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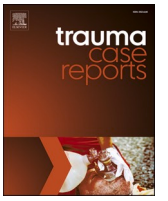

Case Report

Penetrating thoracic injury requiring emergency pneumonectomy supported with two ECMO runs: A testament to multidisciplinary critical care medicine

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ABSTRACT

Post-traumatic pneumonectomies are uncommon and, if necessary, carry significant mortality. The use of extracorporeal membrane oxygenation (ECMO) for lung injury in trauma patient has demonstrated efficacy with minimal bleeding complications. We report a case of a young man with a penetrating thoracic injury that required a pneumonectomy supported with two separate ECMO runs for pulmonary failure postoperatively.

Introduction

Penetrating thoracic injuries requiring pneumonectomy are uncommon and associated with significant morbidity and mortality [1]. Postoperative complications, including pneumonia and respiratory failure, following traumatic pneumonectomy occur in over 85 % of cases [2]. Life-threatening acute respiratory distress syndrome (ARDS) can develop, where severe lung dysfunction and right ventricular failure can compromise outcomes [3,4].

In this report, we describe our experience in managing a penetrating thoracic gunshot injury to a young male requiring emergent right pneumonectomy and venovenous extracorporeal membrane oxygenation (VV-ECMO). Unique to this case, a subsequent aspiration led to acute lung injury exacerbation, requiring a second run of ECMO support.

Case report

A 24-year-old Hispanic sustained gunshot wounds to the chest. Upon emergency medical services (EMS) arrival, he was tachycardic and hypotensive with a Glasgow Coma Scale (GCS) of 8 [E2V1M5]. Upon arrival at the emergency department, the patient had a Shock Index >1. On examination, he had two gunshot wounds on the anterior chest and two to the back. He appeared pale, with decreased

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breath sounds bilaterally. Bilateral chest tubes were inserted with the left chest tube returning air while the right tube returned ~1.5 liters (L) blood. A chest X-ray (CXR) revealed a left-sided pneumothorax and right-sided hemothorax. A focused assessment with sonography for trauma (FAST) scan was positive for free fluid in the right upper quadrant, suggesting hemoperitoneum. Emergent intubation was performed. In concordance with the Advanced Trauma Life Support (ATLS) guidelines, massive transfusion protocol (MTP) was initiated. The patient was taken to the OR for an emergent right-sided thoracotomy.

During surgery, massive hemorrhage from multiple areas of the right middle lobe of the lung was noted. Numerous attempts of clamping the right proximal hilum failed. Concerns arose about potential mediastinal or proximal hilum bleed. After repeated failed attempts to control and visualize the hemorrhaging source, a right pneumonectomy was performed. Intraoperative post-pneunomectomy inspection of the mediastinum noted an additional injury to the mediastinum, superior to the point at which the azygous vein enters the superior vena cava (SVC) and superior to the aorta; this laceration was controlled with a single suture. A right-sided chest tube was placed to drain any further bleed. The patient's hemodynamics stabilized after surgery, but his oxygen saturation was in the 70s. The patient was consequently transferred to the surgical intensive care unit (ICU) for further recovery.

In the initial 6 to 8 postoperative hours, the patient maintained an oxygen saturation of 85 %. Subsequently, the saturation declined into the 60 % range. Attempts to maintain adequate oxygen saturation via mechanical ventilation was unsuccessful. Disruption of the fresh brachial stump by resorting higher positive end-expiratory pressure (PEEP) and peak pressure was also a major concern. The ECMO team was consulted and it was determined that ECMO would provide a protective lung ventilation strategy while maintaining oxygenation.

Due to the anatomically shifted SVC post-pneumonectomy, it was felt that a double-lumen cannula may not be able to be appropriately position. A two-site single-lumen cannula strategy was employed: a percutaneous cannulation of the right internal jugular (IJ) for blood return with a 24-Fr 23 cm cannula and the right common femoral vein with a 28-Fr 55 cm cannula advanced to the intrahepatic inferior vena cava (IVC). Initial flow was between 4 and 5 liters per minute (LPM), with an increase of arterial oxygen saturation of 94–98 % on 4 LPM blood flow. Furthermore, the PaCO2 was reduced to 35 to 45 mm Hg on a sweep flow of 6 LPM. The patient was extubated and placed on a nasal cannula because of the fresh bronchial stump. His respiratory rate varied from 0 to 6 spontaneous breaths per minute.

