Flexible Bronchoscopy for the Pediatric Intensivist: A New Tool in the Handbag?

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Abstract

Foreign body aspiration (FBA) is a common cause of unintentional-injury mortality. Modern bronchoscopy techniques have reduced mortality in children with FBA. In this article, we described a case of a 16-month-old child with refractory hypoxia where flexible bronchoscopy performed by the intensivist led to prompt etiology recognition and proper treatment. Patients presenting with respiratory distress with persistent hypoxia should be evaluated for FBA, considering initial chest X-ray can be normal in at least 30% of the cases. Intensivists trained in flexible bronchoscopy techniques possess a valuable tool to obtain diagnostic information avoiding delays in diagnosis and initiation of unnecessary therapies, such as extracorporeal membrane oxygenation.

Keywords

- bronchoscopy
- aspiration
- foreign body

Introduction

Foreign body aspiration (FBA) is a common cause of unintentional-injury mortality in the United States. Prior to the 20th century, it had a 24% mortality.¹ More recently, in 2016, the National Safety Council reported the rate of fatal choking as 0.43 per 100,000 population in American children less than 5 years of age. Nonfatal choking, on the other hand, in children less than 14 years of age had a higher rate of 20.4 per 100,000, of which 55% were in children less than 4 years of age primarily due to candy, hot dogs, and nuts. Modern bronchoscopy techniques have reduced mortality in children with FBA. We described a case of FBA in a child presenting with respiratory failure and refractory hypoxia where flexible bronchoscopy performed by the pediatric intensivist led to the recognition and proper treatment just in time.

Case

Patient is a 16-month-old male infant with a known history of reactive airway disease (responsive to β -agonist therapy in the past) who presents with acute onset of respiratory distress, bilateral wheezing, slightly diminished breath

sounds in the right lung field, and cyanosis. In the emergency room he immediately received inhaled β -agonists, intravenous steroids, and subcutaneous epinephrine. Respiratory distress worsened over the next few hours, requiring intubation and mechanical ventilation. Initial chest X-ray (CXR) revealed left mid-lung and bilateral lower lung opacities suggestive of infiltrates (►Fig. 1). He continued to have persistent desaturations to 60% despite proper intubation (confirmed via direct laryngoscopy and CXR), requiring intermittent bag mask ventilation with interval improvement of saturations to 82%. His initial venous blood gas immediately after intubation demonstrated a pH of 7.17 and partial pressure of carbon dioxide (pCO₂) of 53 mm Hg. He was transferred to our PICU for further management of refractory hypoxia.

Repeat CXR on admission showed complete opacification of the right hemithorax without evidence of pleural effusion on ultrasound (►Fig. 2). His initial arterial blood gas upon PICU admission demonstrated a pH of 7.23, pCO₂ of 57 mm Hg, partial pressure of oxygen (pO₂) of 54 mm Hg, and bicarbonate of 23 mEq/L, with oxygen saturations in the eighties. After endotracheal tube upsizing and recruitment maneuvers, there was interval improvement of the opacification on CXR;

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Fig. 1 Initial CXR upon ER arrival showing bilateral lower lung opacities suggestive of infiltrates. CXR, chest X-ray; ER, emergency room.

Fig. 2 Repeat CXR in the PICU showing complete opacification of the right hemithorax. CXR, chest X-ray; PICU, pediatric intensive care unit.

however, he developed pneumomediastinum and continued to require high mean airway pressures with poor oxygenation and labile hemodynamics requiring vasopressor support. He was trialed on various ventilator modalities, including synchronized intermittent mandatory ventilation, airway pressure release ventilation, and high-frequency oscillatory ventilation to encourage improved oxygenation and airway recruitment, yet he remained persistently hypoxemic. His refractory hypoxemia was demonstrated by an oxygenation index of 39 and a PaO_2 -to- FiO_2 (P:F) ratio of 54. Extracorporeal

Fig. 3 Visualization of the foreign body in the right mainstem bronchus with flexible bronchoscopy.

Fig. 4 Visualization of the foreign body (peanut) in the right mainstem bronchus with rigid bronchoscopy.

membrane oxygenation (ECMO) was considered given significant hypoxemia after failed recruitment maneuvers.

Prior to ECMO initiation, on day three of admission, the patient underwent flexible bronchoscopy performed by the pediatric intensivist and a foreign body was visualized completely obstructing the right mainstem bronchus (►Fig. 3). Rigid bronchoscopy was then performed on the same day to remove a large peanut (►Fig. 4), also revealing necrosis of the vocal cords. As per patient's mother, there was no known history of FBA. Rigid bronchoscopy was repeated on day ten of admission due to failure of extubation, showing normal supraglottis, small intubation granulomas, no subglottic stenosis, significant necrosis to the lateral walls of the cricoid, with normal distal airways and no residual foreign body. He was extubated 12 days after admission and subsequently weaned to room air prior to discharge with no reported complications.

