Obstetrical and Pediatric Anesthesia

Extraluminal use of the Arndt pediatric endobronchial blocker in an infant: a case report

[L'usage extracavitaire du bloqueur endobronchique pédiatrique Arndt chez un enfant : une présentation de cas]

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Purpose: Attaining lung isolation in the infant undergoing thoracic anesthesia can be challenging for the anesthesiologist. We describe a novel approach to performing lung isolation in an infant undergoing thoracotomy for lobectomy using an Arndt pediatric endobronchial blocker via an extraluminal technique.

Clinical features: Lung isolation in an infant was achieved through the use of an Arndt pediatric endobronchial blocker placed externally to an endotracheal tube. The blocker's placement was facilitated through the use of a pediatric fibreoptic brochoscope placed through the guidewire of the extraluminally placed bronchial blocker.

Conclusion: This novel technique may provide an easier and more reliable method of attaining single lung ventilation in infants and small children.

Objectif *: Parvenir à isoler un poumon chez un enfant qui subit une anesthésie thoracique peut être difficile. Nous décrivons une nouvelle façon de réaliser l'isolement chez un enfant qui subit une thoracotomie pour lobectomie en utilisant un bloqueur endobronchique pédiatrique Arndt selon une technique extracavitaire.*

Éléments cliniques *: L'isolement du poumon chez un enfant a été fait par l'usage d'un bloqueur endobronchique pédiatrique Arndt placé à l'extérieur d'un tube endotrachéal. La mise en place du bloqueur a été facilitée par un fibroscope bronchique pédiatrique placé au moyen du guide métallique du bloqueur bronchique extracavitaire.*

Conclusion *: Cette nouvelle technique peut être une méthode plus facile et plus fiable de ventilation unipulmonaire chez les enfants et les bébés.*

THE Arndt pediatric endobronchial blocker (Cook Critical Care, Bloomington, IN, USA) is an Food and Drug Administration-approved device used to facilitate one-lung ventilation in children and adults. The smallest diameter endobronchial blocker currently manufactured is 5 Fr and can be inserted through an endotracheal tube with an internal diameter of 4.5 mm or greater. We describe a case in which a 5-Fr Arndt pediatric endobronchial blocker was used in conjunction with a 3.0-mm internal diameter endotracheal tube to provide lung isolation in an infant undergoing thoracotomy for left lower lobectomy. Informed consent was obtained from the family for both surgery and anesthesia. Additionally, consent was obtained from the family to publish information from the procedure in this journal.

Case

An otherwise healthy, asymptomatic nine month-old female infant who weighed 7.8 kg presented for elective resection of a congenital cystic adenomatoid malformation (CCAM). The mass measured 3.8 × 4.5 × 3.4 cm and was confined to the lower lobe of the left lung. There was no evidence of mediastinal shift.

In preparation for the procedure, the guidewire loop of a 5-Fr Arndt endobronchial blocker was placed over the distal end (Figure 1) of a styletted 3.0 mm internal diameter cuffed endotracheal tube (Kendall Sheridan®, Mansfield, MA, USA).

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FIGURE 1 Three millimeter internal diameter cuffed endotracheal tube and 5 Fr Arndt pediatric endobronchial blocker prepared for insertion into the trachea.

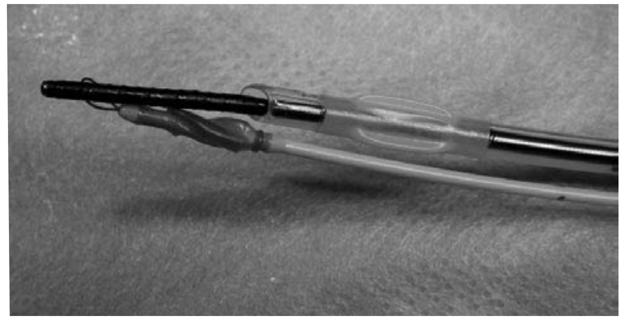

FIGURE 2 Endobronchial blocker advanced off the endotracheal tube and over the pediatric fibrescope.

The infant underwent an uneventful inhalation induction using sevoflurane, and peripheral *iv* access was secured. Rocuronium 0.6 $mg \cdot kg^{-1}$ was administered intravenously, and the child was successfully intubated with the endotracheal tube/endobronchial blocker apparatus. Anesthesia was maintained using isoflurane, continuous morphine infusion, and rocuronium. After the presence of bilateral breath sounds and end-tidal CO_2 were confirmed, the endotracheal tube was secured to the patient with tape while an assistant maintained gentle traction on the endobronchial blocker to ensure that it remained attached to the endotracheal tube. A leak around the deflated endotracheal tube cuff was detected at 20 cm H_2O. The endotracheal tube adaptor was then removed from the endotracheal tube, and a 2.2-mm external diameter pediatric fibrescope (Olympus, Melville, NY, USA) was inserted through the endotracheal tube. Next, the fibrescope was guided into the left main bronchus and the left upper lobe bronchus/lower lobe bronchus division was identified. The endobronchial blocker was advanced until resistance was felt (Figure 2), at which time the fibrescope was withdrawn to a level above the carina. The endobronchial blocker was noted to be in the proximal portion of the left mainstem bronchus, and it was then advanced under fibreoptic visualization until the proximal portion of the endobronchial cuff was just distal to the carina. The endobronchial cuff was inflated, and lung isolation confirmed by auscultation of bilateral lung fields. The endobronchial blocker was secured to the endotracheal tube using tape. The infant was subsequently transferred from supine to right lateral decubitus position, and the endobronchial blocker placement reconfirmed with fibreoptic visualization.