The following day, the patient inadvertently pulled out the right IJ cannula. Blood loss was minimal as nurses held pressure immediately. He was immediately intubated, and an emergent left IJ cannula was percutaneously inserted. He was placed on the previous ECMO setting, and the endotracheal tube was again removed.

Anticoagulation was accomplished using the direct thrombin inhibitor argatroban. The partial thromboplastin time levels were targeted at 50–70 s. The hemoglobin was targeted at 10 mg/dl and platelet counts at >75,000/μL. There were no bleeding issues or noted complications.

Over the next 96 h, the patient did well clinically and a CXR of the left lung revealed dramatic improvement. The patient underwent a bronchoscopic procedure that demonstrated excellent healing of the right bronchial stump, with the left normal left lung airways. He was then decannulated and placed on high-flow nasal cannula. At this point, he was awake, alert, and conversing with family, and tolerating solid foods. Later that evening, however, he had an episode of vomiting that resulted in aspiration requiring immediate endotracheal intubation. Initially his oxygen saturations and CO2 were acceptable at low ventilator settings, however at about 12 h post-intubation his O2 requirements abruptly increased. Despite trying multiple ventilatory modes along with inhaled nitric oxide, no clinical improvement was noted. It was subsequently decided that the patient be placed back on VV-ECMO.

On the second run, the patient was managed under the supervision of both medical and surgical intensivists along with the ECMO team.

The second ECMO run was initiated after placement of a single catheter, dual-lumen cannula inserted into the right IJ and advanced into the hepatic IVC under fluoroscopic guidance. Once on ECMO, the blood and sweep rates matched the previous ECMO run and he was placed on protective lung ventilation. A percutaneous tracheostomy was performed to facilitate airway management and weaning. The patient was supported on VV-ECMO for 23 days, during which time an aggressive physical therapy regime was implemented. The patient was discharged from the ICU to an inpatient rehabilitation facility after 45 days in the ICU. He was ambulatory, eating, and mentally at baseline.

The patient was in inpatient rehabilitation for three weeks, after which he was able to return home. Within six weeks of discharge, he was back to working in the family restaurant with limited disability. At 3-months, he was working full-time with minimal limitations.

Discussion

ECMO has been successfully used in trauma and with minimal bleeding complications [5,6]. The use of ECMO after a traumatic pneumonectomy has been sparsely reported. Traumatic pneumonectomy secondary to unilateral lung injury and acute right heart failure has been associated with a high mortality [7]. This case and other limited reports demonstrate that ECMO can be used after pneumonectomy to allow lung-protective ventilation and to overcome acute hypoxemic changes as the right heart adapts to the new dynamic changes [8].

Nonetheless, ECMO itself can be daunting, labor-intensive, and carries the potential for numerous complications. Our case demonstrates that ECMO can be used safely in trauma and after traumatic pneumonectomy, but its use necessitates multidisciplinary team approach, including but not limited to primary trauma service, the ECMO team, pharmacy, nutritional support, and physical therapy. The inclusion of various services lessens the burden on individual services and intensive care units and improves outcomes [9]. This case further demonstrates that complications after completion of the first ECMO run should in no way negate the initiation of a second

ECMO run if deemed necessary.

Conclusion

Our case demonstrates that ECMO can be a life-saving measure after a traumatic pneumonectomy that results in severe pulmonary and right ventricular failure. This is the first known report describing the two successive uses of ECMO on a patient after pneumonectomy and a subsequent lung injury. This case further demonstrates the role of multidisciplinary services in ECMO care to maximize outcomes and recovery.

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Declaration of competing interest

None of the authors listed on the manuscript have any potential conflict of interest to report.

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