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Foreign Body Aspiration among Children: Risk and Management

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Abstract

Introduction: Delay in diagnosis and treatment of foreign body aspiration, especially if treatment involves bronchoscopy by specialists, can have serious consequences and can even lead to the death of children. This review aimed to discuss the risks and management of foreign body aspiration among children.

Methods: A systematic search of the Ovid MEDLINE, Ovid Embase, PubMed, Web of Science, and CINAHL databases was conducted to identify all studies that described clinical prediction models (CPMs) for diagnosing foreign body aspiration (FBA) in children. We also reviewed methods for removing foreign bodies and the outcomes for each patient. The following information was collected: demographic data, time interval from the onset of symptoms to presentation at the hospital, presenting symptoms and signs, examination findings, first-line investigations, time interval before bronchoscopy, intraoperative findings, method of foreign body removal, and individual outcome.

Results: There were 10 studies included in this review because they focused on aspirations and ingestions that were either not documented or retrieved in the posterior pharynx. The complication rate for sharp objects increases to greater than 15% to 35% depending on the number, type, and gastrointestinal contact time, compared to a rate of less than or equal to 1% for non-sharp objects. Patients at increased risk of a retained esophageal coin include those who are small, those with underlying esophageal disease such as a stricture. Bronchoscopy may be necessary to diagnose and remove the foreign body and to rule out other common pediatric conditions. Organic foreign bodies, such as nuts and seeds, can cause inflammatory reactions and may cause symptoms like fever and pneumonia. Inorganic foreign bodies, like toy parts and pen caps, may also be aspirated but do not typically cause these types of reactions.

Conclusions: Children are at a high risk of foreign body aspiration due to their narrow airways and other developmental factors. Early diagnosis and removal of inhaled foreign materials can reduce complications and mortality. The type and location of the foreign body can be determined through a chest X-ray and a thorough history.

Keywords: Chocking, Ingestion, Foreign body, Inhalation, Children.

Introduction

Pediatric foreign body aspiration (FBA) is a serious and potentially life-threatening emergency that most commonly affects children under the age of 5. FBA can cause partial or complete obstruction of the airway, leading to complications such as pneumonia, atelectasis, bronchiectasis, anoxic brain injury, or death. It is important to quickly diagnose and manage FBA to prevent these outcomes. However, the diagnosis can be difficult due to the subtle physical examination and radiological findings often associated with FBA, leading to delays and an increased risk of complications [1]. Bronchoscopy, an invasive procedure that requires general anesthesia and is often only available at pediatric centers, is often used to diagnose FBA, but it can have a negative finding rate of 16% to 57%. Therefore, having an algorithm to predict FBA would be extremely useful. Clinical prediction models (CPMs) can help healthcare professionals evaluate the probability of a diagnosis to aid in patient stratification [2].

Foreign body aspiration (FBA) is a leading cause of accidental death in children under the age of five in the United States, accounting for 5% of all accidental deaths in children under the age of four and the leading cause of accidental deaths in the home among children under the age of six [3]. It continues to be a significant problem in pediatrics, resulting in thousands of emergency room visits and over 100 deaths each year in the United States. Delay in diagnosis and treatment, especially if treatment involves bronchoscopy by specialists, can have serious consequences and can even lead to the death of children. The mortality rate in children with FBA and compare it to the findings of other authors. The main focus is on the mortality rate in children with FBA. Tracheobronchial foreign body aspiration is a common pediatric emergency and a significant cause of morbidity and mortality, particularly in preschool-aged children [4].

Symptoms of foreign body aspiration can vary depending on the location of the foreign body in the airways. When the foreign body is trapped in the larynx or trachea, respiratory distress or stridor may be immediately evident. However, diagnosing bronchial foreign body aspiration can be challenging when there are few or no symptoms [5]. Rigid bronchoscopy under general anesthesia is currently the standard technique for extracting bronchial foreign bodies in children, but this procedure is often used for both diagnostic and therapeutic purposes, resulting in a negative bronchoscopy rate of 10% to 61% and complications, particularly in young children. Based on a review of the literature, the most appropriate complementary investigations in cases of suspected bronchial foreign body in children should be identified to reduce the negative rigid bronchoscopy rate[6].