Once the procedure had begun and thoracotomy was performed, the left lung was noted to be deflated and remained so for the duration of the lobectomy. Upon completion of the lobectomy, the endobronchial blocker was suctioned, yielding bloody secretions. The endobronchial blocker cuff was then deflated, and the left upper lobe reinflated. At the end of the procedure the infant was returned to supine position and successfully extubated. The remainder of the infant's hospital course was unremarkable, and she was discharged on postoperative day three.

Discussion

Providing anesthesia for thoracic surgical procedures in infants can be especially challenging for the anesthesiologist, largely due to the unique anatomy and physiology of infants as compared to older children and adults. Because they have a higher ratio of minute alveolar ventilation to functional residual capacity, infants desaturate much more quickly than older patients do when rendered apneic during endotracheal tube placement. Additionally, from a ventilation/perfusion standpoint, infants do not benefit as much as adults from the dependent position of the non-operative lung while in lateral decubitus position. This is due to a variety of factors in infants, including an increased lung closing capacity, more compliant chest wall, and a reduced hydrostatic pressure gradient between the non-dependent and dependent lungs.[1] Anatomically, the trachea and bronchi of infants are small enough to require specially sized equipment for airway evaluation and intervention. As a result, it becomes more challenging to provide lung isolation in infants than in older children and adults.

Frequently, infants undergoing thoracotomy do not require lung isolation. Both lungs are ventilated, and the surgeon retracts and/or packs the operative lung as needed for operative exposure. Increasingly, however, single lung ventilation is being requested by surgeons, especially with the advances in technology that have permitted the use of video-assisted thoracoscopic surgery in infants and small children.[1] For the surgeon, there are several advantages to using single lung ventilation. The operative lung remains deflated and calm, thereby optimizing surgical exposure and enabling adequate "working space" in a relatively small anatomic compartment. This is particularly helpful when space-occupying lesions of the thorax are present, such as CCAM, pulmonary sequestration, and bronchogenic cyst. In cases of congenital lobar emphysema, single lung ventilation can help to minimize overdistension of the pathologic lobe. Lung isolation will also facilitate demarcation of normal from abnormal lung in cases where incomplete fissures between the lobes make this differentiation difficult. From a mechanical standpoint, lung isolation prevents blood and secretions from the ipsilateral lung from migrating into the trachea and contralateral lung.[2] In this reported case, the infant underwent resection of a CCAM, a procedure that not uncommonly results in the release of copious mucoid, purulent and/or bloody secretions from the mass into the ipsilateral mainstem bronchus. Indeed, Nishimoto *et al.*[3] describe extreme difficulty in managing a patient's airway due to endotracheal tube occlusion secondary to the release of copius purulent material during CCAM resection. By isolating the patient's operative lung with an endobronchial blocker, we were successful in avoiding this complication.

While there are a variety of techniques available for achieving lung isolation in the adult and larger child, the options are few in the infant. The most commonly used method for achieving lung isolation in the infant is endobronchial intubation with a standard endotracheal tube in the contralateral mainstem bronchus or insertion of a Fogarty catheter as an endobronchial blocker in the ipsilateral mainstem bronchus.[4] The Arndt pediatric endobronchial blocker (5 Fr) has recently been introduced as a device for achieving lung isolation in the pediatric patient aged two to 16 yr.[5] Because the smallest lumen through which the pediatric endobronchial blocker can be inserted is an endotracheal tube with a 4.5-mm internal diameter, it cannot be placed from within an endotracheal tube of a size appropriate for infants the size of our patient. However, as we have described herein, the pediatric endobronchial blocker can be effectively utilized in a small infant when attached to the outside of an appropriately sized endotracheal tube and positioned with the assistance of a fibrescope.

The pediatric endobronchial blocker has advantages over a Fogarty catheter as a means of achieving lung isolation in an infant. Utilization of a Fogarty catheter requires placement of the catheter into the trachea during laryngoscopy followed by the insertion of an appropriately sized endotracheal tube. The catheter is then advanced either blindly or under fibreoptic visualization into the desired mainstem bronchus. The pediatric endobronchial blocker, on the other hand, has the significant advantage of relative ease of control of the direction of the catheter due to the coupling of the endobronchial blocker to the fibrescope via the endobronchial blocker guidewire loop. Another advantage of the endobronchial blocker over the Fogarty catheter for lung isolation is the pressure-volume profile of its cuff. The Fogarty catheter, not designed for use in the airway, has a high-pressure, low-volume balloon, and carries a theoretically greater risk for damage or rupture of the airway.[4,5] One last advantage of the endobronchial blocker over a Fogarty catheter is its central lumen, which provides a port for either ventilation or suction of the ipsilateral lung field.

In summary, we describe the extraluminal use of the Arndt pediatric endobronchial blocker for achieving lung isolation in an infant undergoing thoracotomy for CCAM resection. Further studies are warranted to demonstrate the overall safety and efficacy of this technique.

References

1 *Hammer GB.* Single-lung ventilation in infants and children. Pediatr Anesth 2004; 14; 98–102.

2 *Weber TR, Vane DW, Krishna G, Rao CC, Grosfeld JL.* Neonatal lung abscess: resection using one-lung anesthesia. Ann Thorac Surg 1983; 36: 464–7.

3 *Nishimoto C, Inomata S, Kihara S, Miyabe M, Toyooka H.* Anesthetic management of four pediatric patients with CCAM for pulmonary lobectomy (Japanese). Masui 2002: 51; 162–5.

4 *Golianu B, Hammer GB.* Pediatric thoracic anesthesia. Curr Opin Anaesthesiol 2005: 18: 5–11.

5 *Wald SH, Mahajan A, Kaplan MB, Atkinson JB.* Experience with the Arndt paediatric bronchial blocker. Br J Anaesth 2005: 94: 92–4.