Transpulmonary pressure guided ventilation strategy for patients with severe acute respiratory distress syndrome treated with venovenous extracorporeal membrane oxygenation.

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Abstract

Our team published an article involving a Transpulmonary Pressure (Ptp)-guided ventilation strategy for patients with severe Acute Respiratory Distress Syndrome (ARDS) treated with Venovenous Extracorporeal Membrane Oxygenation (VV-ECMO) in a recent issue of Critical Care Medicine. The higher Positive End-Expiratory Pressure (PEEP) and lower driving pressure were used in the Ptp-guided strategy. Moreover, the changes in respiratory mechanics resulted in stabilization of lung morphology and reduction of serum cytokine concentration. Finally, a lower degree of Ventilator-Induced Lung Injury (VILI) was associated with faster improvement in lung function and more successful weaning from ECMO support. The Ptp-guided ventilation strategy which we propose is an improvement of the lung rest strategy. The optimal ventilation strategy during VV-ECMO support warrants further research.

Keywords: Acute respiratory distress syndrome, Venovenous extracorporeal membrane oxygenation, Transpulmonary pressure, Mechanical ventilation

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Description

Our team published an article involving a Transpulmonary Pressure (Ptp)-guided ventilation strategy for patients with severe Acute Respiratory Distress Syndrome (ARDS) treated Venovenous Extracorporeal Membrane Oxygenation (VV-ECMO) in a recent issue of Critical Care Medicine [1]. This study showed that the Ptp-guided ventilation strategy in patients with severe ARDS supported with VV-ECMO is beneficial and safe. The Ptp-guided ventilation strategy stabilizes lung morphology and reduces Ventilator-Induced Lung Injury (VILI), which are associated with more improvement in lung function and more successful weaning from ECMO support than the lung rest strategy.

VV-ECMO allows mechanical ventilation with very low tidal volumes, and a reduced Plateau Pressure (Pplat) and respiratory rate, thereby potentially minimizing VILI [2]. The optimal mechanical ventilation strategy during VV-ECMO support has not been established. Our proposed Ptp-guided ventilation strategy was developed in a previous randomized control trial involving non-ECMO patients. According to the study protocol for the Ptp-guided group, Positive End-Expiratory Pressure (PEEP) was set to achieve a Ptp of 0-5 cm H2O at end expiration, and peak airway pressure (Ppeak) <25 cm H2O. As a result, the higher PEEP and lower driving pressure were derived in the Ptp-guided group compared to the lung rest group.

Lung rest strategy with a relatively low level of PEEP is thought to cause lung de-recruitment in patients treated with VV-ECMO. "Keeping the lung open" strategy with Ptp-titrated PEEP minimizes atelectrauma by decreasing the cyclic opening and closing of lung units [3]. However, excessive PEEP also leads to overdistention. In addition, a higher PEEP impedes venous return, thus compromising right ventricular function and central hemodynamics. So, what is the "optimal" PEEP? In our study, PEEP was set to keep the Ptp at end-expiration slightly positive. When the Ptp approaches 2 cm H2O, the mechanical properties of the lung are close to the best compromise with minimum airway collapse and alveolar hyperdistention. Therefore, the concept that keeping the lung opens with reasonable levels of PEEP is important.

In our study, the Ppeak was <25 cm H2O and the PEEP was approximately 15 cm H2O in the Ptp-guided group. As a result, a driving pressure was <10 cm H2O during VV-ECMO support. Therefore, a lower driving pressure in the Ptp-guided group was the consequential result of the "keeping the lung open" strategy. A previous study showed that a low driving pressure during ECMO is independently associated with improved in-hospital survival in patients with ARDS treated with ECMO [4]. Another recent study suggested the adequacy of lung protection during mechanical ventilation should be assessed primarily in terms of driving pressure rather than tidal volume [5]. Therefore, the Ptp-guided ventilation strategy further avoids VILI and improves survival.

Mechanical power is a summary variable, which includes all the putative causes of VILI (tidal volume, driving pressure, flow, respiratory rate, and PEEP). In our study, mechanical power (27.3 ± 7.6 vs. 6.2 ± 3.1 J/min) was markedly reduced after initiating ECMO. The mechanical power was significantly lower in the Ptp-guided group than the lung rest group during VV-ECMO support. The severity of VILI depends on the amount of energy transferred from the mechanical ventilator to the respiratory system [6]. Thus, lower mechanical power indicated better prevention of VILI.

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