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CASE REPORT AIRWAY MANAGEMENT

Anesthesiologists' perspective on tracheostomy-assisted bronchoscopy for removal of a migrating foreign body in the airway: a case report

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ABSTRACT

Bronchoscopy for foreign body extraction in pediatric patients rarely requires tracheostomy, with only 1.2% of cases necessitating it. In our case, an emergency tracheostomy had to be performed due to laryngeal edema resulting from prolonged bronchoscopy and laryngoscopy attempts.

A 7-year-old boy presented with shortness of breath after inhaling a plastic pen cap 14 days earlier. Physical examination showed left chest retraction, diminished breath sounds, and dullness on percussion, while a chest X-ray indicated atelectasis without visualizing the foreign body. The cap migrated from the left bronchus to the right, compromising both lungs: the left lung was already atelectatic from prior obstruction, while the right lung became obstructed due to the migration. Urgent extraction via rigid bronchoscopy was complicated by laryngeal edema and desaturation episodes. After tracheostomy and direct bronchoscopy through the stoma, the pen cap was successfully removed. The patient received ventilator support and aggressive physiotherapy, eventually weaning off ventilation by day five without complications. Anesthesia strategy was critical; a non-apneic sleep technique was used to maintain spontaneous ventilation but could lead to discomfort and airway complications. Effective communication and quick decision-making were essential for successful team management.

Keywords: Pediatric Anesthesia; Foreign Body; Bronchoscopy; Tracheostomy; Laryngeal Edema; Difficult Airway

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1. INTRODUCTION

Foreign body aspiration in children is a critical clinical emergency, with significant morbidity and mortality associated with delayed intervention. The incidence of foreign body aspiration is particularly high among children under five years, with choking being a leading cause of accidental death in this age group. Reports indicate that approximately 300 pediatric deaths occur annually in the United States due to foreign body aspiration, highlighting the urgency of effective management strategies.[1] While rigid bronchoscopy is often successful in removing aspirated objects, cases requiring tracheostomy for airway management are less common but crucial for severe obstructions. This case report presents a unique instance where tracheostomy-assisted bronchoscopy was employed to remove a foreign body, emphasizing the anesthesiologists perspective in such complex scenarios.[2,3]

2. CASE REPORT

A 7-year-old boy, weighing 18 kg and measuring 118 cm in height, was referred from another hospital with

shortness of breath, particularly during activity, localized to the left chest. His symptom had worsened over the past five days. The patient had no history of fever, cough, asthma, allergies, or congenital diseases. Physical examination revealed left chest retraction, diminished breath sounds, wheezing on the left side, and dullness on percussion. The patient remained alert, showing no signs of respiratory failure; his oxygen saturation was adequate at 99% without supplemental oxygen. He reported accidentally inhaling a plastic pen cap while playing 14 days prior. After visiting a local doctor who tried Heimlich maneuver and back blows without success, he delayed seeking hospital care due to fear of surgery. A chest X-ray indicated atelectasis in the left lung's inferior lobe, but the foreign body was not visualized due to its plastic composition. Laboratory tests were normal, and arterial blood gas analysis showed adequate oxygenation and ventilation with a PO_2 of 409 mmHg and PCO_2 of 39 mmHg. An otolaryngologist planned urgent extraction using rigid bronchoscopy 12 hours later.

The patient was managed with total intravenous anesthesia (TIVA) using propofol and fentanyl while maintaining spontaneous breathing. Anesthesia began with pre-oxygenation via Jackson-Rees circuit, administering fentanyl 20 µg and propofol 40 mg. With maintenance of continuous propofol infusion at a rate of 5-50 µg/kg/min and intermittent boluses of fentanyl 0.5-1 µg/kg as indicated. The patient was positioned in a sniffing position and held by a nurse. We helped with direct laryngoscopy using a No. 2 Macintosh blade achieving Cormack-Lehane grade II visualization. The team faced challenges inserting the rigid bronchoscope, resulting in three periods of desaturation ranged from 78%-90%. We provided oxygenation and assisted breathing until saturation improved for the otolaryngologist's next attempt. After six attempts over 50 minutes at laryngoscopy and bronchoscope insertion, complications arose due to swelling in the larynx. Dexamethasone 5 mg was administered for control of edema. Videolaryngoscopy was then used, successfully allowing for bronchoscope insertion.

