

Chapter 11

Tracheobronchial Foreign Bodies



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Abstract This chapter presents useful pearls and tricks that facilitate the management of children with tracheobronchial foreign bodies. Specifically, the epidemiology, clinical presentation, anesthetic and surgical principles associated with the diagnosis and successful retrieval of tracheobronchial foreign bodies will be reviewed. An overview of the most common foreign bodies and their physical properties is presented.

Keywords Foreign · Tracheobronchial · Choking ·
Dyspnea · Peanut

1. How common are tracheobronchial foreign bodies?

The aspiration of tracheobronchial foreign bodies is fortunately not common. However, asphyxiation caused by an inhaled laryngeal or tracheobronchial foreign bodies is one of the leading causes of accidental death in children under the age of 4 years in many countries.

In Europe, a retrospective study of 19 European countries was undertaken to determine the incidence of airway foreign bodies between 2000 and 2002 [1]. Cases were identified using hospital discharge records and International Classification of Disease (ICD-9) codes. During this time period, 170 cases of laryngeal or pharyngeal foreign bodies (ICD 933) and 552 cases of tracheobronchial foreign bodies (ICD 934) were identified.

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In the United States, non-choking rates were reviewed by the Morbidity and Mortality Weekly Report [2]. In 2001, approximately 17,537 children aged 14 years or less were treated in emergency departments for choking related episodes. This incidence corresponds to a rate of 29.9 per 100,000 population. The rates were reported for specific age groups.

2. What is the age distribution of tracheobronchial foreign bodies?

In a European study, there was a higher reported incidence of tracheobronchial foreign body aspiration in males (63%) and the median age at presentation was 2 years [1]. In a review of cases presenting at a tertiary care center in Eastern India, 82 cases were identified between 2001 and 2008 [3]. The most common age at presentation was between 1 and 3 years (56.4%).

In the US, the highest rates of non-fatal choking events were found for infants aged <1 year (140.4 per 100,000 population) [2]. Overall, 82.3% of all cases were in children 0–4 years of age. As found in the European study, most of the cases were in males (55%).

In a more recent review of the English literature, 12,979 children with suspected (11,145 cases confirmed) foreign body aspiration were reported between 2000 and 2010 [4]. Most of the children were under the age of 3 years. The median age range was 1–2 years and the mean age range was 2.1–3.8 years.

It should be noted that foreign body aspiration is also reported in adolescents. In these instances, the adolescent is commonly neurodevelopmentally delayed or incapacitated by alcohol or drug use. In this age group, non-food foreign bodies are more common (pins, coins, pen caps, etc.).

3. Why are tracheobronchial foreign bodies most common in very young children?

There are several factors that predispose very young children to accidental foreign body aspiration [5]. A major factor is their inherent oral curiosity. Infants typically explore their environment by placing objects in their mouth. This behaviour can be particularly problematic when they begin to crawl or walk and gain access to many objects. Young children lack molars to grind food adequately and prematurely swallow large food boluses. Choking on food substances can occur when the children are given unsuitable foods such as nuts or raw vegetables by an unsuspecting parent or young sibling. Young children typically demonstrate active behaviours while eating which may also predispose to accidental choking. Finally, young children have very small airways that are susceptible to complete blockage of the airway by foods with a round shape such as uncut grapes and hotdogs.

4. What is the mortality associated with tracheobronchial foreign bodies?

The mortality associated with tracheobronchial foreign bodies is not precisely known. However, national mortality data related to choking have been reported in the United States. In 2000, 160 children aged 14 years or less died from obstruction of the respiratory tract as a result of an inhaled or ingested foreign body (ICD

W79–W80, 10th Edition) [2]. Death was more commonly caused by a non-food substance (59%) than a food substance (41%).

In a review of the English literature, mortality data was reported in 26 of the 30 articles included in the review [4]. There were 43 deaths among 10,236 children with aspirated foreign bodies giving an overall mortality rate of 0.42%. It should be noted that many of the reported deaths occurred either during the treatment bronchoscopy or due to a complication of the procedure. The reported mortality rate is likely an underestimate of the true death rate as the review does not include deaths that occurred prior to reaching medical care.

