One-Lung Ventilation in a Malnourished Child Using a Fogarty Catheter: A Practical Solution for Pediatric Airway Isolation

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ABSTRACT:

Background: One-lung ventilation (OLV) in pediatric patients presents significant challenges because of the small airway diameter and limited availability of appropriately sized lung-isolation devices. These difficulties may be further exacerbated in malnourished children, who often have reduced physiological reserves and are more vulnerable to perioperative respiratory complications.

Case Presentation: We report the anesthetic management of a malnourished child requiring a surgical procedure necessitating OLV. Conventional double-lumen tubes and bronchial blockers were unsuitable because of the patient's small airway size. A Fogarty catheter was therefore used as a bronchial blocker to achieve selective lung isolation. Under appropriate guidance, the catheter was positioned to occlude the target bronchus, allowing ventilation of the contralateral lung. Careful intraoperative monitoring was performed to detect hypoxemia, airway obstruction, and catheter displacement.

Results: Effective lung isolation was achieved using the Fogarty catheter, providing satisfactory surgical exposure while maintaining adequate oxygenation and ventilation. No major intraoperative respiratory complications occurred.

Conclusion: A Fogarty catheter can be a practical, accessible, and effective alternative for lung isolation in small or malnourished pediatric patients when conventional pediatric OLV devices are unavailable or unsuitable.

Keywords: Pediatric One-Lung Ventilation, Bronchial Blocker Technique, Fogarty Catheter, Video-Assisted Thoracoscopic Surgery (VATS), Airway Management in Children, Fluidopneumothorax

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. Introduction

One-lung ventilation (OLV) in pediatric patients remains a significant anesthetic challenge due to the combination of limited respiratory reserve, heightened susceptibility to hypoxemia, and restricted availability of lung-isolation devices specifically designed for children. Although the double-lumen tube (DLT) is the standard in adult populations, its use in children is often not feasible, making alternative techniques such as bronchial blockers the primary option; however, their success is highly dependent on accurate placement and device stability throughout thoracic procedures. In patients with chronic lung disease, atelectasis, or conditions that reduce functional residual capacity, the risk of respiratory decompensation increases substantially during OLV, underscoring the need for a safe and reliable lung-isolation strategy. Within this context, the improvisation of techniques using non-conventional devices (such as the Fogarty catheter) gains considerable clinical relevance, particularly in centers with limited access to specialized pediatric equipment.

2. Case Report

A 12-year-old girl with severe malnutrition (weight 30 kg, height 140 cm; height-for-age < −3 SD, BMI-for-age < −2 SD) presented with progressive dyspnea, fever, and productive cough for one week, accompanied by a 2-kg weight loss over the preceding two weeks. On admission, she was alert and cooperative with mild respiratory distress. Vital signs showed a blood pressure of 102/76 mmHg, heart rate of 100 beats/min, respiratory rate of 26 breaths/min, and oxygen saturation of 99% on 2 L/min nasal cannula. Physical examination revealed reduced expansion of the left hemithorax and markedly diminished breath sounds. Chest radiography demonstrated a left thoracic drain with serous output and no air leak (Figure 1), while high-resolution CT imaging showed a left-sided fluidopneumothorax with compressive atelectasis and multiple calcified lymph nodes, consistent with chronic infection. These findings had important implications for the anesthetic strategy required for the planned thoracic procedure.

This condition posed several anesthetic challenges. Malnutrition reflected limited physiological reserve, whereas chronic lung infection and atelectasis further narrowed the respiratory safety margin. The risk of hypoxemia during OLV was a major concern given the compromised pulmonary function. In addition, the unavailability of a pediatric double-lumen tube (DLT) necessitated the use of an alternative lung-isolation technique that was both safe and stable. Based on these considerations, the anesthetic plan for the VATS procedure was tailored to the patient's condition and the equipment limitations.

The patient was scheduled for video-assisted thoracoscopic surgery (VATS) decortication on day 9 after chest tube placement, once her clinical condition had stabilized. Given her body size and equipment constraints, lung isolation was planned using a Fogarty catheter as a bronchial blocker. Following induction of anesthesia with sevoflurane in an oxygen–air mixture and neuromuscular relaxation with rocuronium, endotracheal intubation was performed using a single-lumen tube. Under fiberoptic bronchoscopy guidance, a 4-Fr Fogarty catheter was inserted through the endotracheal tube and positioned in the left main bronchus; the balloon was then inflated until complete occlusion was confirmed (Figure 2). Oxygenation remained stable throughout the procedure, and the blocker position did not shift. This technique enabled stable OLV and provided adequate surgical exposure during the operation.

