Case Report

Point-of-care lung ultrasound to evaluate lung isolation during one-lung ventilation in children: A case report

ABSTRACT

Minimally invasive thoracic surgical techniques require effective lung separation using one-lung ventilation (OLV). Verification of lung isolation may be confirmed by auscultation, visual confirmation using fiberoptic bronchoscopy, or more recently, point-of-care ultrasound (POCUS). We describe anecdotal experience with POCUS to guide OLV during robotic-assisted thoracic surgery in a child. Techniques to confirm thoracic separation are reviewed and potential advantages of POCUS discussed.

Key words: One-lung ventilation; point-of-care ultrasound; thoracic surgery

Introduction

The use of robot-assisted thoracic surgery has increased in children.[1,2] Effective one-lung ventilation (OLV) is imperative for exposure of the operative field as the failure of the technique remains the most common cause for conversion to open thoracotomy.[3] Verification of lung isolation may be confirmed by auscultation, visual confirmation using fiberoptic bronchoscopy, or more recently, point-of-care ultrasound (POCUS). The latter may be superior to auscultation in demonstrating effective lung separation.[4,5] However, there are limited data in children. We describe anecdotal experience with POCUS to guide OLV during robot-assisted thoracic surgery in a child. Techniques to confirm lung separation are reviewed and potential advantages of POCUS discussed. The hospital's institutional review board waived the need for review and approval.

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Case Report

A 7-year-old, 29.3 kg boy presented for robot-assisted thoracic surgery and resection of a right paraspinal mass. His medical history was significant for asthma. He had no surgical history. The medication regimen included budesonide aerosol. The patient was held *nil per os* for 6 hours. Following premedication with oral midazolam (0.5 mg/kg), he was transported to the operating room where routine American Society of Anesthesiologists' monitors were placed. Anesthesia was induced with sevoflurane in oxygen and nitrous oxide. After the induction of anesthesia, a peripheral intravenous cannula was placed. Rocuronium (30 mg) was administered to facilitate endotracheal intubation with a 4.5-mm cuffed endotracheal tube (ETT). The ETT was secured at 15 cm. A second peripheral intravenous cannula and a radial arterial cannula were placed. The

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Yoshikazu Yamaguchi[1], Alok Moharir[1,2], Candice Burrier[1,2], Joseph D. Tobias[1,2]

[1]Department of Anesthesiology and Pain Medicine, Nationwide Children's Hospital, [2]Department of Anesthesiology, The Ohio State University, Columbus, Ohio, United States

Address for correspondence: Dr. Yoshikazu Yamaguchi, Department of Anesthesiology and Pain Medicine, Nationwide Children's Hospital, 700 Children's Drive, Columbus, Ohio 43205, United States. E-mail: Yoshikazu.Yamaguchi@nationwidechildrens.org

plan for OLV was selective endobronchial intubation. The ETT was advanced into the left mainstem bronchus using fiberoptic bronchoscopy (FOB) guidance and taped at 19 cm. A high-frequency (6–13 MHz) linear probe (Sonosite SII, Fujifilm, Japan) was placed sagitally in both midclavicular lines to evaluate the ETT position. The initial examination revealed lung sliding sign resulting in a seashore sign on the right [Figure 1] and lung pulse on the left. Therefore, it was immediately recognized that the ETT had inadvertently been placed into the right mainstem bronchus. The ETT was withdrawn into the mid-tracheal position and guided into the left bronchus using FOB. Repeat lung ultrasound revealed lung pulse on the right side and lung sliding on the left side. Maintenance anesthesia included sevoflurane (expired concentration 2–3%) to maintain the bispectral index at 40–60 and a remifentanil infusion (0.25 μg/kg/min). A rocuronium infusion (0.5 mg/kg/h) was administered to maintain the train-of-four at 0–1/4. After the patient was placed in the left lateral decubitus position, effective lung separation was again confirmed by ultrasound with lung pulse without lung sliding on the right lung. Thoracoscopy revealed that the right lung was collapsed with a thoracoscopic insufflation pressure of 3 mm Hg. After the surgical procedure, ketorolac (15 mg) and hydromorphone (0.2 mg) were administered to provide postoperative analgesia. Ondansetron (3 mg) was administered to prevent postoperative nausea and vomiting. The patient was turned supine and his trachea was extubated in the operating room. The surgical duration was 104 min. The duration of OLV was 112 min. Estimated blood loss was <10 mL. Total fluids included 446 mL of isotonic crystalloid. The patient was transported to the postoperative anesthesia care unit. His postoperative course was uncomplicated, and he was discharged home on postoperative day 1.

