Case Report

Apneic anesthesia with THRIVE for pediatric bronchial foreign body removal: A case series

ABSTRACT

Anesthesia for impacted tracheobronchial foreign body (FB) removal in pediatrics is challenging owing to shared airway, need of tubeless apneic anesthesia, and higher risk of airway complications. Transnasal humidified rapid insufflation ventilatory exchange (THRIVE) has unique applications for apneic anesthesia. The authors describe two pediatric cases of impacted lower bronchial FB that were difficult to retrieve and required long procedure time. They were done successfully under apneic anesthesia using THRIVE that provided intermittent total apnea of 58 and 62 min, respectively, with single-continuous apnea time of 13–18 min. THRIVE facilitated the procedure by providing a safe long apnea time without desaturation and with permissible increase in $PaCo_2$ while maintaining hemodynamic parameters and oxygenation.

Key words: Apneic anesthesia, pediatric bronchial foreign body, THRIVE

Introduction

Various anesthesia techniques for airway foreign body (FB) removal procedure are low flow oxygen supplementation, rigid bronchoscopic port ventilation, intermittent mask ventilation, Jet ventilation etc.[1] Transnasal humidified rapid insufflation ventilatory exchange (THRIVE) has been recently added to armamentarium and can deliver up to 70 L of O_2/min at 37°C, with absolute humidity of 44 mgH_2O/L and an FiO_2 up to 1.[2] It helps to achieve apneic oxygenation, washes out pharyngeal dead space, and provides CPAP and PEEP up to 7 cm H_2O, resulting in prolonged safe apneic time and helps in CO_2 clearance.[2,3]

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Cases

Three-year-old girl presented with chronic cough for2 months. Chest X ray showed metallic FB causing near complete obstruction of bronchus with ill-defined ground glass opaque nodules in branching pattern tree in bud pattern suggestive of retained secretion and atelectasis in anterior, lateral, and posterior segment of right lower lobe [Image 1a].

After discussion with the surgical team as the FB was in the lower bronchus, rigid bronchoscopy may not be accessible, hence, flexible fiberoptic bronchoscope (FOB) with working channel that does not have ventilatory capabilities was to be used. Apneic anesthesia using THRIVE (Optiflow THRIVE

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Fisher and Paykel Healthcare, Auckland, New Zealand) keeping preparation for intubation and Jet ventilation absolutely ready was planned.

Standard ASA monitoring and balanced general anesthesia (GA) was used. THRIVE was attached to the patient with initial flows of 20 L/min. After titrated and weight appropriate intravenous (iv) premedication with glycopyrrolate, fentanyl, and propofol induction, gentle mask ventilation was confirmed before succinylcholine was administered. THRIVE flows were increased to 50 L/min and patient was handed over to surgeons after spraying the airway with topical lidocaine and iv dexamethasone. Patient was maintained on iv propofol and atracurium with continuous monitoring of heart rate, ECG, oxygen saturation (SPO_2), and $ETCO_2$ during mask ventilation and arterial blood gases (ABG). It was difficult to reach and retrieve the FB and total procedure time was 1 h 10 min. Throughout the procedure, hemodynamic parameters were within normal limits with SPO_2 97–100% with THRIVE. Single-continuous apnea time was 13–18 min and patient was gently mask ventilated during instrument changes that was four times during the procedure. ABG at 15 min and immediate post apnea showed a PO_2 of 210 mmHg, $PaCo_2$ of 56 mmHg, and $ETCO_2$ of 50–54 mmHg which came to normal range within 2 min of gentle mask ventilation. Total intermittent apnea time was 58 min. At the end of procedure, child was intubated and positive pressure ventilation (PPV) with PEEP was continued for re-expansion of atelectasis with chest physiotherapy, stomach was decompressed, and extubated when completely awake with adequate protective reflexes and normal ABG parameters. Supplemental humidified oxygen, adrenalin saline nebulization, steroids, and antibiotics were continued in the postoperative period.

Second case was 2 years old male child presented with cough and fever since 2 days with history of peanut ingestion. He was having tachycardia, tachypnea, and wheeze. Computed tomography of chest showed an endobronchial soft tissue density measuring approximately 7 × 4 mm, in left main bronchus just proximal to bifurcation with hyper inflated and oligemic left lung parenchyma [Image 1b]. Standard balanced GA was used and procedure started with rigid bronchoscope but during instrumentation piecemeal FB was pushed further and hence FOB was used. Procedure was performed under apneic anesthesia with THRIVE as described above and total intermittent apnea time was 62 min with single-continuous apnea time of 13–16 min [Image 2]. ABG at 15 min and immediate post procedure had normal PO_2 and moderate hypercarbia. Child had purulent secretions and airway edema, hence, was intubated, and thorough endobronchial suctioning, chest physiotherapy, adrenalin saline, and nebulization was done before extubation. Postoperative course was uneventful and X-ray showed marked improvement.