5. What are the most common tracheobronchial foreign bodies encountered?

It is clear from the literature that the nature of foreign bodies encountered varies according to geographical and cultural food preferences.

In a European study, the most common foreign bodies were nuts, seeds, berries, corn and beans [1]. In an Indian study, food materials such as seeds and beans were encountered in 48.8% of cases [3].

In the United States MMWR report, 59.5% of reported cases involved food substances, 31.4% non-food substances and in 9% of cases the nature of the foreign body was not reported [2]. The most common food substances were “solid food” which included cookies, chips/crackers, popcorn, nuts/seeds, bones, bread, meats, fruit, pasta/rice/cereals and candy/gum. Common non-food foreign bodies encountered were coins, toys, marbles, balloons, puzzle pieces, paper, pen caps, tape, and screws.

6. What are the most dangerous tracheobronchial foreign bodies?

It should be emphasized that all tracheobronchial foreign bodies are dangerous as they can cause immediate life-threatening airway compromise and serious longer-term complications such as pneumonia and lung collapse. However, there are several food and non-food foreign bodies that pose an added risk of injury, long term complication and death. The foreign bodies that fall into this category are summarized in Table 11.1.

7. What are the most common clinical presentations associated with tracheobronchial foreign bodies?

A patient that presents to the emergency department with a history of a witnessed choking event should be considered to have a tracheobronchial foreign body until proven otherwise. The suspicion should remain high even if the patient does not have any signs or symptoms suggestive of a foreign body aspiration.

If the choking event was not witnessed, children typically present with a recent onset of unexplained cough, wheezing, and shortness of breath. If the choking event occurred remotely, the patient may present with ‘atypical asthma’ that is not responsive to treatment with bronchodilators, chronic cough, or recurrent or non-resolving pneumonia.

Table 11.1 This table summarizes the foreign bodies, their physical characteristics and the associated airway implications

Foreign body	Characteristic	Implications
Balloons, rubber gloves	Inflatable	Complete blockage of airway lumen
Marbles, rocks, balls	Round, hard, smooth surface	Complete blockage of lumen, unable to be grasped, cannot be broken
Medications (e.g. iron, potassium tablets)	Dissolve causing pain and inflammatory reaction	Inflammation or perforation of airway lumen
Sharp objects (e.g. pins, needles)	Sharp edge	Perforation of the airway lumen
Button batteries	Caustic, heavy metals	Severe caustic burn of the airway lumen
Nuts, seeds	Secrete oils	Inflammation and granulation tissue in airway
Grapes, hotdogs	Round, smooth	Complete blockage of airway lumen

8. What are the most common presenting clinical signs associated with tracheobronchial foreign bodies?

The clinical signs of a tracheobronchial foreign body in children may range from acute airway distress to subtle chest findings. A child with acute airway distress may demonstrate nasal flaring, preference for an upright posture, tracheal and subcostal indrawing, tachypnea, tachycardia, cyanosis and sialorrhoea. Careful inspection of the eyes may reveal multiple scleral hemorrhages. If the foreign body is lodged in the larynx, the child will also present with stridor, dysphonia or aphonia. Aphonia should alert the treating physician to the possibility of a laryngeal foreign body and the need for immediate intervention as laryngeal foreign bodies are associated with a very high risk of death.

Foreign bodies in the lower airway are more commonly associated with diminished breath sounds in a unilateral lung field, ronchi, or wheezing. These clinical findings are more likely to be detected in the right lung field. Foreign bodies are more likely to migrate to the right main bronchus given its orientation which is more in line with the trachea.

9. What are the most common and useful imaging modalities to assess a patient with a suspected tracheobronchial foreign body?

The chest radiograph is the most useful imaging modality for the initial assessment of a child with a suspected tracheobronchial foreign body. It is particularly useful for the detection and localization of radio-opaque foreign bodies. However, the chest radiograph may not be helpful with food substances or with objects that are typically non-radio-opaque. In several reported case series, chest radiographs were reported as normal in 17% of cases of confirmed FB aspiration [4].

