



# REVISTA BRASILEIRA DE ANESTESIOLOGIA

Publicação Oficial da Sociedade Brasileira de Anestesiologia  
[www.sba.com.br](http://www.sba.com.br)



## CLINICAL INFORMATION

# Will ultrasound replace the stethoscope?: a case report on neonatal one-lung ventilation



Adriana Rodrigues \*, Petra Alves, Carla Hipólito, Helena Salgado

Hospital de Braga, Braga, Portugal

Received 20 April 2019; accepted 29 June 2019

Available online 5 September 2019

### KEYWORDS

Neonate;  
Lung ultrasound;  
One-lung ventilation;  
Video assisted  
thoracoscopic surgery

### PALAVRAS-CHAVE

Recém-nascido;  
Ultrassonografia  
pulmonar;  
Ventilação  
monopulmonar;  
Cirurgia  
toracoscópica  
assistida por vídeo

### Abstract

**Background and objectives:** One-lung ventilation and selective intubation in neonates can be challenging due to intrinsic physiological specificities and material available. Ultrasound (US) is being increasingly used in many extents of anaesthesiology including confirmation of endotracheal tube position.

**Case report:** We present a case report of a neonate proposed for pulmonary lobectomy by thoracoscopy in which lung exclusion was confirmed by ultrasound.

**Conclusion:** US is a rapid, more sensitive and specific method than auscultation to evaluate tracheal intubation and lung exclusion.

© 2019 Sociedade Brasileira de Anestesiologia. Published by Elsevier Editora Ltda. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

### O ultrassom substituirá o estetoscópio?: relato de caso sobre ventilação monopulmonar neonatal

### Resumo

**Justificativa e objetivos:** A ventilação monopulmonar e a intubação seletiva em recém-nascidos podem ser um desafio devido às especificidades fisiológicas intrínsecas e ao material disponível. O aparelho de ultrassom tem sido cada vez mais usado em muitas situações no campo da anestesia, incluindo a confirmação da posição do tubo endotraqueal.

**Relato de caso:** Apresentamos o relato do caso de um recém-nascido proposto para lobectomia pulmonar por toracoscopia em que a exclusão pulmonar foi confirmada por ultrassom.

**Conclusão:** O ultrassom é um método rápido, mais sensível e específico do que a ausculta para avaliar a intubação traqueal e a exclusão pulmonar.

© 2019 Sociedade Brasileira de Anestesiologia. Publicado por Elsevier Editora Ltda. Este é um artigo Open Access sob uma licença CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

\* Corresponding author.

E-mail: [adriana.acsr@gmail.com](mailto:adriana.acsr@gmail.com) (A. Rodrigues).

<https://doi.org/10.1016/j.bjane.2019.07.002>

0104-0014/© 2019 Sociedade Brasileira de Anestesiologia. Published by Elsevier Editora Ltda. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Background and objectives

The frequency of video-assisted thoracoscopy surgeries (VATS) is increasing. These procedures have proven to be safe in children and they are advantageous when compared to open thoracoscopies.<sup>1-3</sup> They are less invasive, cause lesser pain and are associated with shorter hospitalizations and anaesthetic improvement.<sup>1</sup>

This surgical procedure requires effective pulmonary exclusion, which can be challenging for the anaesthesiologist, especially in neonates, since there are some handicaps: availability of lung exclusion equipment and paediatric physiological changes related to ventilation.<sup>2</sup>

Ultrasound (US) has been increasingly used in medical care. In anesthesiology, it has been used to guide peripheral nerve blocks, endovascular catheters placement and, more recently, in airway evaluation, confirmation of endotracheal tube position and pulmonary assessment.<sup>3,4</sup>

Still, there are very few cases of VATS and one-lung ventilation (OLV) on neonatal patients, possibly due to both surgical and anaesthetic difficulties. The optimal technique to achieve lung exclusion in neonates is not established.<sup>2</sup>

We report a clinical case in which ultrasound was used to confirm endobronchial tube placement in a newborn in whom OLV was required.

## Case report

A 17 days-old neonate, weighting 3200 g, diagnosed with congenital lobar emphysema was scheduled for pulmonary lobe resection by VATS.

