Independent Lung Ventilation And Alveolar Recruitment In Tracheostomized Patient With Unilateral ARDS


Citation

Abstract
Unilateral pneumonia and pulmonary contusion may result in asymmetric acute respiratory distress syndrome (ARDS). Due to the heterogeneity of the pulmonary injury, severe gas exchange abnormalities occur, thus conventional mechanical ventilation (MV) may become an exceedingly intricate task. We report the case of a tracheostomized 25-year-old patient with unilateral ARDS successfully treated with Independent lung ventilation (ILV) and differential lung recruitment.

INTRODUCTION
ILV has been applied to improve hypoxemia refractory to conventional MV. Although the presence of a tracheostomy has traditionally been regarded as an obstacle for the completion of ILV, patients with unilateral ARDS and a previous tracheostomy who deteriorate while on MV, presenting with severe gas exchange abnormalities represent exceptional situations with limited treatment options. We report the management of a tracheostomized patient with asymmetric lung injury who developed severe ARDS and was treated with ILV and independent lung recruitment strategies.

CASE HISTORY
A 25-year-old male patient had severe head injury, blunt chest trauma and pulmonary contusion, and third degree burns over the face and cervical region due to a car crash. He was transferred to our institution and admitted to the ICU 7 days after the trauma. When transferred his neurological status was stable with improvement of the brain edema as shown in the CT scan. Pneumonia was diagnosed and piperacillin/tazobactam was started. His pulmonary function worsened and in spite of increases in PEEP up to 15 cmH2O his PaO2/FiO2 ratio was 92.8mmHg and PaCO2 =74 mmHg. The chest radiograph revealed extensive right lung infiltrates confirmed by CT scan (figure 1). The ICU team decided for the initiation of ILV, the tracheostomy cannula was removed and the tracheostoma was dilated performed with a percutaneous tracheostomy kit (Blue rhino®) allowing the insertion of a double-lumen 9.5mm tracheostomy cannula (Trachpart Rusch®). The position of the cannula was confirmed by bronchoscopy. ILV was performed using two non-synchronized ventilators (Servo 300 Siemens Elema, Sweden and Horus 4 Taema France). The ventilatory parameters for the right and left lung were set as follows. Right : Pressure-regulated volume controlled (PRVC), pressure limited at 35cmH2O, VT=238ml (3.4ml/kg), PEEP= 18cmH2O; RR= 22, FiO2=100%. Left: volume controlled ventilation , VT=260ml (3.7ml/kg), PEEP= 8mH2O; RR= 18, FiO2=100%.
recruitment maneuver was performed for the right lung applying a CPAP of 40cmH20 for forty seconds but resulted in no change in PaO2/FiO2 ratio. No signs of hemodynamic instability were observed.

A new recruitment maneuver for the right lung was performed with Pressure-controlled ventilation, PC of 15 cmH2O, PEEP= 35cmH20 (Pplat 50cmH20 ) and RR=12 for two minutes. Again no signs of hemodynamic instability were detected. The ventilator settings were the same as before the maneuver except for an increase in right lung PEEP to 22cmH20. The was improved oxygenation (PaO2/FiO2=409) with signs of overinflation/ increased dead space ventilation (PaCO2=79.6mmHg) and PEEP levels were reduced to 18 cmH2O. Subsequent blood gas analysis showed improvement in gas exchange (figure 2). The entire ventilatory parameters are in table 1.

**Figure 2**

![Gas exchange after ILV](image)

After 48 hours of ILV gas exchange was stabilized, chest radiographs had improved and ILV was withdrawn. A single-lumen cannula was inserted and the ventilator was set in PRVC and PEEP= 12cmH20 maintaining the PaO2/FiO2 above 300. In the subsequent week the patient was weaned from MV.

**Table 1: Ventilatory parameters before and after ILV**

<table>
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<tr>
<th></th>
<th>Before ILV</th>
<th>After ILV</th>
<th>6h after ILV</th>
<th>24h after ILV</th>
<th>48h after ILV</th>
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</table>

**DISCUSSION**

The rationale for ILV is based on the presence of asymmetry in lung injury producing differences in compliance. During MV, vt is mostly directed towards the less injured lung resulting in overinflation and parenchymal damage \([1,2,3]\). Recent studies have established that in ARDS high Vt and/or airway pressure can worsen lung damage and lead to multiple organ dysfunction by releasing proinflammatory cytokines\([4,5]\). A protective ventilation approach (low Vt and high PEEP) leads to alveolar recruitment and has been recommended in the management of patients with ARDS.
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ILV has usually been applied in mechanically ventilated patients through a double-lumen orotracheal tubes \[2,3\]. Until recently no tracheostomy double-lumen tube was commercially available and to our knowledge this is the first report of its use to deliver ILV to a patient with ARDS \[3,6\]. Although displacement seems to be a frequent and serious problem with Robertshaw tubes, this problem was not observed during the 54 hours that our patient remained with the double-lumen tracheostomy tube. The diameter of the double-lumen tube represents a problem concerning the aspiration of secretions. In the present case bronchoscopy was performed once for aspiration of tenacious secretions. Cinnella et al reported a series of patients with lung contusion ventilated with ILV observing better mechanics and oxygenation when compared to conventional ventilation\[4\]. Our patient had severe hypoxemia that was not responsive to increases of PEEP levels. Although we could have tried to increase PEEP to higher levels or to perform a recruiting maneuver when the patient was still on conventional ventilation, we felt that the asymmetric nature of the injury might lead to overinflation in the uninjured lung if such procedures were applied. Therefore after initiating ILV, a recruitment maneuver was implemented only to the right lung and a protective ventilatory strategy initiated with high PEEP, low VT also limiting plateau. The uninjured lung was ventilated in a conventional way in order to induce no harm. This strategy may have improved regional distribution of VT in both lungs \[8,9\] as the prompt improvement in gas exchange demonstrates.

The case illustrates the successful management of severe asymmetric ARDS using ILV and alveolar recruitment in a tracheostomized patient. Although such cases should remain exceptional our report illustrates the feasibility and efficacy of this strategy in severely ill eligible candidates.

References

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