In some instances, the chest radiograph may detect segmental collapse, atelectasis, hyperinflation of the affected infiltrate or deviation of the mediastinum.

Lateral, inspiratory/expiratory, and lateral decubitus views may be required to detect air trapping caused by a foreign body.

Computed tomography scans and virtual bronchoscopy are other useful imaging modalities to detect tracheobronchial foreign bodies. These investigations are more sensitive, especially for non-radio-opaque foreign bodies, when the diagnosis is equivocal, or if the patient presents with persistent symptoms after bronchoscopy. However, there are concerns with using computed tomography as a first-line investigation such as unnecessary radiation exposure to children, cost and availability. Most importantly, this should not be performed in an unstable or uncooperative patient especially if the imaging equipment is in a remote location or if the child requires sedation. In these instances, the patient should proceed directly to bronchoscopy.

10. How should patients with tracheobronchial foreign bodies be prioritized for treatment?

Children with confirmed or a high suspicion of a tracheobronchial foreign body should be assigned the highest priority for treatment, especially if the patient is presenting with concerning clinical signs. For most institutions, the highest priority indicates that the procedure should be performed within 1 hour. With severe airway compromise, fasting rules may be compromised.

An airway foreign body may lead to acute airway compromise, hypoxia and death. The most serious complications associated with delayed treatment of tracheobronchial foreign bodies include pneumothorax, pneumomediastinum, hypoxic brain injury, post-obstructive pulmonary edema, need for tracheostomy, cardiac arrest and death.

Unrecognized and therefore delayed treatment of tracheobronchial foreign bodies may result in pneumonia and loss of lung function.

11. How are tracheobronchial foreign bodies removed?

Tracheobronchial foreign bodies are removed under general anesthesia and bronchoscopy [6]. In most pediatric medical centres, tracheobronchial foreign bodies are removed with rigid ventilating bronchoscopes. A full range of ventilating rigid bronchoscopes, rigid telescopes and optical grasping forceps are required equipment. A variety of grasping forceps are commercially available that are designed for specific types of foreign bodies (Fig. 11.1). A thorough description of the tools, and methods to remove foreign bodies is beyond the scope of this chapter (see references). Foreign bodies can also be removed by flexible bronchoscopes with side ports that allow the introduction of grasping forceps. They are particularly useful for very distal foreign bodies that are beyond the reach of rigid bronchoscopes.

12. When should a tracheostomy be performed to manage a tracheobronchial foreign body?

A tracheostomy is not usually required for the management of tracheobronchial foreign bodies. However, if the foreign body is firmly lodged at the glottic level, is

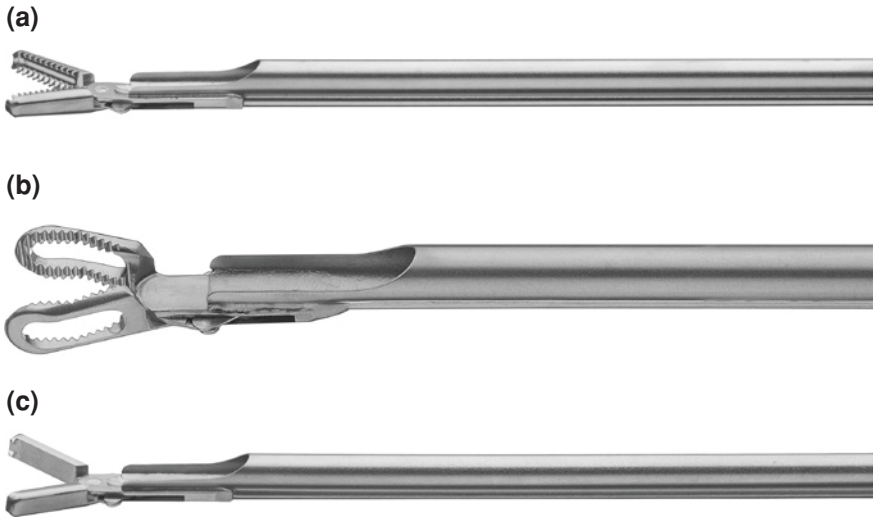


Fig. 11.1 This figure demonstrates a variety of optical grasping forceps commercially available to retrieve foreign bodies. **a** Alligator forceps. **b** Peanut forceps. **c** Coin forceps (photos courtesy of © KARL STORZ SE & Co. KG.)

causing severe airway obstruction, and cannot be easily removed, a tracheostomy may be required.

