



Acute Respiratory Distress Syndrome immediately following the removal of an aspirated foreign body

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A B S T R A C T

Acute Respiratory Distress Syndrome (ARDS) is a form of diffuse lung injury with many potential etiologies, pneumonia being the most common cause developing outside of the hospital. Foreign body (FB) aspiration is a risk factor for pneumonia, and therefore, ARDS. Although these associations exist, the development of ARDS immediately following the removal of an aspirated FB appears quite rare.

We present the case of an 11 year old male who was found to have a right-sided, post-obstructive pneumonia secondary to an aspirated FB obstructing the bronchus intermedius. Relief of the obstruction allowed for rapid, endobronchial spread of infection and within 6 hours of FB removal, our patient developed severe ARDS requiring initiation of extracorporeal membrane oxygenation (ECMO). *Streptococcus constellatus* was isolated from lower respiratory cultures obtained during initial bronchoscopy.

1. Introduction

Acute Respiratory Distress Syndrome (ARDS) is a form of rapidly progressive, diffuse, and inflammatory lung injury associated with a number of etiologies. Bacterial pneumonia is the most common cause of ARDS developing outside of the hospital setting [1]. Although a variety of processes can lead to ARDS, generally, the end result is diffuse alveolar damage with decreased pulmonary compliance and impaired gas exchange [2]. *Streptococcus constellatus*, a member of the *Streptococcus anginosus* group (SAG), is a normal part of human oral flora capable of producing purulent, respiratory infections if introduced into the lower airways [8,9]. Foreign body (FB) aspiration, a common problem in pediatric medicine, is a known risk factor for respiratory infections caused by organisms normally found in the oral cavity. Although there is an association between aspiration, pneumonia and ARDS, to our knowledge, the rapid onset of severe ARDS immediately following FB removal in a patient with post-obstructive pneumonia due to *S. constellatus* has not been previously described.

2. Case presentation

An 11 year old male with a history of intermittent asthma presented

to our emergency department with one week of cough, fever, and decreased activity. Albuterol had been tried at home with minimal improvement. Of note, there was no history concerning for FB aspiration upon initial questioning.

Upon presentation, the patient was slightly febrile, but in no acute distress. He was able to converse comfortably in full sentences. Vital signs were as follows: Temperature: 100.4F, Pulse: 122, RR: 36, Blood Pressure: 108/74, SpO₂: 97%. On physical examination, there was mild tachypnea and diminished breath sounds in the right lung base. The remainder of the examination was unremarkable.

Due to the concern for community acquired pneumonia, a chest radiograph was performed. Imaging revealed a thin, 1.3 cm metallic FB projecting over the right main bronchus as well as significant airspace disease in the right middle and lower lobes [Fig. 1]. After receiving one dose of ampicillin, the patient was admitted with plans for urgent FB removal.

The patient was subsequently taken to the operating room for both rigid and flexible bronchoscopy. Rigid bronchoscopy revealed purulent secretions and the metal end of a pushpin [Fig. 2] emanating from the right main bronchus. The FB was removed with optical forceps revealing near-circumferential granulation tissue partially obstructing the entrance to the bronchus intermedius [Fig. 3]. After removal of the FB,

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Fig. 1. Single view chest radiograph. Note the 1.3 cm metallic FB projecting over right main bronchus with associated right middle and right lower lobe airspace disease.



Fig. 2. An example of a pushpin, the aspirated foreign body.

copious amounts of purulent secretions filled the right main bronchus and trachea with subsequent spill-over into the left main bronchus. Flexible bronchoscopy was then performed to clear secretions and survey the remaining bronchi. No additional pathology or foreign bodies were visualized.

After FB removal, the patient remained electively intubated and was taken to the intensive care unit (ICU) for close monitoring. Over the next

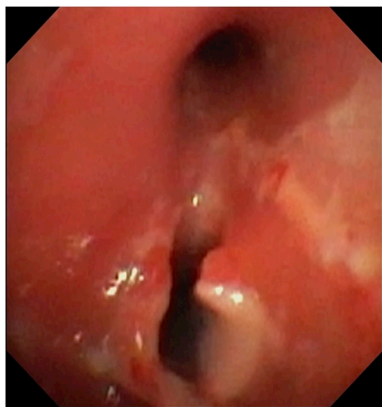


Fig. 3. Still image from flexible bronchoscopy. Note the near-circumferential inflammation and granulation tissue at the entrance to bronchus intermedius (6 o'clock).