The key clinical diagnostic feature is the penetration syndrome, which is the body's respiratory defense reflexes (such as expulsive coughing and laryngeal spasm) in response to the penetration of a foreign body. The penetration syndrome can cause symptoms of asphyxia with cyanosis and coughing fits, but it can also be clinically silent in 12% to 25% of cases. In the acute phase, the most common clinical signs are wheezing, localized decrease or loss of breath sounds, and intercostal retraction. If the penetration syndrome is missed, the child may present later with a history of recurrent pneumonia in the same area [7]. In 80% to 96% of cases, foreign bodies are radiolucent, but an anteroposterior chest radiograph in inspiration and forced expiration can show indirect signs of bronchial obstruction (such as obstructive emphysema with air trapping, present in 17% to 69% of cases due to partial obstruction of the bronchus by the foreign body). Atelectasis, present in 12% to 41% of cases, is caused by complete obstruction of the bronchus with distal collapse of the pulmonary parenchyma. Pneumothorax

or pneumomediastinum may also occur due to perforation of the bronchus by the foreign body or alveolar rupture, but these are less common [8]. Airway fluoroscopy, which allows for the visualization of respiratory movements, can also be used to diagnose FBA, but it is operator-dependent and has limited value compared to multidetector computed tomography (CT). This review aimed to discuss the risks and management of foreign body aspiration among children.

Methods

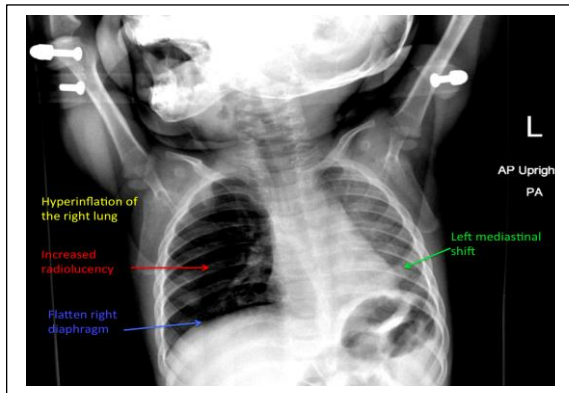
A systematic search of the Ovid MEDLINE, Ovid Embase, PubMed, Web of Science, and CINAHL databases was conducted to identify all studies that described clinical prediction models (CPMs) for diagnosing foreign body aspiration (FBA) in children. The search terms used included "clinical prediction models," "foreign body aspiration," and "pediatrics." The inclusion criteria for the study were: study type (randomized clinical trials, prospective or retrospective observational studies, cross-sectional/case-control trials, prediction model derivation studies with or without external validation, and external model validation studies), population (pediatric patients under the age of 18), intervention/exposure (CPMs developed for use in clinical practice to support the diagnostic decision-making of a healthcare professional during the assessment of pediatric patients with symptoms suggestive of FBA), comparator (not applicable), and setting (inpatient or emergency department). Only original research studies published in English in peer-reviewed journals were included. The citations of studies included in the full-text analysis were screened to ensure all relevant studies were included, and the primary outcome was the diagnosis of FBA as confirmed by bronchoscopy. We also reviewed methods for removing foreign bodies and the outcomes for each patient. The following information was collected: demographic data, time interval from the onset of symptoms to presentation at the hospital, presenting symptoms and signs, examination findings, first-line investigations, time interval before bronchoscopy, intraoperative findings, method of foreign body removal, and individual outcome. Chest radiography was routinely performed for all cases of

suspected foreign body aspiration. Prolonged hospital stays were due to recurrent hospital-acquired pneumonia, sacral sore, and rehabilitation. A negative outcome was defined as no airway foreign body identified in children who received bronchoscopy. The x-axis demonstrates the proportion of models in which the predictor variables were considered or included. WBC indicates white blood cell count.

