Case report: Use of two balloon-tipped catheters during thoracoscopic repair of a type C tracheo-esophageal fistula in a neonate

[Présentation de cas : Utilisation de deux cathéters à ballonnet pendant la réparation thoracoscopique d'une fistule trachéo-oesophagienne de type C chez un nouveau-né.]

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Purpose: To describe a novel airway management technique for thoracoscopic repair of a type C tracheoesophageal fistula (TEF) in a neonate.

Clinical features: A full-term neonate with a type C TEF presented for thoracoscopic repair. The fistula was at the level of the carina, making its isolation from positive pressure ventilation using traditional techniques difficult. In addition, non-ventilation of the right lung was required. The use of two Fogarty type balloon-tipped embolectomy catheters placed alongside the endotracheal tube successfully achieved the goal of blocking ventilation of the fistula and the right lung. The use of fiberoptic bronchoscopy greatly facilitated placement of the blockers. The patient made an uneventful recovery.

Conclusion: Placing two balloon-tipped blockers, one in the TEF and the other in the right mainstem bronchus, is a viable technique for thoracoscopic fistula repair when the fistula is at or very close to the level of the carina.

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Objectif : Décrire une nouvelle technique de prise en charge des voies respiratoires pour la réparation d'une fistule trachéo-oesophagienne (FTO) de type C par thoracoscopie chez un nouveau-né.

Éléments cliniques : Un nouveau-né à terme avec une FTO de type C a été admis pour une réparation par thoracoscopie. La fistule était située au niveau de la carène, rendant difficile son isolation de la ventilation à pression positive avec des méthodes traditionnelles. De plus, la non-ventilation du poumon droit était nécessaire. Grâce à l'utilisation de deux cathéters d'embolectomie

à ballonnet de type Fogarty, placés le long du tube endotrachéal, la ventilation de la fistule et du poumon droit a pu être bloquée. Le recours à une bronchoscopie par fibres optiques a grandement facilité le placement des bloqueurs. Le patient s'est rétabli sans complications.

Conclusion : Lorsque la fistule est au niveau de la carène ou en est très proche, le placement de deux bloqueurs à ballonnet, l'un dans la FTO et l'autre dans la bronche souche droite, est une technique viable pour la réparation thoracoscopique d'une fistule.

MINIMALLY invasive surgical techniques are being used increasingly for the repair of tracheoesophageal fistula (TEF) in neonates. Traditional repair through a right dorsolateral thoracotomy has major disadvantages, including a large scar, significant postoperative pain, and a high degree of scoliosis and shoulder girdle weakness later in development.¹ An advantage of minimally invasive surgery is superior visualization of the fistula and the surrounding anatomy through the thoracoscope.² However, this new approach poses extra challenges to the anesthesiologist because of the requirement for collapsing a lung during the thoracoscopic repair. Thus, the anesthesiologist needs to isolate not just the TEF, but also a mainstem bronchus during the procedure. When the TEF is not too proximal to the carina, it can be isolated by the

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FIGURE The patient had a large tracheoesophageal fistula at the level of the carina (left panel). The fistula was intubated by a balloon-tipped catheter (middle panel). The fistula and the right mainstem bronchus were intubated by balloon-tipped catheters (right panel).

endotracheal tube (ETT).³⁻⁵ However, 11% of TEF are either at or below the carina.⁶ When the TEF is very near or at the carina, this approach becomes impossible and unreliable, and use of a balloon-tipped embolectomy catheter to block the fistula during open TEF repair has been described.^{7,8} The use of a balloon-tipped catheter to achieve single-lung ventilation is a well-established technique.⁹ With the consent of the patient's mother for publication, we herein describe a thoracoscopic TEF repair in which airway management involved the use of two balloon-tipped catheters to block the TEF and the right mainstem bronchus simultaneously.

Case report

A full-term baby girl was born with type C TEF (esophageal atresia with distal fistula communicating between the distal esophagus/stomach and the lower trachea). Her birth weight was 2400 g. Other congenital abnormalities included patent foramen ovale and ductus arteriosus, both with left to right shunt, and horseshoe kidneys. She did not have any known vertebral, anal, or limb abnormalities.

Corrective surgery was undertaken on day two. Preoperatively, SpO₂ was 94% on room air, she was tachypneic with a mild fever for which she received antibiotics, but vital signs were otherwise stable. Relevant blood work was unremarkable. Routine intraoperative monitors were attached; however, attempts to establish an arterial line failed. The *in situ* Replogle tube was placed on gentle continuous suction. Prior to induction, atropine 0.1 mg *iv* was given. General

