Acute Respiratory Distress Syndrome with Septic Shock Rescued by Long-term Use of Extracorporeal Membrane Oxygenation

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We report a 5-year-6-month-old case of pneumonia complicating with septic shock and acute respiratory distress syndrome. He was successfully treated with extracorporeal membrane oxygenation (ECMO). Veno-arterial mode of ECMO was used at first and it was shifted to veno-venous mode of ECMO after hemodynamics were stabilized. Total supporting duration of ECMO was 684 hours. The patient is well now, in functional class I of the New York Heart Association.

Key Words: Extracorporeal membrane oxygenation • Acute respiratory distress syndrome • Pneumonia

INTRODUCTION

Pneumonia complicating with septic shock and acute respiratory distress syndrome (ARDS) is associated with high mortality rate. Conventional therapies include ventilator support, antibiotic treatment, chest care, and infusion of inotropic agents. However, clinical conditions still deteriorate in severe patients. In such circumstance, extracorporeal membrane oxygenation (ECMO) can provide a chance of survival.2,3

CASE REPORT

A 5-year-and-6-month-old boy of body weight 24 Kg was healthy in the past. Cough and high fever occurred suddenly. He was brought to a local hospital and chest X-ray showed increased infiltration over the left lower lung field. He was treated as atypical pneumonia at first because of elevated titers (80 times) of mycoplasma antibody. However, dyspnea and desaturation occurred despite oxygen being used. The patient was referred to our hospital immediately. He was intubated and ventilated with a pressure-controlled mode (peak inspiratory pressure 40 cmH2O, positive end expiratory pressure (PEEP) 15 cmH2O, and pure oxygen). He was still cyanotic. Alveolar arterial oxygen gradient (AaDO2) was 590 mmHg and oxygenation index (mean airway pressure / fraction of inspired oxygen / arterial oxygen pressure) was 53. Bilateral pneumothorax (Figure. 1) occurred subsequently because of high airway pressure. Chest tubes were inserted. Clinical conditions deteriorated very soon. Vital signs (blood pressure 70/30 mmHg, heart rate 160/min) were not maintained by high doses of inotropic agents (dopamine 20 μg/Kg/min, dobutamine 20 μg/Kg/min, norepinephrine 2 μg/Kg/min and epinephrine 1.0 μg/Kg/min). Laboratory examination showed white blood cell count 23000/μL and C-reactive protein 30 mg/dL. Under the impression of pneumonia with acute respiratory distress syndrome, we set up ECMO. We used venoarterial-mode ECMO with centrifugal pump (Medtronic Inc., Anaheim, CA, USA) to support the patient through right neck approach with vascular...
exploration. One 15-French cannula (Medtronic Inc., Anaheim, CA, USA) was inserted into the right common carotid artery, the distal end of which was ligated. One 19-French venous cannula was inserted through the right internal jugular vein and advanced into the right atrium. He was sedated and paralyzed with fentanyl and pancuronium. The condition was stabilized gradually. The ventilator was adjusted to low setting (PIP 30 cmH2O, PEEP 5 cmH2O) and pressure-controlled mode. Intravenous infusion of heparin was given to maintain the activated clotting time (ACT) around 200 seconds. Total parenteral nutrition (TPN) was used for nutrition support. Microbiological culture of pleural effusion and blood was pneumococcus. Usage of antibiotics was adjusted by culture results.

After 8 days of support, inotropic agents were tapered to low dosages (dopamine 5 μg/Kg/min and dobutamine 5 μg/Kg/min). We tried to wean ECMO, but retention of carbon dioxide persisted. We shifted ECMO to venovenous-mode. We changed all the ECMO circuits and cannulae. One 19-French cannula was inserted via the right internal jugular vein into the superior vena cava for inflow of oxygenated blood. Another 19-French cannula was inserted through the right femoral vein into the junction of the inferior vena cava and right atrium for drainage of deoxygenated blood. The right common carotid artery was repaired with direct suture. Gradually, air leakage from chest tubes decreased and finally disappeared. However, chest film showed no significant improvement in haziness of lung fields after ECMO support for 3 weeks. High-frequency oscillatory ventilation (HFOV) was tried. After use of HFOV, chest film (Figure. 2) showed significant clearance of the left lung field. Oxygenation improved gradually and we started to wean ECMO. For weaning, we decreased gas flow of ECMO gradually. There were no decrease of arterial oxygen saturation and no retention of carbon dioxide after discontinuation of ECMO gas flow for 24 hours. ECMO was removed after support duration of 684 hours. The endotracheal tube was removed 7 days after removal of ECMO. Computed tomography of the chest showed one 5 × 7-cm encapsulated thrombus, which was removed by thoracoscopy. The patient was discharged without medications or oxygen therapy.

DISCUSSION

Our case received venoarterial-mode ECMO at first because of unstable hemodynamics and poor oxygenation. We still kept the basic level of ventilator settings because the coronary blood flow still was mainly from the left ventricle during the support of venoarterial-mode ECMO. For cases with large amounts of air leakage, the lungs have little chance to re-expand if air leak persists. Improvement in pneumothorax after ECMO was the first critical point for the patient’s recovery.

The second critical point in this patient was the adjuvant therapy with HFOV. After about 3-week use of ECMO, chest film showed no significant improvement and lung compliance was still poor. We tried HFOV to
improve the patient’s ventilation. With the use of HFOV, ventilation is achieved through variable oscillations around a set of mean airway pressure, with both active inspiration and active expiration. Kachel et al.\textsuperscript{5} reported that HFOV or inhaled nitric oxide was the first choice of treatment in an attempt to avoid ECMO use. In our case, we inserted ECMO first because the patient was in severe shock and rapid deterioration. HFOV may be used as an adjuvant therapy if ECMO is used for a prolonged period and pulmonary alveolar re-expansion is not satisfied.

In summary, although there is high mortality risk for a child suffering from bacterial pneumonia complicating with septic shock and ARDS, ECMO can provide the chance of survival in patients with circulatory collapse and severe respiratory failure.

REFERENCES

我們報告一個 5 歲半的男童在一次的肺炎併發急性呼吸窘迫症與敗血性休克之後，生命徵象與血中含氧量在高劑量的強心剤與呼吸器的使用下，仍無法維持穩定，成功地以體外維生系統（ECMO）治療的經驗。首先使用靜脈動脈型的體外維生系統，在生命徵象穩定之後，改為靜脈靜脈型的體外維生系統。體外維生系統總共使用 684 小時，氣管內管亦在體外維生系統移除 7 天後拔除。病人狀況良好，為紐約心臟學會功能分類第一級。

關鍵詞：體外維生系統，急性呼吸窘迫症，肺炎。