Results and discussion

There were 10 studies included in this review because they focused on aspirations and ingestions that were either not documented or retrieved in the posterior pharynx. The complication rate for sharp objects increases to greater than 15% to 35% depending on the number, type, and gastrointestinal contact time, compared to a rate of less than or equal to 1% for non-sharp objects. Patients at increased risk of a retained esophageal coin include those who are small, those with underlying esophageal disease such as a stricture (e.g. due to previous injury from a caustic ingestion), those who have undergone esophageal surgery (e.g. repair of a tracheoesophageal fistula or esophageal atresia, or gastric fundoplication), and those who ingest multiple coins at one time. A retrospective review of 31 pediatric patients with esophageal coin ingestions found that nine of the 11 asymptomatic patients had passed the coin at a 24-hour follow-up radiography, avoiding the need for removal [9,10].

Approximately 60% to 70% of ingested objects impact at the upper esophageal sphincter or thoracic inlet, 10% to 20% lodge in the mid-esophagus at the level of the aortic notch, and 20% stick just above the lower esophageal sphincter. If an object has not passed after 2 to 3 weeks, a repeat abdominal film can be obtained and, if it still has not passed after 4 to 6 weeks, endoscopic removal can be performed [11]. Equipment for removal may include tripod or pentapod forceps, the Roth retrieval net, and a friction fit adaptor for the endoscope end to allow suction during removal. Asymptomatic patients can be observed for passage of the object. After a diagnostic endoscopy, endoscopic forceps can be preloaded with a long surgical suture through the biopsy channel, with the remainder of the suture outside of and adjacent to the endoscope.



The suture can then be advanced with the forceps through the opening of the object requiring removal, and retrieved on the other side of the opening with the forceps. Children often swallow foreign objects accidentally, whereas adults may do so intentionally [11]. The rate of accidental foreign body ingestion in children is higher than in adults, with coins and toys being among the most common objects swallowed. Sharp foreign objects increase the risk of complications, including obstruction and perforation. There are various techniques for removing foreign bodies, including the use of suture, double snare, and combined forceps/snare techniques for larger or sharper objects. In cases where multiple magnets have been ingested, there is a significant risk of obstruction, perforation, and fistula development. It is important to obtain a radiograph in cases of suspected coin or other radiopaque foreign body ingestion. As more common objects become magnetized, education about the risk of ingestion will be necessary [12].

If a coin becomes stuck in the esophagus and a patient is experiencing respiratory symptoms for more than a few days, it is possible that the coin is causing erosion in the esophagus. In this case, the coin should be removed as soon as possible through endoscopy, especially if the patient is unable to swallow their secretions or is experiencing acute respiratory symptoms [13,14]. Endoscopy carries a risk of aspiration of gastric contents, so appropriate precautions should be taken. If the patient is not experiencing symptoms or is able to handle their secretions, the procedure can be delayed for 12 to 24 hours to allow for a pre-anesthetic fast. Most coins that pass through the esophagus and into the stomach will

pass through the rest of the gastrointestinal tract without causing any complications, except in certain cases such as small children, those with underlying health conditions or prior surgery, or those who have swallowed very large coins. If a coin passes through the gastrointestinal tract, parents can check the stool for evidence of its passage. Button batteries are more commonly ingested by children than cylindrical batteries, and can come from sources such as hearing aids or other household items. The management of battery ingestion differs from coin ingestion, despite the similar size of the two objects. If a battery is suspected to have been ingested, it is important to locate it through immediate radiography, even if the patient is not experiencing symptoms [15]. If a battery is found in the esophagus, it should be removed through endoscopy as soon as possible, even if the patient has not been fasted, to avoid the risk of aspiration. If a battery is found in the stomach, it is likely to pass through the rest of the gastrointestinal tract without causing any problems, with 80% passing within 48 hours. However, larger batteries that do not pass through the pylorus within 48 hours in an adolescent are less likely to pass spontaneously and may require removal. The size of the battery will determine whether it can pass through the pylorus in younger patients, and modifications to the size criteria may be necessary. For example, an AA battery may not pass through the pylorus in a 1-year-old child, and early endoscopy may be necessary in this case [16, 17].