Discussion

Our anecdotal experience provides clinical evidence that POCUS may be a rapid and effective means of evaluating OLV in children. Studies in the adult population have demonstrated that POCUS may be superior to auscultation to confirm the correct placement of the ETT. A diagnostic accuracy, randomized controlled study showed that identification of tracheal versus bronchial intubation was 62% with auscultation and 95% with POCUS.[5] Similar results have been reported when using double-lumen ETTs. Hu *et al*. evaluated the diagnostic accuracy of auscultation and POCUS, using both right and left double-lumen tubes in the supine and lateral positions. POCUS showed statistically significant higher diagnostic accuracy than auscultation.[4] Despite this evidence from the adult population, there is only one anecdotal case report in the pediatric population.[6]

Verification of lung isolation may be confirmed by auscultation, visual confirmation using fiberoptic bronchoscopy, or more recently, POCUS. POCUS has become more commonplace in the ICU arena for central venous cannulation, peripheral venous and arterial cannulation, and evaluation of cardiac function and intravascular volume status.[7] Additionally, thoracic ultrasound has been used for the evaluation of various pathological processes including pneumonia, pleural effusion, and pneumothorax.[8]

Lung sliding, which is a twinkling visible at the pleural line that spreads homogeneously below it, is used to confirm whether the lung is ventilated or not.[9] Lung sliding during ventilation results in a sea-shore sign in M-mode [Figure 1]. If the lung is not ventilated, we can see lung pulse in B-mode and bar-code sign in M-mode [Figure 2].[10] M-mode is easier

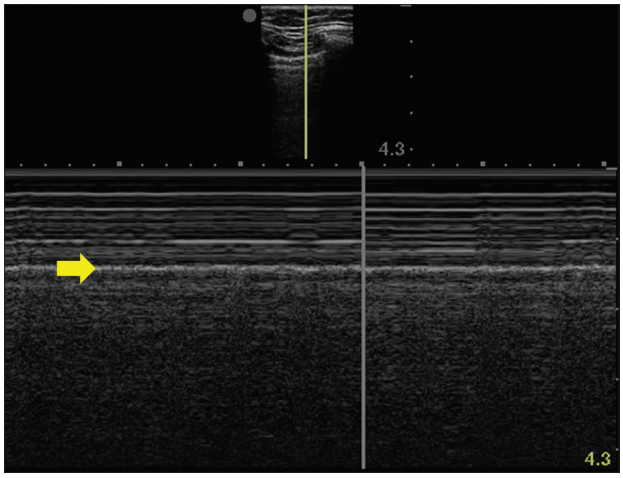

Figure 1: Point-of-care ultrasound showing the seashore sign. The pleural line is marked (yellow arrowhead). Above the pleural line, the motionless soft tissue creates horizontal or stratified lines. Below the pleural line, the sliding lung creates a granular pattern, the sand or seashore