6 hours, our patient developed rapidly progressive hypoxemic and hypercarbic respiratory failure. Interval chest imaging demonstrated worsening bilateral opacities [Fig. 4], and repeat flexible bronchoscopy did not reveal any obvious cause for the patient's acute decompensation. Due to a lack of improvement with high flow oscillatory ventilation, the patient was placed on venous-venous extracorporeal membrane oxygenation (VV-ECMO). At the time of ECMO cannulation, the patient's PaCO₂ was 110 mmHg and the ratio of arterial oxygen tension to fraction of inspired oxygen (PaO₂/FiO₂) was 63 mmHg.

Our patient remained on VV-ECMO for 2 days while concurrently being treated with broad spectrum antibiotics. Systemic and topical corticosteroids were also administered while intubated to address the endobronchial granulation tissue and lung inflammation. Three days after ECMO decannulation, in preparation for extubation, flexible bronchoscopy was repeated and demonstrated improvement in the granulation tissue at the entrance to the bronchus intermedius. The patient was successfully extubated to supplemental oxygen via nasal cannula.

While in the ICU, our patient's antibiotic coverage was narrowed to ampicillin/sulbactam based on isolation of *Streptococcus constellatus* from respiratory cultures obtained during initial bronchoscopy. He was ultimately transitioned to clindamycin (due to concerns for acute interstitial nephritis related to beta-lactam usage) and completed 14 total days of therapy. Follow-up chest radiography showed significant improvement [Fig. 5]. Due to significant muscle weakness, he remained inpatient for 1 week after extubation and was ultimately transitioned to an outpatient rehabilitation program. Other than mild residual muscle weakness, no significant neurologic deficits were appreciated at the time of discharge.

3. Discussion

Although ARDS secondary to pneumonia is relatively common, our patient's rapid deterioration immediately following FB removal seems quite rare. A recent case series described the use of ECMO to facilitate FB removal in cases of life-threatening FB aspiration, however, only one reported the development of progressive respiratory failure following FB removal, and in this instance, the time from FB removal to ECMO initiation was 7 days [3]. The most likely explanation for our patient's acute decompensation was a sudden and overwhelming exposure to a highly pyogenic strain of bacteria which had been confined to a relatively localized region of the lung. Removal of the aspirated pushpin

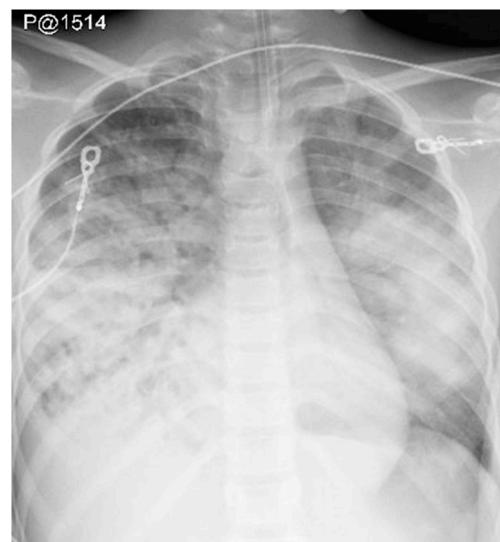


Fig. 4. Single view chest radiograph. Note the worsening multifocal opacities in both lungs just prior to ECMO initiation.

