Chapter 15

OBSTRUCTION OF AIRWAY BY FOREIGN BODIES IN PEDIATRICS

Ana Clara Correa Langhi
Sabrina da Silva Santos
Hanna Gabriela Bezerra de Macêdo Tinôco
Mariana Marques Rodrigues de Almeida
Josvaldo da Silva Viana Júnior
Gabriela Herani da Costa
Letícia Passos de Brito
Giullia Garcia Dos Santos
Kethlen Torres Cavinato
Isabela Lyria de Alencar Bassanezi
Lucas Sonoda Buzzo
Sarah Brandão Domingues

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Ana Clara Correa Langhi
Universidade do Oeste Paulista (UNOESTE)
Jaú- SP

Sabrina da Silva Santos
Universidade Federal do Maranhão
Imperatriz- MA

Hanna Gabriela Bezerra de Macêdo Tinôco
Universidade Federal do Rio Grande do Norte (UFRN)
Natal - RN

Mariana Marques Rodrigues de Almeida
Universidade Nove de Julho (UNINOVE)
Bauru - SP

Josvaldo da Silva Viana Júnior
Universidade Federal de Roraima (UFRR)
Boa Vista - RR

Gabriela Herani da Costa
Faculdade Ciências Médicas de Minas Gerais (FCMMG)
Belo Horizonte- MG

Letícia Passos de Brito
Universidade Cidade de São Paulo (UNICID)
São Paulo - SP

Giullia Garcia Dos Santos
Pontifícia Universidade Católica de Campinas - PUCCAMP
Campinas - SP

Kethlen Torres Cavinato
Universidade Nove de Julho (UNINOVE)
São Bernardo do Campo - SP

Isabela Lyria de Alencar Bassanezi
Universidade do Oeste Paulista (UNOESTE)
Jaú - SP

Lucas Sonoda Buzzo
Universidade Cesumar (UNICESUMAR)
Maringá-PR

Sarah Brandão Domingues
Universidade Evangélica de Goiás (UNIEVA)
Anápolis - GO

A foreign body is any object or substance that penetrates the body or its cavities. Accidents involving foreign bodies are extremely common in children, especially in the age range of 0 to 3 years, which can result in drastic consequences and represent a public health problem. The

type of foreign body varies according to anatomical location, cultural habits, socioeconomic characteristics, and the intellectual level of the patient. Therefore, quick attention, accompanied by precise diagnosis and removal of the foreign body, is crucial to determine the patient's outcome and reduce associated morbidity and mortality (Bohadana; Santos; Magalhães and Cesar, 2023).

Foreign body aspiration is a frequently encountered situation in pediatric emergencies, where total or partial obstruction of the respiratory tract can hinder or even prevent air exchange between the lungs and the external environment. This can result in clinical events such as pneumonia, bronchiectasis, lung abscess, atelectasis, or even death. Unfortunately, accidents with foreign bodies are the leading cause of accidental death during the first year of life and the fifth cause of death among children aged one to four years. The severity of this emergency underscores the need for early intervention to avoid complications (Fasseeh *et al*., 2021).

The incidence of foreign body aspiration is especially high in children under three years of age, with a higher prevalence in boys (Salih; Alfaki and Alam-Elhuda, 2016). Patients involved in this clinical emergency range from 0 to 15 years old (Bohadana; Santos; Magalhães and Cesar, 2023), with the ingestion of foreign bodies being the main cause of accidental death in the first year of life and the fifth cause among one to four years (Fasseeh *et al*., 2021). In addition to age and gender, the type of foreign body, its location, and the time of ingestion are determining factors for potential complications (Oliva *et al*., 2020). Due to the severity of these conditions, there is a trend not only to ensure effective prevention but also to enhance multidisciplinary emergency care (Bohadana; Santos; Magalhães and Cesar, 2023).

The diagnosis of foreign bodies in the respiratory system is crucial for the proper management of material removal and prevention of complications. A thorough clinical history and physical examination, along with complementary tests such as chest radiography, are essential. In these cases, diagnostic bronchoscopy is fundamental (Salih; Alfaki and Alam-Elhuda, 2016). Innovations such as the development of algorithms that increase diagnostic sensitivity and accuracy, including factors like witnessed choking, chest wheezing, and unilateral hyperinflation, have been successfully applied (Fasseeh *et al*., 2021).