If a battery is found in the stomach and the patient is experiencing symptoms, it should be removed through endoscopy as soon as possible. Ingestion of a straight pin can be a special case in the management of sharp objects. Pins tend to perforate tissues if the pointed end is facing forward, but not if it is facing backward. Most perforations caused by pins occur near the ileocecal valve. Over-tubes are not currently available in sizes suitable for pediatric patients, so they are not commonly used in this age group [18]. Open safety pins may cause laceration or perforation during ingestion or attempts at removal, while closed pins can be removed safely using forceps. Open pins that have advanced to the stomach can be closed in the stomach and then safely withdrawn. Long or large objects that become stuck in the esophagus, pylorus, or duodenal

"C" loop may need to be removed through endoscopy. The size and shape of the object will determine whether it can pass through the pylorus, and size criteria may need to be modified for younger or smaller patients [19]. An object's shape and size may also affect its ability to pass through the pylorus, and ovoid objects larger than 5 cm in length and 2 cm in thickness may not pass through the pylorus in an adolescent. The size criteria for determining whether an object can pass through the pylorus should be modified for younger and smaller pediatric patients. If a patient has swallowed a non-sharp long or large object and is not experiencing symptoms, endoscopy can be performed after a period of pre-anesthetic fasting. If the patient is experiencing symptoms, more urgent endoscopy is required, despite the risks of aspiration and impaired visualization during the procedure [20]. If a patient is suspected of having ingested magnets, radiography should be performed to locate them. If the magnets are not large and are beyond the reach of the endoscope, the options for treatment may include careful monitoring for passage through the gastrointestinal tract or surgical consultation for removal, depending on the individual case. If a patient has ingested a product that is suspected to contain lead, such as lead-based paint, a toy, or a clothing accessory, early endoscopic removal is recommended, especially if there is an elevated blood lead level [21].

If a patient is suspected of having a food impaction, a plain radiograph can be obtained to confirm the diagnosis. However, contrast should be avoided to minimize the risk of aspiration of contrast that has pooled above the impaction. If a patient is unable to handle their secretions, they should receive urgent endoscopic disimpaction [22,23]. If the patient is able to handle their secretions, endoscopy should be performed within 12 hours. It is important to avoid using "meat tenderizers," as this can lead to hypernatremia and damage to the esophagus. When removing a foreign body, it is best to have a protected airway to avoid the risk of aspiration. There are several newer techniques available for removing foreign bodies, including the double snare technique for long objects like spoons, the combined forceps-snare technique for safety pins, and the use of a friction fit adaptor or Roth retrieval net for meat impactions [24].

These techniques can help to orient the foreign body correctly for removal, allowing it to be removed in a parallel direction to the esophageal axis.

Conclusions

Children are at a high risk of foreign body aspiration due to their narrow airways and other developmental factors. Early diagnosis and removal of inhaled foreign materials can reduce complications and mortality. The type and location of the foreign body can be determined through a chest X-ray and a thorough history. Bronchoscopy may be necessary to diagnose and remove the foreign body and to rule out other common pediatric conditions. Organic foreign bodies, such as nuts and seeds, can cause inflammatory reactions and may cause symptoms like fever and pneumonia. Inorganic foreign bodies, like toy parts and pen caps, may also be aspirated but do not typically cause these types of reactions.

Conflict of interests

The authors declared no conflict of interests.

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