

Choking in children: causes, prevention and intervention strategies

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ABSTRACT

Choking episodes in children are a significant public health problem that can lead to serious consequences if not addressed quickly and effectively. Early diagnosis, appropriate treatment and prevention are key to ensuring the safety of children. This review article aims to comprehensively examine the causes, symptoms, diagnosis, and intervention methods of choking in the pediatric population. The review methods included the analysis of scientific publications located in databases such as PubMed and scientific journals, including meta-analyses, randomized trials and systematic reviews regarding the scope of the problem of choking in children, excluding case reports. Choking is most often caused by the aspiration of foreign objects such as small toys, food (e.g. grapes, nuts, pieces of meat) and other small objects that children often put into their mouths out of curiosity. Children aged 1 to 4 are particularly vulnerable as they have a natural tendency to explore their surroundings using their mouths. Symptoms of choking may include sudden difficulty breathing, intense coughing, wheezing, cyanosis and loss of consciousness. Quick recognition of symptoms is crucial to prevent serious consequences, such as cerebral hypoxia or cardiac arrest. In diagnostics, it is also important to take a thorough history and use imaging tests, such as X-ray or bronchoscopy, to locate and remove the foreign body. This article seeks to better understand the factors contributing to choking in children and provide the latest evidence-based recommendations for prevention and intervention.

KEY WORDS: foreign body, choking, obstruction

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INTRODUCTION

Choking incidents in the pediatric population constitute a pressing public health issue, demanding attention due to their potential for severe consequences on children's well-being. Each year, it is approximated that tens of thousands of deaths are attributed to choking, with an incidence rate of 0.66 per 100,000 population [1]. While the majority of Foreign Body Airway Obstruction (FBAO) events are nonfatal, FBAO is a major cause of coincidental death in children less than one year old and accounts for 7% of deaths in children under four years old [2]. The vulnerability of children to choking hazards is heightened by their developmental stages, dietary habits, and exploratory behaviors, making it imperative to understand the causes, assess preventative measures, and develop effective interventions [3].

The World Health Organization (WHO) estimates that unintentional injuries, including choking, are a leading cause of mortality and morbidity among children globally. Choking, specifically, arises from the inhalation or ingestion of foreign objects, primarily food items, toys,

or small objects, posing a significant risk to the respiratory and cardiovascular systems of young children [4].

Choking incidents are not only a result of physical hazards but also a consequence of inadequate supervision and knowledge. Parental and caregiver education about the risks and preventive measures are crucial components of a comprehensive approach to reducing pediatric choking incidents.

Despite advances in medical care and emergency response, the timely and effective management of choking incidents remains a critical challenge. Basic life support training for caregivers, educators, and healthcare professionals is crucial in alleviating the consequences of such incidents and enhancing overall community preparedness.

AIM

This review article aims to comprehensively examine the causes, symptoms, diagnosis, and intervention methods of choking in the pediatric population.

MATERIAL AND METHODS

The review methods included the analysis of scientific publications located in databases such as PubMed and scientific journals, including meta-analyses, randomized trials and systematic reviews regarding the scope of the problem of choking in children, excluding case reports.

REVIEW AND DISCUSSION

CAUSES OF CHOKING IN CHILDREN

AGE-RELATED RISK FACTORS

Instances of Foreign Body Airway Obstruction (FBAO) are frequent among children, especially in the preschool age group, most commonly occurring between the ages of one and four years [5, 6]. This is due to a number of factors, including underdeveloped chewing abilities, immature dentition, narrower airways, and specific behaviors such as heightened activity levels, playfulness, and distractibility, all of which elevate the risk of choking [3, 7].

While there is some variation in the literature, an overwhelming amount of data suggests that the highest risk is observed in young males [3, 8]. The majority of these choking events involving children occur either at home or at preschool, where parents or kindergarten teachers typically provide care and supervision, given that these are the primary settings where children spend their time [9].

Age plays a crucial role in the susceptibility of children to choking incidents. Infants, with their limited motor skills and reflexes, are particularly vulnerable, while toddlers and older children may face different risks associated with their developmental stages. Understanding the age-related factors contributing to choking incidents is pivotal for tailoring prevention and intervention strategies to specific age groups [3, 7].