OLV provided satisfactory surgical exposure during VATS. The intraoperative course was uneventful, with an estimated blood loss of 200 mL and no episodes of hypoxemia or hemodynamic instability. This intraoperative stability continued into the postoperative phase. The patient was transferred to the intensive care unit and extubated on postoperative day 1. She remained stable with an oxygen saturation of 99% on room air, minimal drainage, and no

airway-related complications or issues associated with the bronchial blocker.

3. Results

Successful one-lung ventilation was achieved using a Fogarty catheter as a bronchial blocker in the malnourished child. The technique provided adequate collapse of the operative lung and satisfactory surgical exposure while maintaining acceptable oxygenation and ventilation throughout the procedure. Hemodynamic parameters remained stable, and no significant episodes of hypoxemia or airway obstruction occurred. The Fogarty catheter remained appropriately positioned during surgery, with no major complications related to lung isolation. The patient was successfully managed perioperatively and recovered without significant respiratory complications.

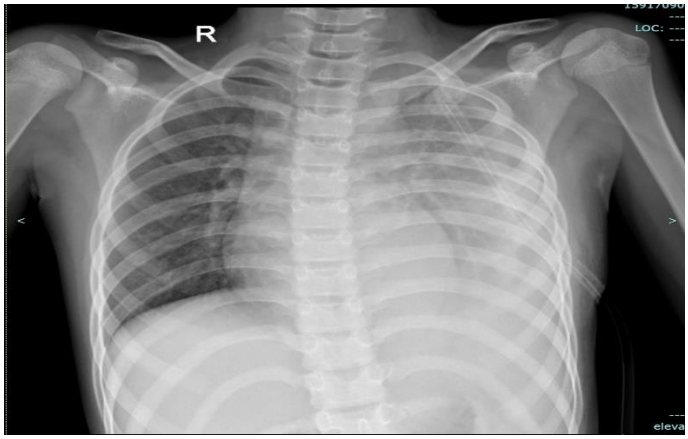

Figure 1. The chest X-ray demonstrates the left hemithorax with an indwelling chest tube, reduced lung expansion, and findings consistent with fluidopneumothorax.

4.

Discussion

The combination of severe malnutrition, chronic pulmonary infection, and radiologic findings of fluidopneumothorax with compressive atelectasis and calcified lymph nodes placed this patient at an exceptionally high respiratory risk during general anesthesia and OLV. At presentation, she already demonstrated respiratory compromise, evidenced by reduced expansion of the left hemithorax and markedly diminished breath sounds, while high-resolution CT imaging revealed a "left-sided fluidopneumothorax with adjacent compressive atelectasis and multiple calcified lymph nodes," consistent with a chronic infectious process likely related to tuberculosis. Malnutrition in pediatric patients not only reflects limited physiological reserve but is also associated with impaired wound healing, immune dysfunction, and increased perioperative complications, and is therefore recognized as a critical component of risk assessment and preoperative optimization in pediatric surgery [1, 2]. In addition, chronic lung disease with extensive atelectasis and a pleural space filled with both air and fluid significantly reduces functional residual capacity and increases the risk of hypoxemia during induction, airway manipulation, and OLV, conditions identified as major contributors to perioperative respiratory complications in children [3-5]. In this context, every anesthetic intervention was performed on a markedly reduced "physiologic floor," where malnutrition diminished systemic compensatory capacity, chronic lung infection and atelectasis narrowed the ventilatory safety margin, and the presence of fluidopneumothorax added mechanical instability to the lung. Consequently, protective ventilation strategies and lung-isolation techniques that minimize oxygenation disturbances were essential to prevent life-threatening respiratory decompensation [5, 6].