A temporary tracheostomy may be required for large or irregularly shaped foreign bodies that cannot be withdrawn through the vocal folds. In these rare instances, the foreign body is removed through the tracheostomy.

It should be noted that tracheostomies are not helpful with foreign bodies in the distal trachea or bronchi and therefore should not be performed.

13. What are the important anaesthetic principles that should be considered when treating a child with a tracheobronchial foreign body?

Children undergoing rigid bronchoscopy for a tracheobronchial foreign body require a general anesthetic [4]. Anesthesia is induced and maintained by either inhalational agent, intravenous medication or a combination of the two modalities. An intravenous agent may be needed if the airway obstruction is severe and absorption of inhalational agent is compromised. Regardless of the agent used, it is preferable that the induction of anesthesia be gradual so that the patient can maintain spontaneous ventilation throughout the procedure. Spontaneous ventilation avoids dislodging a proximal airway foreign body and minimizes the hyperinflation of the involved lung and therefore the risk of pneumothorax.

Patience must be exercised to allow the patient to achieve the ideal plane of anesthesia to avoid coughing, bucking, desaturation and injury to the airway lumen. Topicalization of the larynx and carina may facilitate rigid bronchoscopy by blunting the stimulation caused by the procedure. In severe cases, the surgeon

may need to proceed expeditiously to relieve the airway obstruction and therefore forego an ideal anesthetic plane.

The anesthesiologist should consider the use of anticholinergic medications to decrease the airway secretions and prevent bradycardia, and steroids to minimize glottic and subglottic edema caused by the procedure.

It must be emphasized that rigid bronchoscopy for tracheobronchial foreign bodies requires excellent communication between surgeon and anesthesiologist for an uneventful procedure and best patient outcomes.

14. What are the important surgical principles that should be considered when treating a child with a tracheobronchial foreign body?

The surgeon must develop and communicate the plan for the procedure with the anesthesiologist and nursing team prior to the start of the procedure. A detailed ‘time-out’ with the team will ensure that the necessary equipment and contingency plans are in place if there is difficulty with maintaining a safe airway during the procedure.

The team should have at their disposal a wide array of laryngoscopes, bronchoscopes and optical grasping forceps to deal with any food and non-food foreign body [6]. The equipment should be well organized, easily accessible and familiar to the nursing team. In many institutions, a dedicated ‘airway room’ is established to manage tracheobronchial foreign bodies and other airway emergencies.

15. What is the recommended post-operative care after removal of a tracheobronchial foreign body?

Infants and young children are typically admitted following a rigid bronchoscopy to remove tracheobronchial foreign bodies. A unit with monitored beds is advisable for the early detection of airway complications. A postoperative chest radiograph is considered if the procedure was prolonged, challenging or if there was injury to the airway lumen.

Patients with signs of airway inflammation, granulation or purulent secretions during bronchoscopy may require systemic antibiotics and inhalational steroids as adjuvant treatment.

Patients with persistent symptoms after bronchoscopy may require a repeat bronchoscopy or computed tomography imaging if residual foreign body fragments are suspected.

16. Are there choking prevention programs available to physicians and parents?

There are several established choking prevention programs in North America that provide useful information to physicians and caregivers. The names and websites of available programs is presented below.

American Academy of Pediatrics (www.healthychildren.org/English/health-issues/injuries-emergencies/Pages/Choking-Prevention.aspx).

Canadian Paediatric Society (www.cps.ca/en/documents/position/preventing-choking-suffocation-children).

University of British Columbia (<https://dontchoke.ubc.ca>).

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