PRIMARY CAUSES OF CHOKING IN CHILDREN

Numerous objects and substances prevalent in children's environments have been identified as common choking hazards. Choking incidents in children often involve small and hard foods like nuts, seeds, popcorn, candies, and raw vegetables, as well as small toys, coins, tooth fragments, buttons, and batteries [3, 8]. In the study conducted by Chiu et al., nuts and peanuts were identified as the most frequently aspirated foreign bodies, accounting for 59% of cases [10]. Additionally, the lack of awareness among caregivers regarding these hazards further compounds the risk. Analyzing the types of objects and foods associated with choking

incidents provides insights into effective educational campaigns and childproofing strategies.

SYMPTOMS OF FOREIGN BODY ASPIRATION

Symptoms of foreign body aspiration depend on the degree of airway obstruction, the child's age, the type of foreign body aspirated, and the time elapsed since the event. Delayed diagnosis of foreign body aspiration is common. Data suggest that diagnosis within 24 hours of the event occurs in only 50-60% of cases [11, 12]. The duration between presentation and diagnosis, as well as the time between an FBA and seeking medical assistance, seem to be influenced by a number of factors. These variables include the severity of airway obstruction, whether or not a witnessed choking episode was present, the patient's age, and the kind of foreign body obstructing the airway [3]. To avoid delayed diagnosis and associated mortality, medical personnel should exhibit a high suspicion for this condition.

Most often, children with foreign body aspiration present symptoms of partial airway obstruction. The most common symptom is cough, followed by tachypnea and stridor. An important sign in physical examination aiding in the diagnosis of foreign body aspiration is regional diminishment of breath sounds and the presence of wheezing. The classical triad of symptoms, including cough, wheezing, and diminished breath sounds, is not present in every case. In a description of 135 cases of foreign body aspiration in children, the classical triad of symptoms occurred in only 57% of cases [11].

Symptoms of foreign body aspiration vary depending on its location in the airways. Only 3% of aspirated foreign bodies typically become lodged in the larynx, often characterized by their bulkiness, irregular shape, or sharp, penetrating nature [13]. The majority of aspirated foreign bodies (75%) typically lodge in the lower section of the airway. According to studies 13% of these are lodged in the trachea, 60% in the right lung, and 23% in the left lung. Bilateral foreign body occurrences are rare, accounting for only 2% of cases [14, 15].

Location in the larynx or trachea – foreign bodies in the larynx and trachea are rare but particularly life-threatening. Symptoms include wheezing, cough, drooling, dyspnea, and voice change. Foreign bodies in this location most commonly manifest as acute respiratory distress [16, 17].

Location in the large bronchi – typical symptoms for this location include cough and wheezing. Hemoptysis, dyspnea, difficulty breathing, diminished breath sounds, fever, and cyanosis may also occur [14, 15, 18]. Foreign bodies most commonly lodge in the right bronchus.

Lower airways – children with a foreign body lodged in this part of the airways may have few or no symptoms in the initial period after choking.

DIAGNOSIS

The diagnostic process for children suspected of foreign body aspiration involves a systematic approach, encompassing clinical evaluation, imaging studies, and, if necessary, endoscopic procedures. The steps typically include:

1. Clinical assessment

Gathering information on the patient's medical history, including details about the choking episode, type of object or food involved, and the duration of symptoms is essential for an accurate diagnosis. According to Yadav et al. study the duration of symptoms ranged from ≤ 6 hours to 3 months [19].

Aspiration of foreign bodies might not be suspected initially due to nonspecific symptoms. A sizable foreign body can lead to complete airway obstruction, resulting in sudden and potentially fatal outcomes. Sharp objects can directly injure the airway. However, in the majority of cases, symptoms of tracheobronchial foreign body aspiration are nonspecific. This underlines the significance of assessing symptoms such as coughing, wheezing, respiratory distress, dysphagia and fever [8, 20].