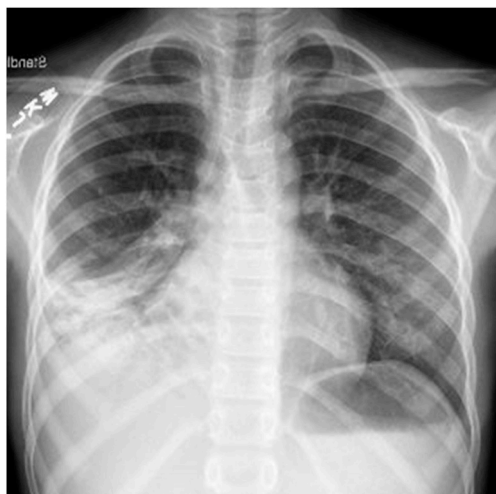


Fig. 5. Single view chest radiograph demonstrating resolution of ARDS. Residual disease is appreciated in the right lower lobe.

allowed for rapid, endobronchial spread of infection followed by the release of large amounts of pro-inflammatory cytokines and toxic mediators.

Foreign body aspiration is a common problem encountered in pediatric medicine and results in thousands of emergency room visits each year. In 2016, 118 deaths in children 1–4 years of age were attributed to suffocation, with nearly half (41%) as a result of FB aspiration [4]. Although roughly 80% of FB aspirations occur in children less than 3 years of age, a significant number continue to occur through adolescence [5,6]. Similar to our patient, the majority of aspirated FBs (approximately 50%) are located in the right main bronchus [7]. Retained FBs are more likely to cause complications such as post-obstructive pneumonia and occasionally, may elicit such intense inflammation that endoscopic removal is not possible. Our patient was fortunate that the object was retrieved on the first attempt, however, significant inflammation was clearly seen after removal, and any further delay in seeking care may have resulted in the need for more invasive surgical procedures (thoracotomy, lobectomy, etc.).

ARDS is typically a clinical diagnosis of exclusion. Histopathologically, it is characterized by diffuse alveolar damage followed by fibroproliferation and fibrosis, however, sufficient evidence for diagnosis is generally available through less invasive studies without the need for lung biopsy. The Berlin definition states that a patient's respiratory failure must not be explained by alternative causes, with each of the following criteria also present: 1. Worsening respiratory symptoms within one week of a known clinical insult 2. Bilateral opacities on chest radiograph or computed tomography 3. Respiratory failure not explained by cardiac failure and 4. A moderate to severe oxygenation impairment (measured by the ratio of arterial oxygen tension to fraction of inspired oxygen) [8]. Each of these criteria was met by our patient within 6 hours of FB removal. Although rapidly progressive ARDS has been previously described, the temporal association with FB removal was not anticipated. On this background, ARDS should be considered a potential post-operative complication of FB removal given the right clinical context. Current treatment strategies for ARDS are largely supportive and focus on maintaining appropriate hemodynamics, oxygenation, and nutritional status as well as preventing secondary complications such as hospital-acquired pneumonia and deep venous thrombosis. In addition, recent guidelines from the Society of Critical Care Medicine suggest the early use of glucocorticoid therapy (less than 14 days from onset) in cases of moderate to severe ARDS and those

precipitated by a steroid-responsive process [9].

S. constellatus, *S. anginosus* and *S. intermedius* comprise the *Streptococcus anginosus* group (SAG), a subgroup of viridans streptococci. *S. constellatus* is a common commensal organism in humans existing primarily as a component of normal oropharyngeal, gastrointestinal, and genitourinary flora [10]. Infections due to *S. constellatus* are frequently purulent (often resulting in abscess formation) and appear to predominate in the oropharynx and respiratory tract [11]. This propensity to cause pyogenic infections likely contributed to our patient's significant inflammatory response and rapid deterioration after FB removal. In general, susceptibility patterns against *S. constellatus* are favorable, with adequate coverage provided by usual doses of penicillin, amoxicillin, or ceftriaxone. Although greater than 10% of SAG strains are resistant to clindamycin [12], in vitro testing of our patient's specific isolate revealed normal clindamycin sensitivity.

4. Conclusion

We report a case of rapidly progressive ARDS secondary to endobronchial spread of infection immediately following the removal of an aspirated FB. Although ARDS is not a common complication of FB removal, certain risk factors such as retained FB, post-obstructive pneumonia, and degree of microbial virulence should alert the clinician to the potential for its development. While current treatment strategies for ARDS are largely supportive, anticipation and timely identification may lead to earlier initiation of aggressive management and improved patient outcomes.

Declaration of competing interest

The authors declare they have no relevant funding or financial interests.

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