Antenatal ultrasounds were normal. He was born at 38 weeks of pregnancy. Apgar score was 10 at birth and 5 min later. Few hours after birth, he had an episode of respiratory distress with perioral cyanosis and SpO<sub>2</sub> <90%, being admitted to the Neonatal Intensive Care Unit (NICU). Chest radiography revealed lung asymmetry. On the 10th day of life, there was a respiratory worsening that motivated a CT angiography, leading to the diagnosis of congenital lobar emphysema on the upper left lobe and surgery was proposed. At NICU, he was dependent on oxygen supplementation but presented no other dysfunctions.

After ASA's standard, neuromuscular blockade and cerebral oximetry monitoring, general anaesthesia was induced with sevoflurane-oxygen, fentanyl (2 µg.kg<sup>-1</sup>) and propofol (1.5 mg.kg<sup>-1</sup>). Maintaining spontaneous ventilation, an uncuffed single-lumen endotracheal tube 3.0 mm was inserted. Left lung exclusion was attempted by inserting a little further the endotracheal tube, expecting it would enter the right main bronchus. Left lung exclusion was confirmed by auscultation and ultrasound. Using GE LogiqE™ US machine, with high frequency (8–15 MHz) linear probe, at an intercostal approach, the pleural sliding on the right lung was identified, including on the right upper lobe, and its absence and the presence of lung pulse noted on the left lung. Using motion-mode (M-mode) imaging, the "seashore" and "barcode" signs were, respectively, identified on the right and left sides, confirming right endobronchial intubation. Positive pressure ventilation was then initiated.

A tunnelled caudal catheter was placed under aseptic conditions. The tip of the catheter was placed at T8–T9 level under ultrasound visualization. After placement of the epidural catheter, the newborn was positioned on the right lateral decubitus and endotracheal tube position was reconfirmed by ultrasound. Neuromuscular blockade was achieved with rocuronium (0.3 mg.kg<sup>-1</sup>). Anaesthesia was maintained with a sevoflurane/oxygen/air mixture and epidural infusion of 0.1% ropivacaine.

The neonate remained hemodynamically stable, presenting SpO<sub>2</sub> >90%, with volume-controlled ventilation, ranging FiO<sub>2</sub> from 40% to 60%.

During the surgery, there was a period of hypercapnia (max etCO<sub>2</sub> of 67 mmHg) that coincided with a rise on cerebral oximetry. This was reversed with reduction of pneumothorax inflation pressure and surgical tools pressure on the right dependent lung, allowing its easier expansion. The surgery lasted 3.5 hours, with good surgical field exposure, as evaluated by the surgeons, and was uneventful. The patient was extubated at the end of the procedure and discharged back to NICU.

Forty-eight hours after surgery the thoracic drain was removed, the patient did not need oxygen supplementation and was able to be breastfed. Epidural analgesia with ropivacaine 1 mg.mL<sup>-1</sup> infusion was maintained for two days, with good pain control. He was discharged home asymptomatic at the 6th day postoperative.

Ten days later, owing to signs of respiratory distress, the neonate was taken to the Emergency Department. The chest radiograph showed a left pneumothorax. The patient was admitted to the hospital for oxygen supplementation and surveillance. He was discharged home asymptomatic a week later. Seven months after the surgery, he was asymptomatic and with age-appropriate psychomotor development.

## Discussion

Congenital lobar emphysema is a rare pulmonary malformation that most often requires surgical treatment, either by VATS or open thoracotomy. This pathology requires special attention at anaesthesia induction, as positive pressure ventilation may aggravate air trapping at the emphysematous lobe, resulting in mediastinal shift, decreased venous return, hypotension and hypoxia.

An efficient lung exclusion is essential for successful lung resection by VATS.<sup>1</sup> OLV in neonates is especially challenging for many reasons. The functional residual capacity is closer to residual volume which potentiates atelectasis. The oxygen consumption is higher. The use of inhalational anaesthetics impairs hypoxic pulmonary vasoconstriction increasing the dead space. There are two additional worsening factors related to the positioning of lateral decubitus. First, the ventilation/perfusion mismatch is more prominent because, owing to a more complacent rib cage, there is compression of the dependent ventilated lung. Second, neonates present a decrease in hydrostatic pressure gradient between the two lungs and therefore the favourable response of increased perfusion of the dependent lung is attenuated.<sup>1,2</sup>

Hypercarbia and hypoxemia are more frequent in small children.<sup>1,2</sup> In our case, there was a brief period of hyper-

carbia which was promptly resolved with pneumothorax pressure decrease. Also, the fact that our patient was a full-term baby may have contributed to his tolerability for OLV.

