Independent lung ventilation in the postoperative management of large bronchopleural fistula

Igor E. Konstantinov, MD, PhD, and Pankaj Saxena, MCh, DNB, Perth, Australia

Independent lung ventilation (ILV) is rarely used to separately ventilate each lung in patients with respiratory failure caused by unilateral lung disease or injury.¹⁻⁵ Herein we describe a successful application of ILV in the postoperative management of a critically ill patient with empyema, large bronchopleural fistula (BPF), bilateral pneumonia, and sepsis.

CLINICAL SUMMARY

A 43-year-old, previously healthy woman had high fever, chills, and cough. She was initially treated with oral cephalosporin by her family doctor, but her condition deteriorated, and she was admitted to her local hospital with pneumonia and started on intravenous ticarcillin and azithromycin. Within 3 weeks from the onset of symptoms, she had acute respiratory distress and was transferred to our hospital on an emergency basis. On arrival, she had fever and productive cough, with copious foul-smelling secretions. Chest radiographic analysis demonstrated right-sided pleural effusion, pneumothorax, pleural thickening, and bilateral lower lobes pneumonia (Figure 1, A). The patient was hypoxic, with a P_{aO_2} of 51 mm Hg, despite 10 L of oxygen administered through a mask. Her C-reactive protein level was 428 mg/L, and her white blood cell count was $15.6 \times 10^9/L$. Metronidazole was added to her antibiotic regimen after admission. BPF with aspiration into the contralateral lung was suspected, and the patient was taken for an emergency operation. Anatomic separation was promptly achieved with a double-lumen endotracheal tube to prevent further contamination of the left lung. Right posterolateral thoracotomy was then performed, and 800 mL of thick yellow pus was drained on exploration. A thick fibropurulent coating was peeled from the lung surface, allowing some re-expansion of the right upper lobe. The middle and lower lobes, however, remained atelectatic,

with multiple erosive BPFs in the lobar bronchi. There was superficial erosion and osteomyelitis of multiple vertebral bodies. Five 32F pleural drains were placed. Intraoperatively, the patient experienced septic shock necessitating volume resuscitation, noradrenaline, and vasopressin infusion. Meropenem, vancomycin, and metronidazole were administered. *Arcanobacterium haemolyticum*, *Staphylococcus epidermidis*, *Streptococcus viridans*, and *Streptococcus anginosus* (formerly *Streptococcus milleri* group) were cultured from the pleural fluid. Bilateral patchy infiltrates progressed postoperatively (Figure 1, B). With worsening compliance of the left lung, the air leak on the right side increased (Figure 2, A), resulting in a P_{O_2} of 40 mm Hg despite maximal ventilation, with a fraction of inspired oxygen of 100%. An attempt to ventilate the left lung only did not improve P_{O_2} . Acute respiratory failure despite maximal ventilation required physiologic separation of the lungs (Figure 2, B). Synchronous ILV was instituted with 2 Dräger Evita-2 ventilators (Dräger Medical, Lübeck, Germany) with a set rate of 18 breaths/min: the right lung was ventilated with a tidal volume of 150 mL, no positive end-expiratory pressure, and an inspiratory time of 1.2 seconds, whereas the left lung was ventilated with a tidal volume of 300 mL, a positive end-expiratory pressure of 10 cm H_2O , and an inspiratory time of 1.7 seconds. ILV resulted in improved left lung expansion and a decrease in air leak (Figure 1, C, and Figure 2, B). ILV was continued for 5 days. The patient was extubated 11 days after the operation. The air leak decreased, allowing removal of chest drains by the 23rd postoperative day and discharge home 2 days later. The patient was asymptomatic at 3 months after the operation (Figure 1, D).

DISCUSSION

Patients with empyema and BPF require prompt drainage of the empyema to protect against contamination of the contralateral lung. Our patient has already contaminated her contralateral lung before admission. Thus we performed prompt anatomic separation of the lungs to prevent further contamination during emergency surgical intervention. Once contamination of the contralateral lung occurs in a septic patient, the patient can have acute respiratory failure caused by pulmonary edema and worsening lung compliance. Chest tubes allow a continuous leak of air from the tracheal tree to the external world (Figure 2, A), resulting in loss of airway pressure and progressive alveolar collapse

From the Department of Cardiothoracic Surgery, Sir Charles Gairdner Hospital, University of Western Australia, Perth, Australia.

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Address for reprints: Igor E. Konstantinov, MD, PhD, University of Western Australia, Department of Cardiothoracic Surgery, Sir Charles Gairdner Hospital, Nedlands, Perth, WA 6009, Australia (E-mail: konstantinov.igor@alumni.mayo.edu).

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FIGURE 1. Chest radiographic analysis on admission (A), immediately after surgical intervention (B), after institution of isolated lung ventilation (C), and at 3 months after the operation (D).

FIGURE 2. Air leak through the bronchopleural fistulas increases with worsening compliance of the contralateral lung (A). Independent lung ventilation diminishes air leak and maintains an adequate alveolar volume of the contralateral lung (B).

bilaterally. Increasing airway pressure only worsens the magnitude of the fistula.¹⁻⁴ Physiologic separation of the lungs by means of ILV can be life-saving in this situation.⁵ It allows appropriate ventilation and minimizes the air leak through the BPF (Figure 2, B).

In summary, after prompt anatomic isolation of the lungs, the physiologic isolation was a life-saving intervention in a septic patient with a large BPF and decreased compliance of the contralateral lung.

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