The otolaryngologist visualized the plastic pen cap in the left main bronchus but encountered difficulties extracting it due to its tight adherence to the bronchial wall from being lodged for 14 days as shown in Figure 1. After a total of two hours of attempts, the foreign body was slowly pulled out; however, significant secretions and its slippery surface—along with its size being larger than that of the bronchoscope lumen—forced the operator to withdraw both the bronchoscope and foreign body simultaneously. Consequently, the foreign body could not pass through the subglottis (the narrowest part of the airway) and larynx due to severe edema, remaining lodged in the trachea. Oxygenation and ventilation were initiated using a tight mask with

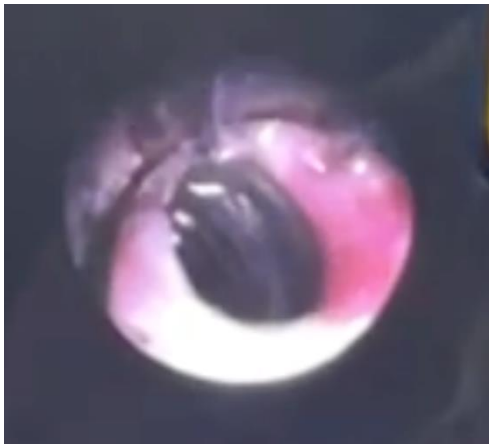

Figure 1: First visualization of pen cap through bronchoscope

Figure 2. Severe laryngeal edema after repeated attempts at extracting the foreign body

an oropharyngeal tube; however, the patient experienced desaturation to 40% for approximately 1–2 min without bradycardia. Saturation slowly improved back to 98% after deepening the anesthesia, as a laryngeal spasm, along with tracheal blockage, could have contributed to the desaturation. This suggested that the foreign body was not obstructing the trachea and may have shifted back into the left main bronchus or migrated into the right bronchus since oxygenation could still be maintained.

Videolaryngoscopy revealed severe edema, as shown in Figure 2. However, we were still able to intubate with a size 5.5 non-cuffed endotracheal tube, followed by an emergency tracheostomy due to impending airway obstruction. Following the successful tracheostomy, we assessed the patient's condition on ventilator support. The evaluation showed an $EtCO_2$ level of 104 mmHg, tidal volumes between 40 and 50 mL, and peak pressures of 30 mmHg, indicating significant airway obstruction. The otolaryngologist performed rigid bronchoscopy again through laryngoscopy above the tracheostomy cannula after removing the endotracheal tube but did not find any foreign body. Subsequently, fiberoptic laryngoscopy

through the tracheostomy cannula revealed that the foreign body had migrated into the right main bronchus. The otolaryngologist decided to remove the tracheostomy cannula and perform rigid bronchoscopy through its stoma; within one minute, they successfully extracted the pen cap using forceps as shown in Figure 3.

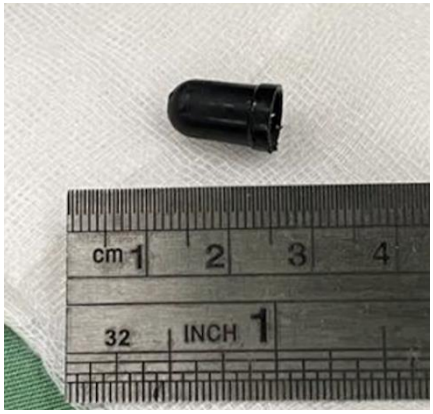

Figure 3: Size of successfully removed pen cap

In the ICU, ventilator support was set up in spontaneous mode with pressure support at 14 cmH_2O and PEEP at 6 cmH_2O. Peak pressures reduced to 20 cmH_2O, with tidal volumes averaging around 127 mL. Respiratory rates varied between 20-23 breaths per min, while SpO_2 remained stable between 97-98%. Arterial blood gas analysis showed combined metabolic and respiratory acidosis with pH at 7.17 and PCO_2 at 49 mmHg PO_2 119, HCO_3 17,8, BE -10, P/F 297. Hemodynamics remained stable with a GCS score of 4x6 without neurological deficits. Aggressive chest physiotherapy was administered to resolve atelectasis in the left lung, along with nebulization of bronchodilators and corticosteroids for managing laryngeal edema. On day two, follow-up chest X-rays demonstrated successful weaning from ventilator support was possible. On day five, trial decannulation was performed successfully without stridor, allowing transition to a low-care unit for further monitoring and recovery.