anesthesia was induced with up to 4% sevoflurane (end-tidal) in 100% O₂ with the child in a slight reverse Trendelenberg position. Spontaneous respiration was maintained. After spraying the larynx and trachea with lidocaine 10% (total approximately 15 mg), fiberoptic bronchoscopy (Olympus LF-P 1.8 mm, Tokyo, Japan) was performed to discover that the TEF was at the carina (Figure). The fibroscope was withdrawn and the trachea was intubated with a 4 Fr Fogarty arterial embolectomy catheter (Applied Medical Technology, Inc, Cleveland, OH, USA) with its tip slightly bent so that the balloon was facing posteriorly. Next inserted was an uncuffed internal diameter 3 mm ETT. Under fiberoptic bronchoscopy through the ETT lumen, the TEF was intubated successfully with the Fogarty catheter tip on the first attempt (Figure), and the balloon was inflated just enough so that it appeared to completely occlude the fistula. The approximate inflation volume was 0.2 mL of saline. The ETT was then removed, and another 4 Fr Fogarty catheter with the tip slightly bent towards the right was passed into the trachea followed by reintubation with the same ETT. The second Fogarty catheter tip was then positioned in the right mainstem bronchus with the aid of fiberoptic bronchoscopy, again through the ETT lumen (Figure). Inflation of the second catheter balloon with approximately 0.2 mL of saline resulted in satisfactory isolation of the right lung. The child was then paralyzed and controlled ventilation was started. The balloon pressures were not measured. There was no gas leak around the *in situ* ETT and the catheters at a peak ventilatory pressure of 20 cm H₂O.

The baby was turned into a semi-prone position, right side up. The right endobronchial blocker was inflated after an exhalation pause. Surgically, a camera port was inserted at the fourth intercostal space at the posterior axillary line. Two additional ports, one 5 mm above and another below, were also inserted at the anterior axillary line. Carbon dioxide insufflation at 5 mmHg was induced for thoracoscopic division of the fistula and anastomosis of the two esophageal stumps. After the anastomosis, a 10-Fr chest drain was inserted and the right lung was re-inflated. One-lung ventilation lasted just over four hours. The child at times needed hand ventilation with 100% O₂ to maintain SpO₂ > 88%. Surgery took longer than expected because of difficulties with the anastomosis, but was otherwise uneventful.

Postoperatively, the child was treated with antibiotics for pneumonia and intermittent *iv* boluses of fentanyl for analgesia and sedation. Her trachea was extubated on postoperative day six upon resolution of the pneumonia. She was discharged to a peripheral hospital on postoperative day 12. Subsequent recovery was uneventful, as evaluated during multiple visits to clinic up to one year later.

Discussion

We have described the use of two embolectomy catheters to simultaneously isolate the right mainstem bronchus and a TEF that existed at the level of the carina. This approach afforded a “quiet” lung that did not require the surgeons to create an extra port for lung retraction. This approach greatly facilitated surgery and minimized trauma to the right lung.

Formulation of the airway management plan was possible after the airway anatomy was delineated with fiberoptic bronchoscopy. Once a two-blocker technique was chosen, the TEF blocker was the first to be inserted. As reported by others,⁷ and due to the downward direction of the tracheo-distal esophageal/gastric fistula, this task was not time-consuming. Because the ETT was too small to accommodate a Fogarty catheter and a fibroscope, both blockers had to be outside of the ETT. The ETT thus was inserted twice: after the fistula blocker was placed, and after the endobronchial blocker was inserted. The accurate positioning of both blockers required bronchoscopy through the ETT lumen. One concern which arose was whether the presence of two blockers and an ETT would create excessive pressure on the tracheal mucosa. We were unable to objectively investigate this aspect, but noted that the child had no clinical evidence of tracheo-malacia or stenosis on multiple follow-up visits. Bearing in mind that the cross-section

of the neonatal trachea has a partial oval shape, it was thought that the stems of the blockers would migrate into the gaps between the tracheal mucosa and the ETT. Others have not reported this potential problem with the use of a single blocker and an ETT.^{7,8}

The disadvantages of bronchial blockers include the possibility of retrograde migration of either blocker into the tracheal lumen, resulting in partial or complete airway obstruction; and insufficient blockade of the mainstem bronchus leading to partial ventilation of the collapsed lung; and bronchial rupture.¹⁰

One alternative technique of blocking the TEF and the right mainstem bronchus simultaneously is to deliberately slide the ETT into the left mainstem bronchus.^{11,12} This simple approach is sometimes effective.¹³ However, differences in the diameters of either mainstem bronchus and the trachea may result in an ETT that fits a mainstem bronchus well but is too small for the trachea, or one that fits the latter but is too large for the former. This might predispose to left bronchial edema. In one report, left upper lobe collapse also highlighted the low margin of safety in deliberate endobronchial ETT placement in neonates to achieve one-lung ventilation.¹¹ Another disadvantage stems from the not uncommon occurrence of desaturation during one-lung ventilation in TEF repair.¹⁴ As such, intraoperatively, the ETT may need to be retracted several times to ventilate both lungs. Subsequent repositioning of the ETT tip back into the left mainstem bronchus requires fiberoptic bronchoscopy, which may be hazardous and cumbersome in a semiprone neonate, made even more difficult by the clutter of sterile drapes separating the small distance between the operative field and the patient's mouth.

Use of a specially designed bifurcated tracheal tube for TEF repair has also been described.¹⁵ This is not a double-lumen tube, and is therefore not suitable for differential lung ventilation. Intubating the TEF with a balloon-tipped catheter pulled through a gastrostomy has also been described¹⁶ but has been criticized for its complexity.⁸

In summary, the need to avoid communication between the stomach and the lungs and the importance of collapsing the right lung during thoracoscopic TEF repair led to the use of two balloon-tipped embolectomy catheters placed alongside the ETT in a neonate. This appears to be a viable technique and may be considered when the TEF is too proximal to the carina to be easily blocked with an ETT.

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