2. Imaging studies and endoscopic evaluation

In the assessment of airway foreign bodies in pediatric patients, whether radiopaque or non-radiopaque, radiography, serves a crucial role in both initial detection and subsequent follow-up evaluations [20]. Magnetic resonance imaging (MR) and computed tomography (CT) are additional imaging techniques that may be beneficial, but usually aren't required to make the diagnosis [13].

The majority of foreign bodies are radiolucent, primarily composed of organic material, such as food. Only around 10% of aspirated foreign bodies appear radiopaque [13]. In many cases, particularly when the foreign body doesn't completely obstruct the airway, chest radiographs may show no abnormalities. Radiographic findings are influenced by the location and characteristics of the obstruction, whether it is partial or complete. For upper airway obstruction caused by foreign bodies, indirect signs may be observed, including hypopharynx overdistention and prevertebral soft-tissue swelling. In cases of partial airway obstruction, which is most common, there might be evidence of unilateral hy-

perinflation, atelectasis, or mediastinal shift. Due to the typical delay in clinical manifestations (averaging 24 hours), careful examination is crucial for identifying complications such as pneumomediastinum and pneumothorax [13].

CT is usually not indicated because it will delay diagnosis. However CT is recommended to examine for any remaining foreign body post-bronchoscopy or when there is concern about severe complications, such as aortic perforation. Esophageal foreign bodies might also lead to airway obstruction due to mass effect and inflammation [13].

Bronchoscopy stands as the definitive standard for both the diagnosis and management of aspirated foreign bodies, even in cases where radiographs show no abnormalities [13]. Shlizerman et al. reported that the occurrence of positive bronchoscopies for foreign bodies was notably higher in children aged ≤ 2 years (82.6%) in comparison to older children (57.1%) ($p = 0.001$) [21].

3. Additional tests and follow-up assessments

Additional tests may be ordered to further assess specific aspects of foreign body aspiration cases. Pulmonary function tests are conducted when there is suspicion of compromised airway function, providing valuable insights into lung performance. Blood tests are also utilized to check for signs of infection or inflammation, aiding in the overall diagnostic evaluation and differential diagnosis of respiratory failure [3].

Continuous monitoring of the patient's clinical status is vital in foreign body aspiration cases. This includes regular observation of symptoms and respiratory condition, with the possibility of repeat imaging for resolution confirmation or complication identification. This proactive monitoring strategy ensures timely responses to any changes in the patient's condition, enhancing overall management effectiveness [13].

Recognition of esophageal, tracheal or bronchial lodging of disc batteries is crucial due to the risk of serious complications, including perforation. After removal, bronchoscopy and an upper gastrointestinal examination is essential to assess for potential issues like strictures, erosions, tracheoesophageal, or aorto-esophageal fistulas [13].

The diagnosis process involves a collaborative effort among healthcare professionals, including pediatricians, pulmonologists, and otolaryngologists, to ensure a comprehensive and accurate assessment. Timely and precise diagnosis is crucial for initiating appropriate management, which may include bronchoscopic removal of the foreign body and addressing any associated complications.

MANAGEMENT

In cases of partial airway obstruction, characterized by audible breathing and the ability to produce sound, children should be encouraged to cough and observed. For complete airway obstruction, where the child cannot speak or cough but remains conscious, attempts should be made to remove the obstruction using back blows and chest thrusts in infants and the abdominal thrusts in older children. However, these interventions should be avoided in children who can speak or cough, as they may convert partial obstruction into complete obstruction [11].

Recommendations from the American Heart Association differ for children under 1 year of age and older.

Management in children under 1 year of age

The child should be placed on the caregiver's forearm with the head lowered, using the index finger and thumb to grip the chin, taking care not to grasp the child's neck. The caregiver should deliver five back blows with the heel of their other hand between the shoulder blades and check if the foreign body has been dislodged.

If five back blows are unsuccessful, the child should be laid on their back, and the caregiver should use two fingers to perform chest compressions at a rate of 100-120 per minute to a depth of about $\frac{1}{3}$ of the anterior-posterior diameter of the chest. Up to five chest compressions should be performed, checking if the foreign body has been expelled from the child's mouth. If there is no improvement, repeat the back blows and chest compressions until successful.