The treatment of foreign body ingestion in pediatric patients aims to remove the objects, following guidelines that optimize care in urgent and emergency situations. Emergency endoscopies are frequently used, with priority given to cardiopulmonary resuscitation in cases of clinical instability. In stable cases, other managements are suggested (Oliva *et al*., 2020). Innovations in management include algorithms for correct bronchoscopic intervention. In recent years, significant advances in diagnostic and treatment techniques have been achieved. Rigid bronchoscopy remains the standard method for foreign body removal, while the growing use of flexible bronchoscopes offers a less invasive approach. Low-dose computed tomography has also improved the accuracy in identifying aspirated objects (Fasseeh *et al*., 2021).

For prevention, it is essential that parents and caregivers closely supervise children, ensuring a safe environment, especially regarding toys and objects. The appropriate use of diagnostic techniques and treatment modalities, according to the type of foreign body, has proven highly effective, highlighting the importance of standardized protocols and specialized training for healthcare professionals in managing this condition (Salih; Alfaki and Alam-Elhuda, 2016).

EPIDEMIOLOGY

Understanding the epidemiology of foreign body aspiration in pediatric patients is essential for adequately planning healthcare processes and targeting population-specific care. Knowledge of prevalence, incidence, demographics, and geographic distribution of this condition is fundamental. Airway obstruction by foreign bodies is one of the leading causes of accidental deaths in children under five years old, with a particularly high incidence in children under three years, representing about 80% of cases (Salih, Alfaki and Alam-Elhuda, 2016). Children aged 0 to 2 years are especially vulnerable due to the still incomplete development of swallowing function, lack of teeth which hinders chewing, the habit of exploring objects with their mouths, and the practice of playing and moving while eating (Ding *et al.*, 2020).

Most foreign bodies obstructing the airways are organic in nature and often ingested by boys. However, cultural and geographical conditions of population groups influence the nature of these foreign bodies, mainly due to specific dietary habits of populations. While several studies indicate a higher prevalence in boys, some research shows similar incidence between genders, especially in younger age groups. Financial conditions and income of the population also affect the nature of ingested foreign bodies (Ding *et al.*, 2020). The ingestion of toxic substances and metallic objects is common among young children, especially boys under two years old. Coins are one of the most frequently ingested foreign bodies worldwide by children, and substances such as caustic soda and household cleaning products are often observed in pediatric emergencies. Children with psychiatric disorders and emotional disturbances are classified as a high-risk group for this condition (Speidel; Wölfle; Mayer and Posovszky, 2020).

Historically, cases of airway obstruction by aspiration of objects or food are very common and have been described numerous times over time. With the evolution of medicine and technological advances, the prognosis and survival rate of these cases have significantly improved. A notable example is the case of 1897, where Gustav Killian successfully managed the aspiration of a foreign body using bronchoscopy, becoming a pioneer in the extraction of these objects (Salih; Alfaki and Alam-Elhuda, 2016).

In the pediatric field, accidents related to foreign body aspiration are even more frequent compared to adults. This is due to several factors related to the physical

characteristics and physiological development milestones of children. The study by Speidel *et al*. (2020) analyzed 1,199 cases of pediatric accidents by foreign body aspiration and ingestion of chemical substances over 13 years (2005-2017) in a German University Medical Center, revealing a significant annual increase of 80%, from 6.1 in 2005 to approximately 11 per 10,000 children in 2017 in the coverage area. Additionally, the study by Ding *et al.* demonstrated that the incidence of foreign body aspiration cases was estimated at 29.9 per 100,000 pediatric inhabitants, accounting for 160 deaths in the USA in 2000.

Despite the increase in the number of cases over the years, there has not been a proportional increase in mortality. On the contrary, mortality rates have substantially decreased in the current context. This reduction in mortality can be attributed to significant advances in the medical field, especially regarding modern bronchoscopy techniques (Ding *et al*., 2020).

Foreign body aspiration (FBA) presents a variety of risk factors, varying according to the type of inhaled object and the cultural and socioeconomic conditions of each region. In high- and middle-income countries, nuts are responsible for 40% of aspiration cases (Ding *et al*., 2020). Besides the risk of choking on nuts, it is important to alert caregivers to the danger posed by small toys (Parvar *et al.,* 2023). The type of inhaled foreign body varies globally, reflecting differences in dietary habits of each country.

As discussed in the article "Airway Foreign Bodies: A Critical Review for a Common Pediatric Emergency," 91% of Western patients inhaled organic materials, with peanuts accounting for half of these cases, or 45.5%. On the other hand, bones were the most common foreign bodies in Southeast Asia and China. Watermelon seeds, sunflower seeds, and pumpkin seeds are more prevalent in Egypt, Turkey, and Greece, respectively (Salih; Alfaki and Alam-Elhuda, 2016).

