

External tracheal manipulation for bronchial blocker placement in children undergoing thoracic surgery requiring one lung ventilation: A case report

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ABSTRACT

Limited options exist for pediatric one lung ventilation (OLV). Compared to adults, pediatric OLV can be more challenging due to physiological/anatomical differences, various pathologies, and size limitations of lung isolation devices. Fiberoptic bronchoscopy can be harder due to the restricted tube sizes through which bronchial blockers (BB) and scopes can appropriately fit, while providing adequate oxygenation and ventilation. Recent literature is sparse concerning facilitation of BB placement in children. A 2-, 8-, and 10-year-old presented for thoracic surgeries requiring OLV. External tracheal manipulation (ETM) facilitated BB placement in each case and can potentially offer unique advantages in pediatric OLV.

Keywords: Bronchial blocker, pediatric one lung ventilation, tracheal manipulation

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BACKGROUND

One lung ventilation (OLV) poses unique challenges in pediatric patients. In particular, there are limited options for pediatric OLV when compared to adults. Although not always necessary for pediatric thoracic surgery, OLV can be more difficult due to the nature of pediatric airway anatomy, pediatric lung physiology, various pathologies, and size limitations of available lung isolation devices. Double lumen tubes, the preferred method of lung isolation in adults, cannot be used in children under approximately 8 years of age due to smaller airway size. Univent tubes, if available, can only be used in children ≥ 6 years of age.^[1] Therefore, endobronchial intubation using traditional single lumen tubes (SLT) or bronchial blockers (BB) are often required for younger children. Due to disadvantages of OLV associated with SLTs, the preferred method for

many pediatric anesthesiologists is placement of BBs for lung isolation.

We describe a technique in the pediatric population whereby external tracheal manipulation (ETM) is utilized to assist appropriate placement of BBs for OLV. This technique has previously been utilized in adults,^[2] but offers unique advantages in children requiring lung isolation for thoracic surgery. Informed written parental consent and patient assent were obtained.

CASE PRESENTATION #1

A 2-year-old with a metastatic posterior mediastinal neuroblastoma with paraspinal involvement presented for tumor resection. After mask induction, vascular access

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was established and total intravenous (IV) anesthesia was initiated to assist neuromonitoring. A nasal cannula was used to administer 15 liters per minute of apneic oxygenation throughout airway securement. A 5-French (Fr) Arndt BB was passed into the trachea under direct laryngoscopy (Miller #1 blade), after which a 4.0 cuffed endotracheal tube (ETT) was inserted alongside the BB using a 2.8 mm fiberoptic bronchoscope (FOB) through the ETT. Gentle rightward sub-cricoid pressure applied to the left side of the trachea improved tracheobronchial alignment and the distal trajectory enabling smooth advancement of the BB into the left main bronchus in the first attempt; hence allowing left lung isolation.

CASE PRESENTATION #2

An 8-year-old with a femoral osteosarcoma had imaging suspicious for metastatic lung disease. She was scheduled for bilateral thoracotomies to obtain multiple wedge resections. IV anesthesia was induced and C-MAC video laryngoscopy (MAC blade #2) for teaching purposes was utilized to pass a 7-Fr Arndt BB through the vocal cords under direct visualization, followed by adjacent placement of a 5.5 cuffed ETT. A 3.8 mm FOB was passed via the ETT. ETM using gentle rightward pressure applied to the left side of the trachea facilitated appropriate advancement of the BB into the left main-stem bronchus under fiberoptic guidance in the first attempt [Figure 1]. Proper placement was confirmed by FOB and auscultation after BB cuff inflation. After right lateral decubitus positioning and re-verification of proper placement using FOB, the left-sided thoracotomy and wedge resection was performed uneventfully. Subsequently, in the supine position, the BB was deflated, slightly withdrawn, and re-advanced under FOB visualization into the right main-stem bronchus for right lung isolation, using leftward pressure applied to the right side of the trachea [Figure 2].

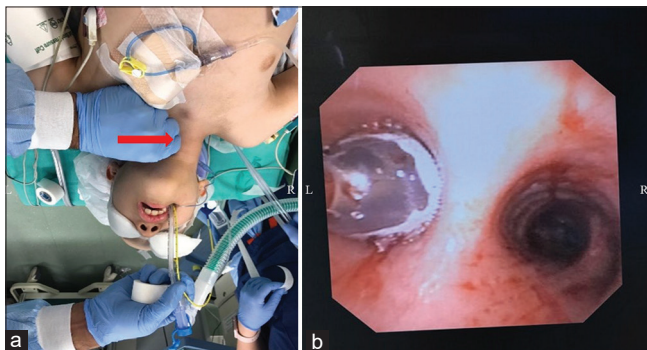


Figure 1: (a) Application of rightward [arrow] external tracheal pressure (b) Proper positioning of inflated bronchial blocker in left main-stem bronchus

CASE PRESENTATION #3

A 10-year-old with a brain neuroectodermal tumor and bilateral lung lesions was scheduled for a thoracoscopic wedge resection and diagnostic right lung biopsy. IV anesthesia was induced and C-MAC video laryngoscopy (MAC blade #2) for teaching purposes was utilized to pass a 7-Fr Arndt BB through the vocal cords under direct visualization, followed by 5.5 cuffed ETT placement. A 3.8 mm video FOB was passed via the ETT. Gentle leftward pressure applied to the right side of the trachea facilitated BB advancement into the right main-stem bronchus in the first attempt for right lung isolation.