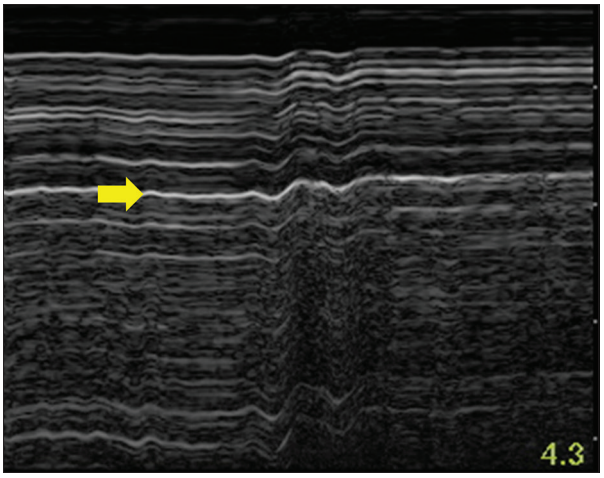

Figure 2: Point-of-care ultrasound showing the bar-code sign. No motion of the chest wall results in a homogeneous, stratified pattern above the pleural line while no motion of the lung because of effective lung separation results in a similar stratified pattern below the pleural line (yellow arrow head)

than B-mode to confirm ventilation for beginners. In our case, we were able to evaluate lung sliding and lung pulse without difficulty.

Although POCUS in all of the previously mentioned studies except one was performed in the supine position, we performed the study in both the supine and lateral decubitus positions.[4] As the position of the ETT may change after the patient is placed in the lateral decubitus position, a repeat study may be indicated once the patient is positioned. We were able to evaluate easily the nondependent lung by ultrasound after positioning. However, it became more difficult to access the dependent lung for POCUS because of the presence of the bean bag immobilizer and other equipment used for positioning and padding the patient.

There has been increased interest in the use of POCUS during airway management. Our anecdotal experience supports its value in confirming effective lung separation during OLV in a child. POCUS can be quickly and noninvasively performed in the operating room to provide documentation of effective lung separation and to facilitate minimally invasive thoracic surgical procedures.

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Conflicts of interest
There are no conflicts of interest.

References

1. Hartwich J, Tyagi S, Margaron F, Oitcica C, Teasley J, Lanning D. Robot-assisted thoracoscopic thymectomy for treating myasthenia gravis in children. J Laparoend Adv Surg Tech 2012;22:925-9.
2. Ballouhey Q, Villemagne T, Cros J, Vacquerie V, Berenguer D, Braik K, *et al*. Assessment of paediatric thoracic robotic surgery. Interact Cardiovasc Thorac Surg 2015;20:300-3.
3. Bataineh ZA, Zoeller C, Dingemann C, Osthaus A, Suempelmann R, Ure B. Our experience with single lung ventilation in thoracoscopic paediatric surgery. Eur J Pediatr Surg 2012;22:17-20.
4. Hu WC, Xu L, Zhang Q, Wei L, Zhang W. Point-of-care ultrasound versus auscultation in determining the position of double-lumen tube. Medicine 2018;97:e9311.
5. Ramsingh D, Frank E, Haughton R, Schilling J, Gimenez KM, Banh E, *et al*. Auscultation versus point-of-care ultrasound to determine endotracheal versus bronchial intubation: A diagnostic accuracy study. Anesthesiology 2016;124:1012-20.
6. Nam JS, Park I, Seo H, Min HG. 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.
7. Levitov A, Frankel HL, Blaivas M, Kirkpatrick AW, Su E, Evans D, *et al*. Guidelines for the appropriate use of bedside general and cardiac ultrasonography in the evaluation of critically ill patients-part II: Cardiac ultrasonography. Crit Care Med 2016;44:1206-27.
8. Frankel HL, Kirkpatrick AW, Elbarbary M, Blaivas M, Desai H, Evans D, *et al*. Guidelines for the appropriate use of bedside general and cardiac ultrasonography in the evaluation of critically ill patients - part I: General ultrasonography. Crit Care Med 2015;43:2479-502.
9. Lichtenstein DA, Meziere GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure: The BLUE protocol. Chest 2008;134:117-25.
10. Lichtenstein DA, Lascols N, Prin S, Meziere G. The "lung pulse": An early ultrasound sign of complete atelectasis. Intensive Care Med 2003;29:2187-92.