The accidental ingestion of caustic substances is frequently reported in children worldwide, affecting up to 75% of children under six years old (Speidel; Wölfle; Mayer and Posovszky, 2020). Various objects and toxic substances are ingested by children, including coins, fish bones, toys, jewelry, button batteries, magnets, household utensils, cleaning products, and caustic soda (Speidel; Wölfle; Mayer and Posovszky, 2020).

FBA is a common problem in the pediatric emergency room, accounting for 2,000 hospitalizations and 17,500 emergency department referrals in the United States. It is the leading cause of distress, morbidity, and accidental infant deaths, as well as the fourth most prevalent cause of death in elementary school children (Parvar *et al*., 2022).

A study conducted by Ding *et al.* (2020) on the prevalence of the type of aspirated object revealed that 93.3% of aspirated foreign bodies by children are organic in nature, with the vast majority being food items. Among these, 43.3% were peanuts, followed by watermelon seeds (13.9%) and sunflower seeds (9.8%).

Analyses of studies indicate that boys are the majority of foreign body aspiration cases in pediatrics (Salih; Alfaki and Alam-Elhuda, 2016). This can be explained by different

upbringing patterns between boys and girls, a higher level of motor activity among boys, and specific cultural and dietary variations between countries. This higher incidence in boys was identified mainly in Asian countries (Parvar *et al.*, 2022).

The prevalence of FBA is significantly higher in children under two years old, with more than three-quarters of cases occurring in this age group (Parvar *et al.*, 2022). Babies and young children are more likely to put objects in their mouths as a form of exploration, increasing the likelihood of swallowing them. This behavior is part of the child's natural development and, combined with the absence of premolars and molars and an immature gag reflex, results in a higher frequency of foreign body aspiration cases in children under three years old.

The complication rate is directly related to the time elapsed between aspiration and diagnosis/treatment. Many patients are referred to emergency rooms within the first 12 to 24 hours after aspiration. However, delays in diagnosis and hospital admission can result in long-term lung damage and complications such as air trapping, pneumonia, and atelectasis (Parvar *et al.*, 2022). After removing the foreign body, it is crucial that the main right and left bronchi and their respective branches are carefully investigated by bronchoscopy to detect any remaining objects or particles.

The socioeconomic status of the countries analyzed in the studies was a determinant for the prognosis of each case. In developing countries with middle-low income, there was a high incidence of complications, especially due to delays in diagnosis (Salih, Alfaki & Alam-Elhuda, 2016). This delay was attributed to the lack of experience of parents and doctors, the lack of bronchoscopy equipment, and the distance from major hospitals (Parvar *et al.*, 2022).

DIAGNOSIS

The diagnosis of foreign body aspiration in pediatrics involves the use of clinical history, physical examination, chest radiography, and rigid and flexible bronchoscopy. Common symptoms of obstruction include dry or wet cough, choking, dyspnea, wheezing, crackles, tachypnea, and fever, usually observed early within a week (Goyal *et al.*, 2020). On chest radiography, unilateral lung hyperinflation, collapse, consolidation, and mediastinal shift can be found, although in the early phase the radiograph may be normal (Truong and Luu, 2023).

Rigid bronchoscopy, considered the gold standard, is an invasive procedure under general anesthesia, crucial for early diagnosis and endoscopic removal to prevent complications such as lung collapse, pneumonia, and even death. Both rigid and flexible bronchoscopies present respiratory complications, such as desaturation and laryngospasm, with flexible bronchoscopy being preferred for its greater availability and safety (Wiemers *et al.*, 2023).

To determine the appropriate timing for endoscopy in children with ingested foreign bodies, factors such as age, body weight, clinical presentation, time since the last meal and ingestion, type, size, shape, and current location of the foreign body in the gastrointestinal tract are considered (Lee, 2018). Depending on the location of the foreign body, symptoms vary and determine the urgency of removal: in the esophagus, suspicion should be high in children with symptoms like sore throat or difficulty swallowing, with urgent removal in cases such as coins or sharp objects. In the stomach, button batteries should be removed quickly due to the risk of complications, while in the small intestine most foreign bodies pass spontaneously, with guidance for monitoring and seeking assistance if necessary (Lee, 2018).

The diagnosis of bronchial foreign body (BFB) is based on the typical history of aspiration, physical examination, and chest computed tomography, with the presence of choking witnesses being crucial for correct diagnosis. Even in the absence of a clear choking history, children with persistent respiratory symptoms should be investigated, as late diagnosis can lead to severe complications such as pneumonia and atelectasis (Wu *et al.*, 2019).