Discussion

Tracheobronchial FB aspiration in children is common with varied presentation from the asymptomatic to severe respiratory distress depending on the type, duration, and location of FB.[4] Balanced GA maintaining steady deep level using total intravenous anesthesia is a preferred technique for airway FB removal. Optimal conditions for bronchoscopy, avoidance of coughing, topical lidocaine spray, limiting the time of intervention, and steroids are essential to prevent airway edema and other complications.[1,4,5]

THRIVE provides warm and humidified oxygen delivery via wide-bore soft nasal prongs [Image 2]. During apneic oxygenation, alveolar oxygen uptake occurs due to concentration gradient allowing maintenance of oxygenation

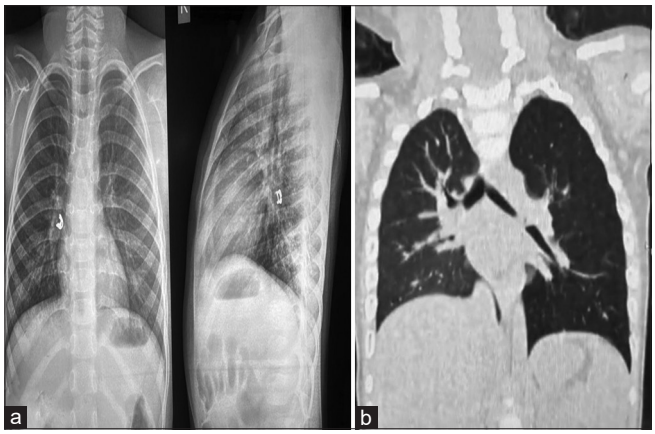

Image 1: Chest X-Ray Image of patients showing foreign body and lung parenchyma (a) -Case 1, (b) -Case 2

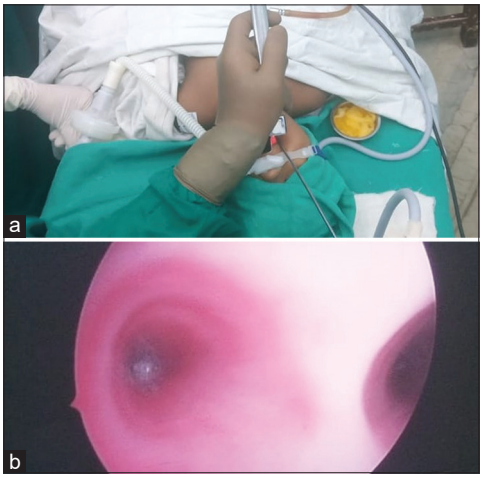

Image 2: Apneic anesthesia with THRIVE (a) and suspected FB on FOB view (b) in case 2

and high flows and cardiogenic oscillations improve the clearance of CO_2.[2,3,6] THRIVE combines the advantage of standard apneic oxygenation with CPAP and gaseous exchange through flow-dependent dead space flushing.[3] Patel *et al*.[3] showed safe apnea time of 5–65 mins without arterial desaturation and the rate of increase in $ETCO_2$ was 0.15 kPa. min. In our both the patients' safe single apnea time of 13–18 min without desaturation, with permissible increase in $PaCo_2$ levels and normal hemodynamic parameters was observed. In a recent review on THRIVE, Huang *et al*.[7] showed a median safe apnea time of 13–27 min and Rajan *et al*.[8] demonstrated 40 min safe apnea with recommended CO_2 monitoring. Humphreys *et al*.[9] demonstrated successful use of THRIVE in children. THRIVE in pediatrics has shown several advantages over conventional apneic oxygenation techniques, it prolongs the safe apnea time in children but CO_2 clearance should be monitored by transcutaneous CO_2/ABG.[9-11]

Advantage of using THRIVE for FB removal was extended apneic window that minimized interruption to surgeons for bronchoscope removal and patients were mask ventilated only when surgeons changed instruments thus minimizing airway edema. THRIVE continues oxygen supplementation irrespective of type of bronchoscopes used. Chances of dislodgement of FB farther is possible with Jet ventilation but less likely with THRIVE and it does not cause tissue vibration, hence, has improved efficiency and better operating conditions.[2] THRIVE has been demonstrated as a safe, effective-shared airway technique with an improved field maintaining adequate oxygenation whilst providing sufficient apneic windows; however, exquisite cooperation between the anesthesiologist and surgeon, vigilance for hypercarbia, and gastric distension is crucial.[2-4,11]

To conclude, THRIVE facilitated safe apnea time maintaining oxygenation with permissible increase in $PaCo_2$ and stable hemodynamic parameters. THRIVE has distinctive appeal for quality of apneic anesthesia in shared airway surgeries.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the legal guardian has given his consent for images and other clinical information to be reported in the journal. The guardian understands that names and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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