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Selective bronchial block with Uniblocker ™ in paediatric pulmonary sequestration

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ABSTRACT

Technological advances and improvements in surgical equipment have made possible minimally invasive surgical methods, which offer multiple advantages for patients [1]. We can find among them Video-Assisted Thoracoscopic Surgery (VATS). The indications for VATS in children have increased exponentially [2]. It requires the collaboration of the anesthesiologist, who adapts the anesthetic management to achieve correct one lung ventilation. It allows an adequate surgical field exposure [1], and it prevents hypoxemia. How we can achieve a correct lung isolation technique is one of the hypotheses that the anesthesiologist has to consider, basically in cases involving infants and children, because some techniques we would use in adults are not available. In this case, we use a Uniblocker™ 5 Frames (Fr) bronchial blocker. In the pediatric population, the problem is that bronchial blockers have very small or no working channels. This makes it difficult to aspirate the lung to collapse it. We want to show how to achieve complete lung collapse in a pediatric patient with Uniblocker™ 5 Fr which has no working channel.

A 6-month-old 9.5 kg infant is scheduled for resection of pulmonary sequestration in the left lower lobe. We perform an intubation with an endotracheal tube (ETT) nº 4,5 without cuff and we connect it to a multiport adapter.

1. Aim and methods

Our goal is to obtain a non-ventilated and completely collapsed lung to facilitate surgical manipulation. We are going to use a Uniblocker™ 5 Fr bronchial blocker, which is a close-tip one. For this reason, the next steps should be followed correctly to achieve complete lung collapse.

1. Firstly, under fibroscopic vision with neonatal Machida ® fibrobronchoscope (2.2 mm), through the multiport connector, we introduce the bronchial blocker into the ETT and place it in the main left bronchus. We cut the proximal part of the ETT to improve the handling with the fibrobronchoscope (being a 2.2 mm one, the length of the insertion tube is 300 mm). During the execution of the technique, the patient remains at all times connected to controlled mechanical ventilation, because Uniblocker™ is equipped with a multiport adapter with three ports, which connects:
   i. Tracheal tube, that allows pulmonary ventilation during the placement of the blocker (Anesthesia circuit)
   ii. Bronchial blocker with a self-sealing diaphragm that can be tightened around the bronchial blocker to hold it in space
   iii. Fibrobronchoscope
2. We inflate the balloon with 2.5 ml of air under direct fibroscopic vision.
3. We objectify extrusion of the Uniblocker™ cuff, falling EtCO2, as well as elevation of peak and plateau pressures, and nullify auscultation in both hemitoraxes. We proceed to deflate the balloon. We introduce it again under fibroscopic vision, and we inflate it, this time without ventilation alterations.
4. Surgeons introduce the VATS trocar and camera, and then they confirm the non-ventilated lung isn't collapsed. To get it, we perform the following technique (Fig. 1):
   a. We deflate the balloon of the bronchial blocker and the patient remains in apnea (PEEP = 0).

Abbreviations: VATS, Video-Assisted Thoracoscopic Surgery; EKG, electrocardiogram; SpO2, Blood oxygen saturation; ETCO2, end-tidal CO2; NIBP, non-invasive blood pressure; ETT, endotracheal tube.

