

DOI: 10.21767/2386-5180.1000162

Management of Low Tidal Volume and ETCO₂ during Thoracoscopy in the Treatment of Tracheo-Esophageal Fistula: A Case Report

Yi Zhao and Xiangdong Chen

Department of Anesthesiology, Union Hospital of Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, China

Corresponding author: Xiangdong Chen, Department of Anesthesiology, Union Hospital of Tongji Medical College, Huazhong University of Science and Technology, 1227 Jie Fang Road, Wuhan, Hubei, China, Tel: 15827067036; E-mail: xiangdong_chen@yahoo.com**Received:** 12 March 2017; **Accepted:** 27 March 2017; **Published:** 31 March 2017;**Citation:** Zhao Y, Chen X. Management of Low Tidal Volume and ETCO₂ during Thoracoscopy in the Treatment of Tracheo-esophageal Fistula: A Case Report. Ann Clin Lab Res. 2017, 5: 1.

Abstract

Esophageal atresia with tracheo-oesophageal fistula (TEF) occurs in 1 in 2500-3000 live births. Management of airway and ventilation in TEF repair is challenging. Nowadays, advances in minimally invasive surgical techniques and neonatal intensive care for neonates have allowed endoscopically repair of TEF, which lends another level of complexity to airway management. Usually, a sudden increase in ETCO₂ should alert the anesthesiologist to possible surgical trauma and entrainment of thoracoscopic gas. However, low ETCO₂ emerging with low tidal volume can also alerts the anesthesiologist to possible surgical trauma. We had an uncommon situation, where a sudden low ETCO₂ emerged with low tidal volume when doing the complete anastomosis. After communicating with surgeons, they stopped and tried to find the possible causes. Finally, it appeared to be a surgical injury on the right lung. Continuous communication between the surgeon and the anesthesiologist is imperative when performing these operations.

Keywords: Tracheo-oesophageal fistula(TEF); ETCO₂; Airway; Thoracoscopy

Introduction

Anesthesia management for tracheo-oesophageal fistula (TEF) repair may be a challenge, especially in the endoscopic repair. For better surgical exposure, one-lung ventilation is often required. Surgical insufflation of CO₂ to 5 mmHg collapsed the right lung, and patients may desaturated to 84% to 91% and mostly required 100% O₂ [1-3]. In this case, anesthesiologists should pay a close attention on the end-tidal carbon dioxide (ETCO₂). During one-lung ventilation, it is common that end-tidal carbon dioxide (ETCO₂) can be falsely low or almost total loss [4]. We had an uncommon situation, where a sudden low ETCO₂ emerged with low airway pressure when doing the complete anastomosis, by performing manual bag insufflations the saturation of pulse oxygen (SPO₂) still maintained about 90%. After communicating with surgeons,

they stopped and tried to find the possible causes. Finally, it appeared to be a surgical injury on the right lung. After fixing it, all the SPO₂, ETCO₂ and tidal volume returned to the acceptable level.

