

Case Report

Non-invasive ventilation in prone position for refractory hypoxemia after bilateral lung transplantation

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Abstract: Temporary graft dysfunction with gas exchange abnormalities is a common finding during the postoperative course of a lung transplant and is often determined by the post-reimplantation syndrome. Supportive measures including oxygen by mask, inotropes, diuretics, and pulmonary vasodilators are usually effective in non-severe post-reimplantation syndromes. However, in less-responsive clinical pictures, tracheal intubation with positive pressure ventilation, or non-invasive positive pressure ventilation (NIV), is necessary. We report on the clinical course of two patients suffering from refractory hypoxemia due to post-reimplantation syndrome treated with NIV in the prone and Trendelenburg positions. NIV was well tolerated and led to resolution of atelectatic areas and dishomogeneous lung infiltrates. Repeated turning from supine to prone under non invasive ventilation determined a stable improvement of gas exchange and prevented a more invasive approach. Even though NIV in the prone position has not yet entered into clinical practice, it could be an interesting option to achieve a better match between ventilation and perfusion. This technique, which we successfully applied in lung transplantation, can be easily extended to other lung diseases with non-recrutable dorso-basal areas.

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Background

Severe hypoxia after lung transplantation can be caused by many factors including the so-called post-reimplantation syndrome. Oxygen by mask inotropes, diuretics, and pulmonary vasodilators, are usually effective in non-severe post-reimplantation syndromes. However, in less-responsive clinical pictures, non-invasive positive pressure ventilation (NIV) or tracheal intubation become necessary. As stated by many authors (1), intubation and mechanical ventilation are the main predisposing factors for developing nosocomial bacterial pneumonia.

At our center, one trial of NIV is nearly always attempted before intubation in the case of severely hypoxic lung-transplanted patients, while the

prone position is adopted in order to promote faster healing of consolidated atelectatic areas (2, 3). Experience with these techniques has prompted us to combine both procedures in an effort to avoid a more invasive approach.

We briefly summarize the clinical course of two patients suffering from refractory hypoxemia due to post-reimplantation syndrome who were both treated with NIV in the prone and Trendelenburg positions.

Case 1

CC, a 37-yr-old woman, underwent bilateral sequential single lung transplant (BSSLTx) because of end stage respiratory failure due to lymphangioleiomyomatosis. Four hours after arrival in the

Table 1. Blood gas analysis before and after NIV

Before NIV institution (O ₂ enrichment by facial mask)	After NIV treatment
Case 1	
pH 7.43 (± 0.02)	pH 7.42 (± 0.04)
PaO ₂ mmHg 59 (±12)	138 (± 39)
PaCO ₂ mmHg 40 (± 8)	38 (± 4)
SaO ₂ % 92 (± 3)	98 (±2)
FiO ₂ 0.8–1	0.3–0.5
Case 2	
pH 7.36 (± 0.04)	pH 7.39 (± 0.05)
PaO ₂ mmHg 62 (±14)	92 (± 28)
PaCO ₂ mmHg 44 (±7)	42 (±9)
SaO ₂ % 94 (±4)	98 (± 2)
FiO ₂ 0.7–1	0.3–0.5

ICU, the trachea was extubated. A few days later she developed extensive patchy alveolar consolidations in the dorsal and basal regions of both lungs. Due to an unresponsive hypoxia despite the high O₂ enrichment by the facial mask (Table 1), she was treated with helmet-delivered NIV (pressure-support mode with peak inspiratory pressure [PIP] up to 18 cm H₂O, positive end expiratory pressure [PEEP] +5, FiO₂ 80%). NIV improved gas exchange, allowing her to move to intermittent spontaneous breathing several times a day. In the following days, however, blood oxygenation became highly helmet-dependent, with no improvement in patchy infiltrates. With her consent and cooperation, we turned her over into the prone position while continuing non-invasive ventilation (Fig. 1A). Light sedation also allowed us to place the patient in the Trendelenburg position, in order to deliver part of the gas flow to the caudal diaphragmatic areas. The preselected mode of NIV was not modified except for increasing the PEEP to 9 cm H₂O. Six to eight hours a day of NIV in the prone and Trendelenburg positions were sufficient to lower the FiO₂ from 80% to 60%.

Towards the fourth day of treatment chest X-rays demonstrated that the implanted lungs were better filled with air, with partial distension of basal atelectasis as well. A persistent improvement of oxygenation allowed for definitive removal of the helmet on the 10th post-operative (p.o.) day (Table 1).

Case 2

CD, a 44-year-old man with cystic fibrosis, underwent BSSLTx because of end-stage respiratory failure. Ten hours after arrival in the ICU the trachea was extubated. On the fourth p.o.