The need for one-lung ventilation in pediatric patients with limited respiratory reserve places

anesthesiologists in a situation with an extremely narrow safety margin, where intraoperative hypoxemia becomes a primary complication to anticipate. Recent multicenter cohort studies have shown that hypoxemia during OLV in children may occur in up to one-quarter of cases, particularly in younger patients, those with impaired pulmonary function, and those requiring prolonged OLV, underscoring that OLV in this population is a high-risk practice requiring highly targeted ventilation and monitoring strategies [7]. Physiologically, children are more susceptible to rapid desaturation due to low FRC, high oxygen consumption, and perfusion redistribution that does not always favor the dependent lung in the lateral position. As a result, even a brief reduction in effective ventilation during OLV can quickly lead to clinically significant hypoxemia [8]. These challenges are further compounded when standard devices such as pediatric DLTs are unavailable, necessitating lung isolation with alternative techniques such as bronchial blockers, which are technically more demanding and highly dependent on accurate placement and positional stability throughout surgery. Reports from resource-limited settings indicate that age- and weight-based algorithms can assist in selecting bronchial blockers for small children and can yield safe OLV, but only when combined with meticulous confirmation of device position, adequate fixation, and vigilant monitoring for desaturation and hypercapnia throughout the procedure. In this case, the absence of a pediatric DLT and equipment limitations were not merely logistical constraints but integral elements of the anesthetic problem statement, requiring the anesthesiologist to design a lung-isolation strategy that preserved oxygenation and ventilation as effectively as possible amid a high risk of hypoxemia, while still providing adequate surgical exposure, a delicate balance that lies at the core of pediatric OLV [9].

The use of a 4-Fr Fogarty catheter as a bronchial blocker in this case represents a pragmatic yet sophisticated technical solution for achieving safe lung isolation in a pediatric patient in the absence of a dedicated pediatric DLT. Consistent with case series and institutional reports, the Fogarty catheter has been evaluated as an effective bronchial blocker for one-lung ventilation in infants and children, demonstrating high success rates in achieving adequate lung collapse and low rates of major complications when placement is performed deliberately and confirmed with bronchoscopy. In this case, selecting a 4-Fr Fogarty catheter inserted through a single-lumen tube and positioning it in the left main bronchus under fiberoptic bronchoscopy guidance enabled precise occlusion while minimizing the risks of malposition, airway trauma, or contralateral bronchial obstruction, challenges frequently reported with blind or non-visualized techniques [10, 11]. The stability of the blocker throughout the procedure, without dislodgement despite surgical manipulation and positional changes, demonstrates that with proper fixation and periodic verification, the Fogarty catheter can provide reliable lung isolation even in resource-limited settings. Equally important, the maintenance of stable oxygenation during one-lung ventilation confirms that this technique was not only technically feasible but also physiologically safe in a patient with minimal respiratory reserve, aligning with other pediatric reports highlighting the Fogarty catheter as a rational alternative when pediatric DLTs are unavailable, provided its use is integrated with protective ventilation strategies and vigilant monitoring for hypoxemia [10-12].

The absence of hypoxemia or hemodynamic instability throughout one-lung ventilation in a patient with severely limited respiratory reserve indicates that the combination of bronchial-blocker–based lung isolation, protective ventilation, and close monitoring can yield an excellent intraoperative safety profile in high-risk pediatric populations. Recent cohort studies and case series of children undergoing VATS with OLV emphasize that maintaining oxygen saturation within safe limits correlates strongly with accurate placement of the lung-isolation device, adequate FiO_2, low tidal volumes, and careful adjustment of PEEP, and that severe hypoxemia typically arises when one or more of these components are suboptimal

[13]. he minimal blood loss and hemodynamic stability observed in this case are consistent with literature showing that a coordinated anesthetic approach (combining adequate analgesia, targeted ventilation, and optimized volume status) can reduce transfusion requirements and limit blood pressure fluctuations during pediatric thoracic surgery [14, 15]. arly extubation on postoperative day 1 without respiratory failure, need for prolonged ventilation, or airway complications aligns with current recommendations supporting early extubation and early mobilization after VATS in children, as these practices are associated with shorter hospital stays and fewer pulmonary complications [16, 17]. The patient's stable postoperative course, with good oxygen saturation on room air and no bronchial-blocker–related complications, reinforces that alternative lung-isolation strategies in the setting of equipment limitations are not only technically feasible but also safe and effective, even in patients with extremely high respiratory-risk profiles [11].

5. Conclusion

The use of a Fogarty catheter is a practical and effective alternative for achieving one-lung ventilation and airway isolation in small or malnourished pediatric patients when conventional lung-isolation devices are unsuitable or unavailable. With careful positioning and continuous intraoperative monitoring, this technique can provide adequate lung separation, satisfactory surgical exposure, and stable oxygenation. This case highlights the importance of individualized airway management and the value of readily available alternatives in challenging pediatric anesthetic situations.

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