Case Presentation

A 12 days old, full term, male neonate (2.6 kg) was diagnosed with TEF (C/IIIb, proximal esophageal atresia with distal tracheoesophageal fistula). The baby presented as excessive frothing from the mouth, choking and cyanosis after feeding only a few hours after birth. The peripheral hospital diagnosed him TEF by the result of chest X-ray which also showed pulmonary infection. An operation was planned for repairing the fistula with thoracoscope. Intraoperation monitoring including electrocardiograph, capnograph and blood oxygen saturation. The baby was induced by inhaling sevoflurane. The baby had an intravenous induction, including administration of fentanyl 30 µg, midazolam 0.2 mg and cis-atracurium 0.1 mg bag-mask ventilation without gastric distension. Then a cuffed 3.5 endotracheal tube (EET) was passed through the glottis under a laryngoscope. By auscultating bilateral breath sounds, the depth of EET was adjusted to 12 cm to make the EET tip in left mainstem bronchus in attempt to obtain single lung ventilation. Anesthesia was maintained on inhalational agent and opioid with pressure-controlled ventilation (the airway pressure was set accordingly, no higher than 25 cm H₂O) or manual ventilation. The neonate is positioned in a three-quarters prone position is vitally important to allow the lung to fall away from the posterior mediastinum through gravity and positive pressure insufflations [4], after that, we confirmed the location of the EET tip again in the same way before. Surgical insufflation of CO₂ to 5 mmHg collapsed the right lung, and the baby desaturated to 90% to 94% and required 100% O₂. The steps of operation including identifying fistula, clipping fistula, finding the upper pouch, mobilizing tissue and complete anastomosis. Operation had been carried out smoothly until the TV, ETCO₂ and airway pressure occurred nearly totally loss. The SPO₂ stayed at about 94%. To exclude shift or compression of EET, we pulled out about 2 cm of the EET to the main bronchus. But the TV and ETCO₂ didn't get better. Immediately, manual ventilation was started and we found airway pressure remaining at (1-2) mmHg. Obviously, there

was a leakage somewhere. After ensuring the cuff was inflated, we communicated with surgeon about the situation. He decided to stop the operation and check the fistula which had been clipped before, but nothing wrong was found. During all this process, manual ventilation was carried on and SPO₂ was maintained at 91%. In light of this situation, the surgeon decided to convert it to an open procedure for surgical damage is highly suspected. When the chest was opened and filled with warm water, the SPO₂ fell to about 85%. We found there was a rip about 3cm on the right lung bubbling with ventilation. After fixing it, the operation went on with two-lung ventilation and the SPO₂ came back to 98%. Although the ETCO₂ had been very high when we shifted back to mechanical ventilation, it fell back to normal gradually. An hour later, we finally finished the operation with good oxygen saturation, blood pressure, TV and ETCO₂. The baby was sent to ICU with EET.

Discussion

Esophageal atresia with TEF occurs 1 in 3500 live births [1]. Minimal access surgery is being applied to neonatal surgical disease more frequently. As for thoracoscopic repair of congenital esophageal anomalies, it definitely avoids significant complications associated with thoracotomy, such as severe pain, rib fusion, scoliosis, chest-wall deformity, and thoracic nerve damage [5]. Along with it comes another level of complexity to airway management for anesthesiologists. During the procedure, the ipsilateral lung was compressed with the operative pneumothorax to achieve an adequate working space, deoxygenation always occurs; and most patients needed 100% oxygen [5]. Coordination between the anesthesiologists and surgeons at this point is important because oxygen desaturation and almost total loss of end-tidal carbon dioxide (ETCO₂) tracing are common. These alarming episodes may be caused partly by compression or kinking during right hemithorax insufflation of the trachea, bronchi, and TEF. Also, the increased intrathoracic pressure can decrease venous return [6]. Generally, low ETCO₂ always emerges with low tidal volume and high airway pressure. This highly alerts anesthesiologists to compression or kinking of the bronchus or the EET. When low ETCO₂ occurs with normal tidal volume and normal airway pressure, decrease venous return should be highly suspected. Repeated gentle, partial re-expansion of the right lung by brief easing of retraction and release of the CO₂ insufflation may be necessary [6]. The volume status of the neonate must be monitored closely because decreased venous return can be exaggerated in a mildly hypovolemic patient with increased intrathoracic pressure. Rarely, if ETCO₂ emerged with low tidal volume and low airway pressure, the anesthesiologist must be mindful of surgical injury and communicate with surgeon. ETCO₂ getting almost total loss in our case because of lack of expired tidal volumes. An alternative method of CO₂ monitoring should be used, like arterial blood gas or TCCO₂ assessment. But in our case, we didn't monitor the neonate with an arterial line, so blood gas analysis was hard to carried out during the procedure. Although there is no emphasize that arterial line is necessary for each baby, it is always safer to do it in case of

emergency like this. In addition, continuous communication between the surgeon and the anesthesiologist is imperative when performing these operations. It is often necessary to intermit the surgery, until the expiratory CO₂ returned to an acceptable level [3].