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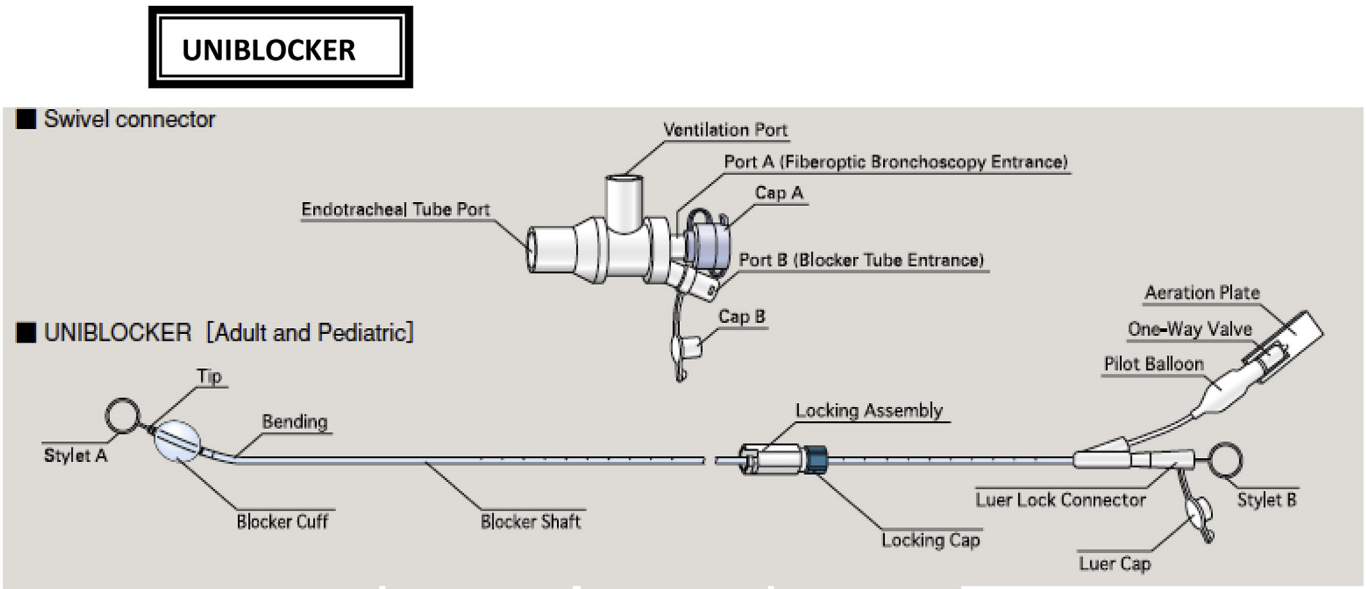

Fig. 1. Scheme of Uniblocker™ Fuji Systems Corporation adult and pediatric with specifications (above). Photo of Uniblocker™ with swivel connector (below). *Courtesy of Fuji Systems Corp. Tokyo, Japan.*

b. The surgeon introduces the first trocar and creates a pneumothorax with CO2 (4–5 mmHg). This pressure helps to passively empty the lung (the deflated balloon allows to exhale the air contained in the lung through the ETT).
c. We inflate the bronchial blocker balloon again (this time with the lung completely collapsed) and we proceed to ventilate the patient.

The surgery is performed without complications. Technically, the one-lung ventilation is correct.

2. Discussion

The VATS technique requires correct one lung isolation to allow adequate exposure to the surgical field [1,2]. Several alternatives have been described depending on the patient's age (Table 1) [3]:

1. Infants: selective intubation of the mainstem bronchus of the nonsurgical side with an small single lumen ETT [4].
2. Children younger than 6:
   - Arndt®: balloon tip and a four-way adapter. It contains a flexible wire that finishes in a loop that slides over fibrobronchoscope. When the guide is withdrawn, the lumen can be used to apply CPAP and suctioning [5].
   - Fogarty catheter
   - Uniblocker™
3. Children 6 years and older:
   - Univent®: bronchial blocker within a separate lumen.

Table 1
Advantages and disadvantages of different options to isolate lung.

	ADVANTAGES	DISADVANTAGES
Single lumen ETT (mainstem intubation)	• Easy use • Can be used under 8 years of age	• Cannot provide CPAP or suction to operative lung • Obstruction of the right upper lobe (in right mainstream bronchus intubation) • Less adequate seal of bronchus and incorrect lung collapse (especially in uncuffed tubes)
Bronchial blocker	• Can be used <6 years • Can provide CPAP or suction to operative lung (not in case of Uniblocker) • Complete block of bronchus • Best in difficult airways • Low pressure cuffs	• Can dislodge to trachea (complete airway obstruction) • Small size work channel (incomplete collapse). • Difficult to use
Fogarty catheter	• 3 Fr up to 4 years • 5 Fr 5–12 years • Easy use	• Low volume, high- pressure cuff (risk of mucosal injury) • Can dislodge to trachea (complete airway obstruction) • Small size work channel (incomplete collapse) • Not designed for this purpose (bronchial injuries)
Univent tube	• 6–8 years • Can provide CPAP or suction to operative lung (if > 4,5 mm ID[a]) • Easy placing of blocker • Less dislodgement	• Low volume, high-pressure cuff (risk of mucosal injury) • Small ventilation lumen (high airway resistances)
Double-lumen tube (DLT)	• Can provide CPAP or suction to operative lung • Conversion from dual to single-lung ventilation is easier • High- volume, low-pressure cuffs not damage airway	• No smaller sizes DLT (for children >8years)

[a] Internal diameter.