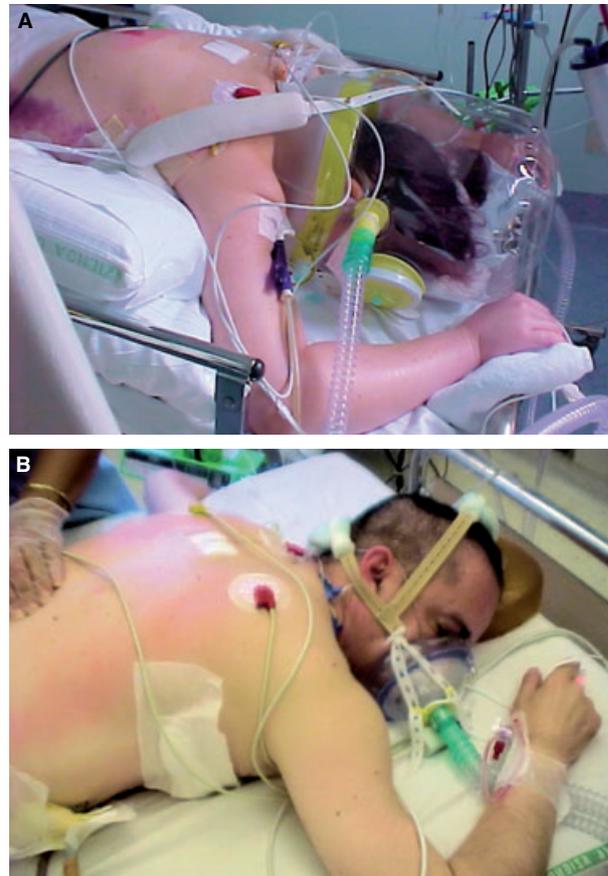


Fig. 1. (A) NIV in prone and Trendelenburg position with helmet system. (B) NIV in prone and Trendelenburg position with facial mask.

day, due to increased oxygen desaturation and respiratory fatigue (Table 1), mask-delivered NIV was applied (ventilator connected to a full face mask, set in pressure-support mode with PIP 18 cm H₂O, PEEP 6, FiO₂ 50%). He refused the helmet system, both as a result of claustrophobia and of having grown used to the facial mask while on the waiting list. A few days later, peri-hilar lung infiltrations with atelectasis of the lower lobes further deteriorated gas exchange. After initial reluctance, he was convinced to assume the prone position while in NIV with facial mask (Fig. 1B). Moderate sedation was given to tolerate the new setting of NIV (PIP 22 cm H₂O, PEEP 7, FiO₂ 70%).

After three d of repeated turning, he reported less respiratory distress, and the FiO₂ was lowered from 70% to 55%. Following this improvement, he voluntarily asked to be positioned prone every night while wearing the tight mask. With a respiratory rate <16–18 beats/min and an FiO₂ <50%, the NIV therapy was definitively discontinued on the eighth day (Table 1).

Discussion

In our center, NIV by facial mask or helmet are nearly always taken into consideration to facilitate ventilatory autonomy after lung transplantation. Withdrawing from invasive ventilation and/or preventing it is a primary target in such individuals (4).

Post-reimplantation syndrome after lung transplant is a well-recognized cause of lung congestion, dishomogeneous infiltrates and marked ventilation-perfusion imbalances.

The refractory hypoxemia of our recipients was probably sustained by the increased intrapulmonary shunt that occurred in the atelectatic areas of both grafts.

In hypoxic, spontaneously breathing lung recipients, the recruitment maneuvers are impracticable, and a complete closure of the small airways in the dependent areas persists even with deep inspirations. In patients mechanically ventilated for diffusely infiltrated lungs, PEEP-induced aeration distributes along the cephalocaudal axis; in the case of regional dishomogeneous infiltrates, however, PEEP-induced aeration affects the lung apex more than the diaphragmatic areas (5). Since pulmonary blood flow in the supine position remains distributed primarily in the dorsal regions, NIV with PEEP in the prone position can obtain a better ventilation/perfusion match along the antero-posterior axis (6).

The decision to put the patients prone and in Trendelenburg, even when ventilated with a helmet or a facial mask, derived from the extensive experience of both attending physicians and staff nurses in "rotating" mechanically ventilated patients for severe ARDS or other lung diseases.

The improvement in oxygenation with NIV in the prone position can be the result of the combined effects of extra vascular fluid redistribution, recruitment of non-aerated alveoli, and redirection of pulmonary blood flow (7).

We deliberately chose to take further advantage of PEEP in the prone position by tilting the bed in Trendelenburg: this procedure apparently helped to remove the respiratory secretions more efficiently.

Maintaining assisted breathing plus continuous positive airway pressure (CPAP) after lung transplantation is of paramount importance in order to avoid the instrumentation of upper airways and in preventing further ventilatory-induced lung damage in non-recruitable, poorly ventilated dorsal areas.

Despite the abundance of articles dealing with non-invasive ventilation in many different settings of respiratory disease, to our knowledge, there are no reports which attest to the efficacy of non-invasive ventilation in the prone and Trendelenburg positions. This technique, which we have successfully applied in lung transplantation, can be easily extended to other lung diseases with non-recruitable dorso-basal areas. In selected compliant lung transplanted patients it should be considered before adopting a more aggressive approach.

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