Several airway and ventilation management options are available, and they all work, at least some of the time. Often it is difficult to predict which option will work best. Traditionally, the maintenance of spontaneous ventilation has been advocated in TEF and an inhalational induction is often recommended [3]. Considering no additional airway anomalies and large, pericarinal fistulas, we still could choose intravenous induction with muscle paralysis and pressure-control ventilation in all patients. Whereas positioning the ETT tube in the left mainstem bronchus or distal to the fistula should minimize gastric insufflation and improve both ventilation and the surgical field, the anesthesiologist must be vigilant regarding the catastrophic risk of tube malposition [7]. In the presentation made by Lele Zhang, bronchial occlude is also a good choice, especially for large tracheoesophageal fistula [8]. High-frequency oscillating ventilation (HFOV) can be used intraoperatively to provide a still operative field without lung isolation. HFOV allows for good intraoperative exposure with good oxygenation and CO₂ elimination [9]. Fiberscopy is also very helpful in delineating the tracheobronchial anatomy and TEF location and size, verifying the ET position, and potentially to assist the surgeons with fistula ligation [7,10]. However, just like HFOV, it cannot be found in every center.

High-level evidence on how best to manage the airway and ventilation in TEF is scarce or nonexistent, especially for endoscopic procedure. So, it is difficult to predict which option will work best. The anesthesiologist should think through all imaginable scenarios and mishaps before embarking on a case.

References

1. Rothenberg SS (2009) Experience with thoracoscopic tracheal surgery in infants and children. *J Laparoendosc Adv Surg Tech A* 19: 671-674.
2. Meier JD, Sulman CG, Almond PS, Holinger LD (2007) Endoscopic management of recurrent congenital tracheoesophageal fistula: A review of techniques and results. *Int J Pediatr Otorhi* 71: 691-697.
3. Broemling N, Campbell F (2011) Anesthetic management of congenital tracheoesophageal fistula. *Paediatr Anaesth* 21: 1092-1099.
4. Kamble RS, Gupta R, Gupta A, Kothari P, Dikshit KV, et al. (2014) Passage of nasogastric tube through tracheo-esophageal fistula into stomach: A rare event. *World J Clin Cases* 2: 309-310.
5. Ma L, Liu YZ, Ma YQ, Zhang SS, Pan NL (2012) Comparison of neonatal tolerance to thoracoscopic and open repair of esophageal atresia with tracheoesophageal fistula. *Chinse Med J Peking* 125: 3492-3495.
6. Ho AM, Dion JM, Wong JC (2016) Airway and ventilatory management options in congenital tracheoesophageal fistula repair. *J Cardiothorac Vasc Anesth* 30: 515-520.

7. Deanovic D, Gerber AC, Dodge-Khatami A, Dillier CM, Meuli M, et al. (2007) Tracheoscopy assisted repair of tracheo-esophageal fistula (TARTEF): A 10-year experience. *Paediatr Anaesth* 17: 557-562.
8. Zhang L, Zhao X, Li Q (2015) Successful single-lung ventilation using a bronchial occluder for repair a large tracheoesophageal fistula: A case report. *Int J Clin Exp Med* 8: 14454-14456.
9. Mortellaro VE, Fike FB, Adibe OO, Juang D, Aguayo P, et al. (2011) The use of high-frequency oscillating ventilation to facilitate stability during neonatal thoracoscopic operations. *J Laparoendosc Adv Surg Tech A* 21: 877-879.
10. Bloch EC, Filston HC (1988) A thin fiber optic bronchoscope as an aid to occlusion of the fistula in infants with tracheoesophageal fistula. *Anesth Analg* 67: 791-793.