3. Venovenous Extracorporeal Membrane Oxygenation (ECMO) Based Life-saving Support for Severe Blast Lung Injury

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Summary: Enhanced-blast explosive devices in modern warfare can generate dreadful blast wave that causes multiple organ damages with the lungs being the most vulnerable, defining as blast lung injury (BLI). The typical clinical manifestations of BLI are much similar to acute respiratory distress syndrome (ARDS), Although venovenous extracorporeal membrane oxygenation (ECMO) has been gaining widely use to bridge the recovery from ARDS, its roles in the management of BLI remains unclear. This study was conducted to evaluate the feasibility of venovenous ECMO in treating severe BLI.

Methods-Results: Thirty healthy adult beagles were included in the study. BLI model was induced by detonating 500 g TNT with a fixed explosive distance. All wounded dogs were randomized into 3 groups: MV group (with protective ventilatory strategies after injury), ECMO group (venovenous ECMO without ventilation support), and ECMO+ group (venovenous ECMO with protective ventilatory strategies). Mortality, pulmonary dynamics, blood gas, extravascular lung water index as well as hemodynamics were monitored at indicated time points. The biochemical features and histological changes of the lung tissues were evaluated after the scarification of animals. There was no significant difference among three groups in basic characteristics. Deaths documented during the 24h period (8/10 in MV group, 5/10 in ECMO group, 1/10 in ECMO+ group respectively) revealed that the mortality in MV group was significantly higher than ECMO+ group (P<0.001). Pulmonary mechanics were well preserved in ECMO+ group than in MV group (P=0.018). Meanwhile, hemodynamic stability was achieved and blood gas improved remarkably without significant hypercapnia in ECMO+ group compare to other groups (P<0.001). The extent of lung tissue edema, consolidation, inflammatory cell infiltration and red blood cell exudation were also mitigated in ECMO+ group, and autophagy-related protein Beclin-1 level and the ratio of LC-3 II /LC-3 I was apparently suppressed compared with MV group (P<0.001).

Conclusions : Venovenous ECMO can significantly improve the tissue oxygenation by preserving pulmonary mechanics and hemodynamic stability. The alleviation of lung pathophysiology and decrease of overall mortality indicate that venovenous ECMO may provide more survival opportunities to those with severe BLI.