- Small double lumen ETT: children older than 8.

Due to the type of patient (9.5 kg infant), in our opinion, the most appropriate technique is a bronchial blocker, specifically Uniblocker™ 5Fr Fuji Systems (Fig. 2).

Uniblocker™ 5Fr Fuji Systems is a new bronchial blocker that has a rigid axis and an angled tip, which can be placed through a simple ETT, guided by fibrobronchoscope. It has a multiport adapter that allows ventilation during the placement of the blocker [5,6]. The balloon cuff is a maximum 3 ml and a lower pressure system, which reduces risk of bronchial mucosal injury. In addition, we can use the fibrobronchoscope to ensure that the volume of the cuff is as low as possible to get the seal [5].

In this case, it is important to obtain a complete sedoanalgesia and neuromuscular block. We use a ETT No 4,5 without cuff to allow the largest possible size of ETT. Furthermore, we reduce the length of the ETT to allow a better handling of the fibrobronchoscope.

Due to its small size, Uniblocker™ has no working channel so the operative lung cannot be suctioned. It is a close-tip bronchial blocker. Thus we develop the steps described above. The use of the pneumothorax at the same time of the deflation of the blocker balloon will achieve to empty the lung and obtain complete lung collapse. This technique obtains a surgical field in optimal conditions for surgery.

If hypoxemia occurs during the one-lung ventilation, we cannot apply CPAP to the non-dependent lung (Uniblocker™ has no working channel). We should follow the next steps [7]:

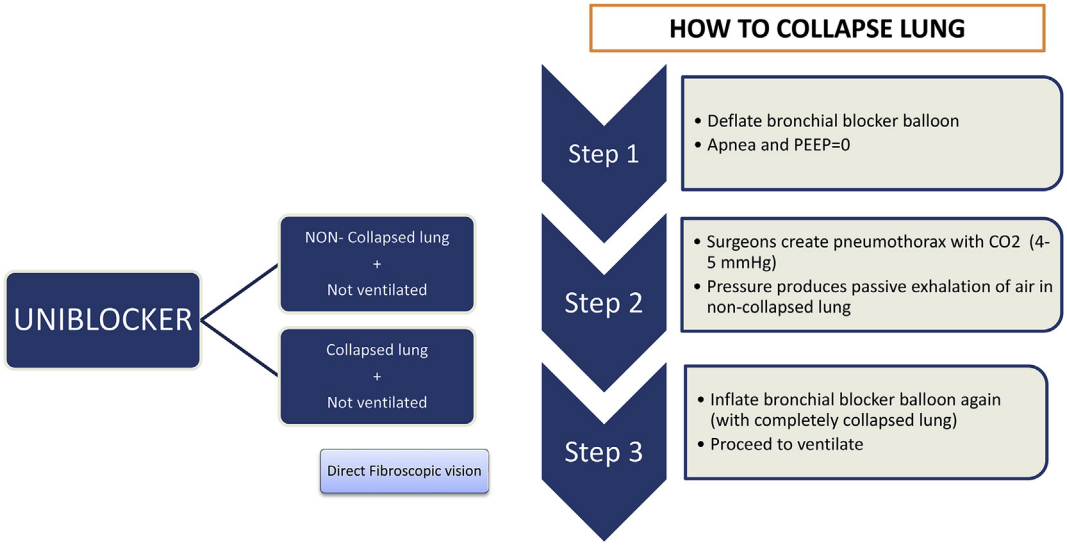

Fig. 2. Two scenarios after placing bronchial blocker (left). Steps to achieve lung collapse (right).

- FiO2 closed to 100%
- Aspirate secretions
- Evaluate position of tube or blocker (auscultation or fibrobronchoscopy)
- Low PEEP to dependent lung
- Intermittent lung recruitment manoeuvres
- In the case of a refractory hypoxemia, surgeon should be informed and the operative lung should be ventilated

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Competing interests

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tacc.2019.08.004.

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