To differentiate the causes of pediatric nasal obstruction, it is essential to perform a detailed history and focused physical examination. Common causes include allergic rhinitis, characterized by symptoms like sneezing and rhinorrhea, and hypertrophy of adenoids and inferior turbinates, associated with sleep respiratory disorders and recurrent otitis. The insertion of nasal foreign bodies should also be considered, especially in cases of persistent unilateral discharge. The complete physical examination includes anterior rhinoscopy and otoscopy to evaluate the upper and middle airways, with referral to specialists for cases with warning signs (Sapsford *et al.*, 2022).

TREATMENT

Effective treatment of foreign bodies in the respiratory tract in children is crucial to mitigate the risks associated with upper airway obstruction, which can be potentially fatal. Early interventions not only improve the patient's prognosis but also reduce the time of exposure to complications such as atelectasis, infection, and structural damage to lung tissues (Morice *et al.*, 2020). Rapid intervention is essential to prevent severe respiratory sequelae and promote long-term quality of life for pediatric patients.

The main therapeutic approaches for removing foreign bodies from the airway include endoscopic techniques, such as bronchoscopy, which allows direct visualization of the foreign body and its removal using specialized instruments, ensuring precise intervention and minimizing additional damage to lung tissue (Ngamsanga *et al.*, 2023).

The choice between rigid and flexible bronchoscopy depends on the location of the object, the patient's age, and the interventional physician's expertise (Wu *et al.*, 2020). Rigid

bronchoscopy is preferred for large or irregularly shaped foreign bodies, allowing direct and precise intervention to keep the airway unobstructed in emergency situations (Wu *et al.*, 2020; Wiemers *et al.*, 2023). On the other hand, flexible bronchoscopy is more indicated for foreign bodies in hard-to-reach areas or in patients with complex anatomy (Han *et al.*, 2022; Schramm *et al.*, 2022).

In addition to traditional endoscopic techniques, cryotherapy has emerged as a promising option in specific situations, prioritizing tissue preservation and minimizing damage, with a low rate of reported adverse complications (Sapsford; Dawson and Anderson, 2022). The selection of the ideal therapeutic approach is based on a detailed evaluation of each clinical case, ensuring personalized treatment for patients with airway obstruction (Sezer; Eliçora and Topçu, 2024).

In recent years, flexible fiberscopes have played an increasing role in managing airway foreign bodies, allowing the use of specialized tools such as ultrathin basket-shaped forceps, facilitating the removal of objects through the working channel (Bohadana; Santos; Magalhães and Cesar, 2023). Various complementary technologies can be employed during flexible bronchoscopy, adapting to the specific nature of the foreign body, including special forceps, net baskets, freezing, balloons, and lasers. In complex situations, when foreign bodies resist conventional endoscopic methods and present an increased risk of complications such as severe hemoptysis or airway perforation, surgical intervention becomes inevitable (Han *et al.*, 2022).

For patients with clinical suspicion of a foreign body but without defined location by imaging or initial bronchoscopy, hydrosoluble contrast bronchography associated with flexible bronchoscopy can be an effective diagnostic and therapeutic approach (Bohadana; Santos; Magalhães and Cesar, 2023). Contrast bronchography provides a detailed visualization of the respiratory tree, facilitating the precise location of the impacted foreign body (Bohadana; Santos; Magalhães and Cesar, 2023). For cases of unilateral upper airway obstruction by a foreign body, the technique known as mother's kiss has proven effective, where the caregiver blocks the unaffected nostril and, with a sealed mouth, provides a burst of air into the child's mouth, facilitating object removal (Sapsford; Dawson; Anderson, 2022). In situations of total airway obstruction, the Heimlich maneuver has been effective, especially outside the hospital environment (Sezer; Eliçora and Topçu, 2024).

The combined use of flexible bronchoscopy with various specialized therapeutic techniques has demonstrated a satisfactory safety profile, with few reports of severe complications such as hemoptysis, dyspnea, and pneumothorax (Han *et al.*, 2022). If the initial attempt with the mother's kiss technique is unsuccessful, it is imperative to immediately refer the patient for evaluation in an emergency service (Sapsford; Dawson and Anderson, 2022). After combined hydrosoluble contrast bronchography and flexible bronchoscopy procedures, patient observation in an intensive care unit for 24 hours is recommended due to the potential for complications such as infection, perforation, or pneumonia (Bohadana;

Santos; Magalhães and Cesar, 2023). According to a recent review, no admissions to intensive care units or deaths related to cryotherapy complications have been reported, indicating a good safety profile for this emerging treatment (Schramm *et al.*, 2022). This adjustment aims to provide a comprehensive and updated overview of treatment strategies for airway obstruction by foreign bodies in children, highlighting the importance of the careful choice of the therapeutic approach for each specific clinical situation.

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