastinal infection, tracheoesophageal fistula, or erosion into major vascular structures with life-threatening hemorrhage. Batteries have a distinctive radiographic appearance, and the combination of frontal and lateral radiograph imaging is useful.\textsuperscript{20} An anterior radiographic battery image may show a double-density shadow, or halo, caused by the bilaminar structure of the battery. A lateral view may also show the step-off at the junction of the cathode and anode. Once diagnosed or suspected, retained esophageal batteries require emergent removal via rigid or flexible esophagoscopy. Asymptomatic gastric batteries may be allowed to pass spontaneously, but passage should be documented with follow-up radiographs. Symptomatic patients with gastric batteries require urgent retrieval of the battery. Retrieval of gastric button batteries is also recommended if a magnet was also ingested, if the battery is greater than or equal to 15 mm in diameter, the child is younger than 6 years, or the battery remains in the stomach for greater than or equal to 4 days.\textsuperscript{21}

Rigid esophagoscopy is performed under general anesthesia with placement of an endotracheal tube to reduce the risk of aspiration. Positioning the table lateral to the anesthesiology team and securing the endotracheal tube to the left side of the child’s mouth is helpful. Plain films or esophagram images with preoperative localization of the foreign object should be available in the operating room. The child is placed supine; placing the neck in slight extension with a towel roll under the shoulders may be useful. The esophagoscope is directed posteriorly and through the upper esophagus under direct visualization. The object may be removed with either optical forceps or, with older esophagogoscopes, with forceps placed through the viewing channel. In general, objects larger than the esophagoscope diameter require removal of the forceps, FB, and esophagoscope together. Repeat esophagoscopy should be performed to assess for any esophageal mucosal injury, and, if found, the depth of injury should be documented.

If the FB is accurately identified as a coin retained in the esophagus, the coin may be removed by rigid or flexible esophagoscopy under general anesthesia, fluoroscopically guided balloon retrieval, or pushed into the stomach using esophageal bougienage. All of these techniques in the management of retained esophageal coins are similar in safety and efficacy; balloon retrieval and bougienage do not require anesthesia, making these more cost-effective approaches.\textsuperscript{17} The authors have used esophageal bougienage for the management of acute, uncomplicated esophageal coins for several decades. The rationale for bougienage of esophageal coins is to push the coin from the esophagus into the stomach, with subsequent passage of the coin through the gastrointestinal tract. Box 1 lists our current criteria for esophageal bougienage.\textsuperscript{18}
CLINICAL OUTCOMES

The complication rate of rigid endoscopy for either airway or esophageal FB is low (0.2%–5%) and mortality is rare (<0.1%). A retrospective, administrative database review identified 2771 children admitted to the hospital during 2003 for an FB causing airway obstruction, with 94 deaths (3.4%) while in the hospital. Known complications include extraction failure, retained fragments, laryngeal edema or bronchospasm requiring tracheotomy or reintubation, tracheal or bronchial laceration, pneumothorax, pneumomediastinum, respiratory infection, airway or esophageal injury, cardiac arrest, and hypoxic brain damage.

Consideration should be given to performing esophagoscopy in children who undergo bronchoscopy for suspected aspiration with a negative bronchoscopic examination. The trachea is compressible in young children and an esophageal FB may cause obstruction of the trachea as well. Complications related to endoscopic removal of esophageal FB are generally related to the type of FB and duration of time the FB is retained in the esophagus. The risk of erosion of metallic and plastic esophageal FBs into the mediastinum and great vessels increases with duration of retention, and life-threatening hemorrhage requiring emergent intervention has been reported from our institution. For partial-thickness or full-thickness esophageal injury from a retained FB, follow up esophagram at 4 to 6 weeks following extraction may be useful to evaluate for esophageal narrowing secondary to inflammatory stricture.

SUMMARY

Aerodigestive tract FBs are common in infants and children. The most commonly retrieved airway FBs in young children are food products, particularly peanuts and seeds; in older children, pins, toy pieces, pen caps, and nonfood objects are commonly found. Airway FBs require prompt diagnosis and management given the complications associated with diagnostic delay. Rigid bronchoscopy under general anesthesia is the most widely accepted diagnostic and therapeutic intervention. For esophageal FBs, retained button batteries must be removed emergently. For retained food or coins, rigid
esophagoscopy is commonly used. For a selected population with retained esophageal coins, experience with balloon catheter retrieval or esophageal bougienage suggests these methods as safe, efficient, and cost-effective methodologies.

REFERENCES