If the child loses consciousness, resuscitation should be initiated.

Management in older children

The caregiver should sit and place the child bent forward over their knees. In this position, the child should receive five back blows between the shoulder blades. If there is no improvement, five abdominal thrusts should be performed. The caregiver should stand behind the child, wrap their arms around the child's armpits, place their left hand in a fist just below the xiphoid process, grasp with their right hand, and vigorously pull their hands towards themselves and upwards to increase pressure in the chest. This action should be repeated five times, alternating with back blows.

In the oldest children and adults, place the left hand on the chest in front and bend the person down with the right hand. Then, five vigorous thrusts should be delivered with the heel of the hand between the shoulder blades, checking if the foreign body has been expelled from the mouth. If unsuccessful, the caregiver should

stand behind the patient, wrap their arms around them under the armpits, place their left hand in a fist just below the xiphoid process, grasp with their right hand, and vigorously pull their hands towards themselves and upwards. This action should be repeated five times, alternating with back blows.

Pre-hospital procedures

Pre-hospital care is critical in stabilizing pediatric patients with airway obstructions before hospital arrival. Emergency medical teams should aim to partially clear the airway to enable safe transport. If the child can maintain minimal respiration, transport to the hospital can proceed, where advanced procedures, like bronchoscopy, can be performed. Pre-hospital interventions may include suction, manual clearance, or intubation, depending on the severity of the obstruction. Timely action significantly improves outcomes and reduces the risk of complications.

Hospital Management

If airway obstruction persists despite the above measures, attempts may be made to remove the foreign body through direct laryngoscopy using Magill forceps. However, this method is only applicable to foreign bodies located above the vocal cords.

If the foreign body is not visible during laryngoscopy, surgical airway clearance or attempts to push the foreign body into the right main bronchus with an intubation tube may be considered. Additionally, rigid bronchoscopy may be utilized.

When obstruction caused by a foreign body is below the larynx and recommended measures are ineffective, intubation and ventilation of the patient should be considered until rigid bronchoscopy can be performed.

Complications of foreign body aspiration

Foreign body aspiration can lead to acute and life-threatening obstruction. Over 300 deaths of children annually in the United States result from foreign body aspiration. Undiagnosed foreign bodies can also cause serious complications such as pneumonia, wheezing, bronchiectasis, or atelectasis.

High vigilance is necessary to avoid significant morbidity and mortality [22-24]

Most children recover completely after the removal of a foreign body following an aspiration incident. However, some, particularly with delayed diagnosis, may experience a complicated recovery course characterized by persistent respiratory symptoms such as cough and wheezing or require prolonged hospitalization. Many of these events are associated with inflammatory processes initiated by the foreign body [24, 25].

A study conducted by Karakoc, F. et al. involved long-term observation of 110 patients, in which no persistent symptoms such as cough or wheezing or bronchiectasis were found after removal of inorganic foreign bodies. However, it was noted that organic foreign bodies were associated with an increased risk of persistent symptoms and bronchiectasis, as confirmed by computer tomography [26].

The frequency of distant complications after aspiration of an organic foreign body was associated with the time elapsed from aspiration to diagnosis. The risk of distant complications increased with the duration from aspiration to diagnosis. No complications occurred in children diagnosed within the first 24 hours, while the complication rate reached 60% in children diagnosed after 30 days ($p=0.0035$). Bronchiectasis was a serious complication in 25% of patients with a delay in diagnosis of more than 30

days ($p=0.0001$). Persistent respiratory symptoms such as cough and wheezing were found in 25% of patients not diagnosed within the first 24 hours [26].

CONCLUSIONS

By addressing the causes, diagnosis strategies, and intervention methods associated with choking incidents in children, this research paper aims to contribute to the development of effective public health initiatives and policies to safeguard the well-being of the pediatric population. Detailed discussion of these issues enables a deeper understanding of the mechanisms leading to choking, identification of the most effective diagnostic procedures, and implementation of interventions that can prevent or minimize the risk of choking in the pediatric population.

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