DISCUSSION

OLV can be challenging in pediatric patients undergoing thoracic surgery for a variety of reasons. Although OLV is not always needed in pediatric thoracic surgery, due to the ability of CO₂ insufflation (thoracoscopic surgery) and proper retractor placement being able to displace lung tissue in the operative field, lung deflation does improve visualization of thoracic contents and may reduce lung injury caused by the use of retractors. Pediatric lung physiology does not allow for OLV to be tolerated as well as it is in adults. Younger children have higher oxygen requirements, relatively lower functional residual capacity, and more ventilation to perfusion mismatch than adults in lateral positions typically needed for thoracic surgery.^[3] These factors predispose children to hypoxemia, particularly when OLV is utilized.

Additionally, not only do unique problems exist with choosing the appropriate sized tubes and lung isolation devices, appropriate placement and maintenance of those devices in the correct position throughout surgery can be cumbersome. Due to differences in airway anatomy, primarily as a result of smaller airways, correct positioning of appropriately chosen lung isolation devices is essential

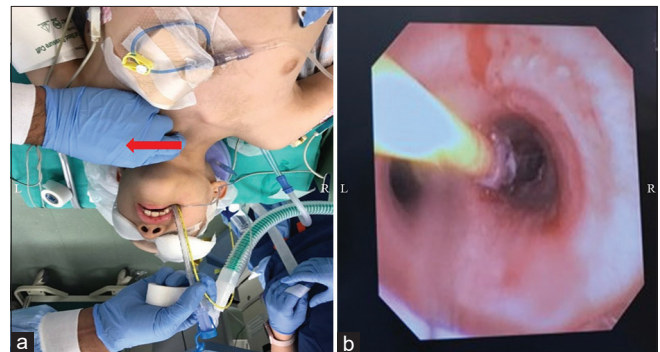


Figure 2: (a) Application of leftward [arrow] external tracheal pressure (b) Proper positioning of deflated bronchial blocker in right main-stem bronchus prior to inflation

in adequate oxygenation and ventilation. Fiberoptic bronchoscopy and even fluoroscopic guidance has significantly improved the ability to properly position lung isolation devices for pediatric OLV.^[4]

In children too small to accommodate certain tubes, lung isolation is performed using a SLT or BB placed into the desired bronchus. While main-stem intubation with a SLT has the advantage of being simple and quick, disadvantages include: the potential for inadequate collapse of the operative lung, inability to suction the operative lung, and inability to deliver continuous positive airway pressure to the operative lung.^[5] Ventilation of the right upper lobe during right lung ventilation can particularly be problematic given the short distance between the right main-stem bronchus and the right upper lobe bronchus. A two SLT parallel placement technique has been described for younger children, where one main-stem bronchus is initially intubated with a SLT, after which another SLT is advanced over a FOB into the opposite bronchus. However, the disadvantages of this technique include technical difficulties, mucosal/bronchial trauma, limitation of gas flow due to smaller SLT sizes, and impediment in suctioning of the airways.^[6]

In scenarios where balloon-tipped bronchial blockers are the appropriate lung isolation method, placing them outside of a SLT as we did allows for appropriate lung isolation, a relatively larger patent ETT lumen available for ventilation, and facilitation of manipulation of the FOB within the ETT. Suctioning can be more easily accomplished via the larger ETT lumen as well. Various techniques for placing a catheter outside the endotracheal tube have been described,^[7] but technical issues and the need for significant expertise with pediatric bronchoscopy can limit their use. ETM offers advantages in pediatric OLV such as helping to avoid some of the technical difficulties associated with those techniques, particularly the need for looping guidewires around the FOB for proper advancement. The technique allows for the bronchial orifice of the lung requiring isolation to be pulled into tracheobronchial alignment by applying lateral tracheal pressure in the opposite direction of the lung to be isolated. Additionally, the cross-sectional area of the vocal cord aperture can be limiting, so using ETM with the FOB scope through the ETT and the BB alongside it, can potentially help avoid vocal cord injury that could occur from each device being placed separately. Turning the head to the opposite direction of the lung that is to be isolated is also a described technique for BB advancement and

can possibly be used in conjunction with ETM. However, with ETM, vertebral manipulation is not needed and the oro/nasotracheal axis is maintained allowing for easier use of the FOB.

ETM is not without limitations. While in adults the maneuver can be challenging in morbidly obese patients, limitations such as prior neck radiation, prior airway surgery, obstruction due to intraluminal tumors, or tracheostomies exist in both the adult and pediatric populations. Tracheal compression in younger children and obstructed views due to lateral compressive tracheal displacement are possible. The potential for tracheomalacia in smaller children does exist and we recommend very gentle ETM to mitigate the risk of tracheal injury.

CONCLUSIONS

ETM can be used to facilitate BBs for pediatric OLV and, when appropriate, offers unique advantages for pediatric lung isolation.

Declaration of patient consent

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

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Conflicts of interest

There are no conflicts of interest.

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