There are many methods of lung exclusion in paediatric population and the choice must consider the child size and the methods available in the institution; currently there is no gold standard for paediatric lung exclusion.<sup>2</sup>

In our case, lung exclusion was made using a single-lumen endotracheal tube due to patient's age and size. There is no adequate double-lumen tube size nor the possibility to couple such a small tube with a bronchial blocker guided by fibroscopy. Single-lumen endotracheal tube provides the simplest way of lung exclusion; however, it has potential disadvantages such as inadequate collapse of the operated lung, impossibility of using CPAP, inability for suction the operated lung and, in case of left lung exclusion, the possibility of upper right bronchus obstruction.<sup>1</sup>

Usually, when using a single-lumen endotracheal tube for OLV, it is preferably inserted with fiberoptic guidance. In our case, the smallest fibroscope available at our institution (2.8 mm) was too big for the orotracheal tube used. Other alternatives to confirm endotracheal tube position are auscultation, chest wall observation or chest radiography. The first two, are fast but unreliable methods while the latter is time-consuming.<sup>4</sup>

Ultrasonography has been increasingly used in airway management. Some authors have already shown its applicability to endotracheal intubation confirmation. Lung sliding and lung-pulse signals can be used to confirm lung exclusion. By using an intercostal approach, it is seen a hyperechoic line between the soft tissue of the chest wall and the aerated lung, the pleural line. In ventilated lung, there is a synchronized movement of these lines with ventilation which corresponds to the tidal movement of the lung, the lung sliding sign. On the other hand, when there is no ventilation, the lung sliding sign is absent due to lung collapse. In a collapsed lung, the pleural line moves with the heartbeat, pulsating, originating the lung-pulse sign.<sup>3-5</sup>

In our case, lung sliding and lung pulse signs were present which allowed us to conclude that we achieved appropriate lung exclusion. It is important to refer that lung sliding sign was present on the right upper lobe meaning that we did not occlude right upper lobar bronchus with the endotracheal tube.

Confirmation of lung exclusion by US is a rapid, easy and non-invasive method that is superior to auscultation. Nevertheless, there are some limitations in the use of US: (1) bedside availability and cost of an ultrasound machine;

(2) inter-individual variability; (3) pneumothorax, pleural adhesion or subcutaneous emphysema can mask lung sliding sign.<sup>3,5</sup>

Although VATS is less painful than thoracotomy, it is important not to neglect analgesia. In these patients, ability to cough and breathe is decreased due to pain and secretions which may contribute to atelectasis and pneumonia. In our case, we maintained an epidural catheter with continuous local anaesthetic infusion, with, apparently, good pain control.

## Conclusion

Lung exclusion confirmation by US is a safe, simple, rapid and non-invasive method that is superior to other options described in the literature. This tool should be considered whenever OLV is required.

## Informed consent

The patient's parents signed informed consent for the publication of this article.

## Conflicts of interest

The authors declare no conflicts of interest.

## References

1. Fabila TS, Menghraj SJ. One lung ventilation strategies for infants and children undergoing video assisted thoracoscopic surgery. *Indian J Anaesth.* 2013;57:339-44.
2. Kashyap L, Nisa N, Chowdhury AR, et al. Safety issues of endobronchial intubation for one-lung ventilation in video-assisted thoracoscopic surgery in neonates: can we extubate on the table? *Saudi J Anaesth.* 2017;11:254-5.
3. Nam JS, Park I, Seo H, et al. The use of lung ultrasonography to confirm lung isolation in an infant who underwent emergent video-assisted thoracoscopic surgery: a case report. *Korean J Anesthesiol.* 2015;68:411-4.
4. Chou EH, Dickman E, Tsou PY, et al. Ultrasonography for confirmation of endotracheal tube placement: a systematic review and meta-analysis. *Resuscitation.* 2015;90:97.
5. Parab SY, Kumar P, Divatia JV, et al. A prospective randomized controlled double-blind study comparing auscultation and lung ultrasonography in the assessment of double lumen tube position in elective thoracic surgeries involving one lung ventilation at a tertiary care cancer institute. *Korean J Anesthesiol.* 2018;72:24-31.