Discussion

FBA in children can lead to serious consequences, such as significant pulmonary disease, unnecessary medical

procedures, and even death. Fortunately, the number of deaths has declined over the past decades with prompt diagnostic strategies, increased parental education, and federally-mandated regulations for toy manufacturers.² Bronchoscopy procedures particularly have reduced the rate of mortality and morbidity associated with FBA, providing both diagnostic and therapeutic advantages.³ Commonly aspirated foreign bodies in children include food, such as peanuts, popcorn, seeds, and hot dogs, and others including bones, toy parts, crayons, pen tops, pins, nails, tacks, and screws.⁴

The diagnosis of FBA can be made with a thorough history or a reliable witness, often complicating the diagnosis. Therefore, the use of physical and radiographic findings is essential. Children may present with respiratory distress, cough, stridor, tachypnea, and diminished breath sounds on exam. Normal breath sounds on exam may not exclude FBA as a diagnosis; however, absent breath sounds occur in 30 to 60% of children with FBA and suggest total airway obstruction. Although CXR is obtained early in the evaluation of wheezing and respiratory distress, it can be normal in at least 30% of the cases, primarily due to many aspirated foreign objects being radiolucent.^{4–6} CXRs can be useful in recognizing particular findings that are suggestive of FBA, including air trapping, mediastinal shift, atelectasis, lobar collapse, pneumonia, consolidation, or the presence of a radiopaque foreign body. The common CXR findings, however, were not evident in our patient, making his diagnosis somewhat challenging. Other diagnostic modalities such as magnetic resonance imaging and computed tomography have limited use in FBA.

Challenges in the initial diagnosis of this patient included lack of common CXR findings and no abnormal vocal cord changes, such as necrosis, reported during intubation and direct laryngoscopy. These were subsequently noted during the first rigid bronchoscopy procedure.

Mortality for FBA prior to the introduction of bronchoscopy neared 50%; this has drastically reduced to less than 1% recently as bronchoscopies are being used frequently in the management of FBA.⁷ Although the diagnostic modality of choice in the treatment of FBA in children is rigid bronchoscopy, studies suggest that flexible bronchoscopy can be used as a first-line modality for the diagnosis and treatment for FBA.⁸ In fact, more reports are available describing flexible bronchoscopy being the primary method of foreign body removal in the pediatric population.⁹

Flexible bronchoscopies have been used in the PICU for several different diagnostic and therapeutic indications including the assessment of endotracheal tube patency and position, intratracheal administration of mucolytic therapy, airway clearance, endotracheal intubation of difficult airways, bronchoalveolar lavage, and assessment of upper and lower airways, among others.^{10,11} When used in a controlled setting, the flexible bronchoscope is a safe and effective modality to assess airway problems in children.¹² Different institutions around the world have varying practices due to the lack of widespread consensus regarding reliable indications for bronchoscopy in children with suspected FBA.^{9,13} Janahi et al found strongest association with the following FBA predictors: wit-

nessed choking event, stridor or noisy breathing, dysphonia, new onset or recurrent or persistent wheeze, abnormal CXR findings, and unilateral reduced aeration on auscultation.¹³

The American Thoracic Society has a multidisciplinary committee which determines specific technical standards for performing flexible airway endoscopy in children.¹¹ These standards include the core competencies for the pediatric flexible airway endoscopist, which encompass adequate understanding for the indications and contraindications of the procedure, familiarity with the necessary equipment, assessment of patient safety with consideration of infection control principles, identification of normal and abnormal upper and lower airway anatomy, ability to perform bronchoalveolar lavage, and management of potential complications. While many agree that a minimum number of flexible bronchoscopies should be performed to attain competency, a formal number has not yet been determined. In 2014, 86% of Pediatric Pulmonology training directors surveyed felt that a median of 50 bronchoscopies (mean of 56.4 ± 33) were required for competency.¹⁴

In supportive institutions, the pediatric intensivist can attain clinical competency to perform flexible airway endoscopies in children. Our institution has four intensivists that possess this valuable skill. Our intensivists have been proctored by pediatric pulmonologists and other pediatric intensivists with bronchoscopy training prior to obtaining hospital privileges, while maintaining adequate documentation of trainee progress. We believe it is a valuable skill to have in the setting of emergent airway concerns, such as FBA and difficult airways.

Any patient presenting with refractory hypoxia and/or unilateral lung findings should be promptly evaluated for FBA, and suspicion of FBA should be promptly evaluated by bronchoscopy. The longer FBA goes undiagnosed or untreated, the greater the risk of subsequent complications. Intensivists trained in flexible bronchoscopy techniques possess a valuable tool to obtain diagnostic information avoiding delays in diagnosis.

Conflict of Interest

None declared.

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