3. DISCUSSION

Bronchoscopic extraction is commonly performed in pediatric patients with foreign bodies in their airways, but the tracheostomy during these procedures is rarely needed. In a study of 342 cases of foreign body airway obstruction, only 4 cases (1.2%) required tracheostomy to assist in foreign body removal or to secure the airway.[4] Indications for tracheostomy included subglottic foreign bodies, sharp foreign bodies, and those larger than the glottic chink that could not be removed using standard techniques.

Two complications arose during the operation cited here: first, the failure to extract the foreign body past the subglottis (the narrowest part of the pediatric airway) or through the larynx and vocal cords, which were already edematous; and secondly, impending airway obstruction occurred due to laryngeal edema from multiple attempts at bronchoscopy and prolonged laryngoscopy lasting 2-3 hours.[5,6] Fortunately, we were able to intubate and subsequently perform an emergency tracheostomy as a management strategy for upper airway obstruction. Positive pressure ventilation through a face mask or intubation should be attempted to push any foreign body below the glottis back into one of the bronchi without obstructing the trachea.[5]

The complications might be connected to the choices of general anesthesia approaches that can be used: maintaining spontaneous ventilation or not. In this case, we chose the non-apneic sleep technique without muscle relaxants for two reasons. First, this technique allows spontaneous breathing without positive pressure, minimizing the risk of pushing the foreign body further into the airway.[7] This also shortens periods of desaturation during attempts to insert the rigid bronchoscope and explore within the airway.[5] When laryngeal edema occurs due to prolonged laryngoscopy and bronchoscope insertion, maintaining spontaneous breathing provides sufficient time and oxygen reserves until an emergency intubation or tracheostomy can be performed.[6] If the patient were apneic and fell into 'can't intubate can't ventilate' situation, we might have had to perform a cricothyrotomy first, along with jet insufflation, complicating the procedure and increasing CO_2 trapping.[8] Additionally, we opted for total intravenous anesthesia (TIVA) to avoid contamination in the operating room from inhalational gases and prevent interruptions in gas delivery during bronchoscopy. It is clear that a drawback of this approach is the relaxation of airway structures, including the larynx, vocal cords, and cough reflex. This can complicate bronchoscope insertion, necessitating adequate depth of anesthesia in terms of sedation and analgesia during airway manipulation. This approach may also be less comfortable for the surgeon and may require more time for the procedure, leading to the mentioned complications above.

As anesthesiologists, monitoring for hypoxia, hypercapnia, pneumothorax, or tracheobronchial injury during surgery is critical to prevent cerebral insult or severe respiratory acidosis.[5,6] Intensive care management is essential for ensuring airway patency, restoring oxygenation and ventilation, recruiting atelectatic lung areas worsened by mucus aspiration or blood clots, and monitoring laryngeal edema and brain function after desaturation or hypercarbia. Pulmonary atelectasis from obstruction necessitated a lung recruitment maneuver. Using a higher tidal volume, we reopened atelectatic areas while adhering to 'Second Pediatric Acute Lung Injury Consensus Conference guidelines',[9] to limit driving and plateau

pressures.[10] After resolving atelectasis with the recruitment maneuver, we transitioned to low tidal volume ventilation as hypoxia improved and metabolic compensation began.[10] Immediate application of low tidal volume could have driven CO_2 levels beyond permissive hypercapnia, further lowering pH into a lethal range. This tailored approach balanced recruitment and ventilation strategies to optimize gas exchange and prevent severe acidosis.

4. CONCLUSION

The removal of foreign bodies from the tracheobronchial tree presents a significant challenge for the anesthesiologists, as it requires optimal communication and airway collaboration with the otolaryngologist. A meticulous assessment and quick decision-making are essential when complications arise, including whether to continue the procedure or stop it due to potential harm.

5. Patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient's parents had given their consent for his images and other clinical information to be reported in the journal. The parents understand that the patient's name and identification will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

6. Conflicts of interest

There are no conflicts of interest declared by the authors.

7. Authors' contributions

CRW : Concept and design of study; Acquisition of data; Analysis and interpretation of data; Drafting the paper; Agreement to be accountable for all aspects of the work.
AS : Revising it critically for important intellectual content, Final approval of the version to be published, Agreement to be accountable for all aspects of the work.

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