The Removal of a Substantial Blood Clot Using the Inflow Cannula of an Extracorporeal Membrane Oxygenation (ECMO) System, Performed Without the Use of an Extraction Device

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ABSTRACT

A woman aged 57 years arrived in a critical condition, displaying a life-threatening scenario characterized by severely low oxygen saturation (40%), maximal administration of Noradrenaline, and a notable decrease in consciousness. Just one month prior to this emergency, the patient had undergone a successful surgical removal of a brain meningioma. However, shortly after her surgery, while recuperating in the post-operative ward, she began experiencing the symptoms mentioned above. Consequently, she was promptly transferred to a more specialized medical facility, where she was diagnosed with a massive pulmonary embolism.

As part of her treatment, Veno-Arterial Extracorporeal Membrane Oxygenation (VAV-ECMO) was initiated, and during this procedure, a substantial blood clot was extracted from her right femoral vein. Remarkably, the patient's condition improved rapidly over the course of a few days, and she was ultimately discharged from the hospital without any enduring complications.

BACKGROUND

The extracorporeal membrane oxygenation machine takes the function of the lungs in patients with acute respiratory failure. It is often used for conditions like Cardiogenic Shock for Non-myocardial Infarction Etiologies, Pulmonary Hypertension, Acute Respiratory Distress Syndrome, and pulmonary embolism[1].

The goal is diverting blood away from the malfunctioning cardio-pulmonary system, and reoxygenating the blood pool. The machine essentially bypasses the heart and lungs[2].

Venoarterial Extracorporeal Membrane Oxygenation is widely used for severe cases of massive pulmonary embolism. There is evidence to its benefits it treating cardiogenic shock and moderate-severe acute pulmonary conditions, but the evidence remains unclear when treating massive pulmonary embolism. Further studies are needed to clarify the role of ECMO in the treatment of pulmonary embolism[3].

CASE PRESENTATION

A 57-year-old female patient presented with a medical history characterized by persistent slurred speech and recurring headaches spanning nearly one year. Upon initial assessment, the patient exhibited full consciousness and orientation, and her vital signs remained stable while breathing room air. A computed tomography (CT) scan of her cranial region revealed the presence of a left parietal tumor, which was exerting pressure, inducing brain edema, and causing midline displacement. To alleviate the intracranial pressure and manage the associated symptoms, the patient was promptly administered dexamethasone and phenytoin, following which she was admitted for surgical excision of the tumor.

A craniotomy procedure was subsequently performed, leading to the conclusive diagnosis of meningioma. Following the surgical intervention, the patient's clinical condition exhibited gradual improvement.

Approximately 40 days following the surgical procedure, the patient experienced a sudden onset of severe shortness of breath and confusion. Upon assessment, she exhibited tachycardia, tachypnea, and severe desaturation, with her oxygen saturation plummeting to 40%. A diagnosis of massive pulmonary embolism was promptly established, necessitating her transfer to a specialized medical facility due to unresponsive hypoxemia.

Upon arrival at the advanced medical center, the patient was intubated and placed on high ventilatory settings before being expeditiously relocated to the intensive care unit (ICU). Recognizing the gravity of her condition, a decision was made to initiate Veno-Arterial Venous-Extracorporeal Membrane Oxygenation (VAV-ECMO) to manage her profound desaturation. Her pre-ECMO vital signs were as follows: oxygen saturation ranging from 60% to 70%, blood pressure measuring 160/89 mmHg, heart rate registering at 110 beats per minute, and a body temperature of 36.5 degrees Celsius.

The Veno-Arterial Venous-Extracorporeal Membrane Oxygenation (VAV-ECMO) system operates by drawing deoxygenated blood from the right femoral vein and then reinfusing oxygenated blood into the left femoral artery and right jugular vein. However, during the initial insertion of the inflow cannula into the right femoral vein, there was an unexpected challenge as no blood could be aspirated from the cannula, despite confirming its correct placement using ultrasound guidance. Subsequently, after a brief period, small clots began to emerge from the cannula, followed by the evacuation of a notably larger clot.

Notably, prior to the procedure, an abdominal ultrasound had been conducted, confirming the presence of a significant clot within the inferior vena cava. Following the VAV-ECMO procedure, a repeat ultrasound examination revealed the absence of the previously identified clot within the inferior vena cava, suggesting that the intervention had successfully addressed this issue.

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Subsequently, the Veno-Arterial Venous-Extracorporeal Membrane Oxygenation (VAV-ECMO) procedure was successfully initiated. At that point, the patient was under the following medication regimen: Adrenaline at 5 mcg/hr, Noradrenaline at 30 mcg/hr, Midazolam at 8 mg/hr, Fentanyl at 150 mcg/hr, and Enoxaparin administered at 70 mg twice daily. Her post-VAV-ECMO vital signs displayed remarkable improvement, with oxygen saturation reaching 100%, blood pressure recording at 80/63 mmHg, heart rate stabilizing at 99 bpm, and a mean arterial pressure (MAP) of 70 mmHg.

As her clinical status gradually ameliorated, the patient was eventually weaned off sedation and inotropic support, ultimately culminating in successful extubation. Subsequently, 20 days following the implementation of VAV-ECMO, the patient was discharged home, having achieved a complete recovery.

INVESTIGATIONS

The patient was closely observed in the ICU. The daily investigations included vital signs, white blood cell count, platelet count, arterial blood gas analysis, coagulation markers, D-dimer, and septic markers. Her WBC upon admission was 24, for which the patient underwent extensive septic screening including stool analysis for clostridium difficile, axilla and skin folds swabs for MRSA, blood culture, sputum culture, and urine culture. All of which were negative. WBC count eventually decreased to 9.2 before discharge, which was in accordance to her baseline.

Platelets count was initially 215, but decreased to 88 within 3 days of admission, and eventually increased to 333 before discharge.

The patient required correction for magnesium and potassium on multiple occasions. Both of these electrolytes were closely monitored and promptly corrected.

Other laboratory investigations included electrolytes, liver function tests, renal function tests, cardiac markers, chest and abdominal x-rays, and abdominal ultrasounds. These tests were repeated on daily basis (with exception of abdominal ultrasound).

OUTCOME AND FOLLOW-UP

The day of discharge the patient was off ECMO and extubated, fully conscious and oriented, vitally stable, and her most recent labs within her baseline.

The patient was discharged on enoxaparin and follow ups with internal medicine (hematology and pulmonology), and chest physiotherapy.

DISCUSSION

In July of 2022, a similar case was reported with one key exception. In the reported case, the patient underwent a neurosurgical procedure and eventually developed massive PE, akin to our patient. Unlike our case, they used an extraction device (Inari FlowTriever Device) for thrombectomy[4].

In recent years, ECMO (and especially VA-ECMO) has been used increasingly used as treatment for massive PE, especially before the development of cardiac arrest. The conclusions still show conflicting results as for the efficacy of ECMO compared to thrombectomy or stand-alone therapy (thrombolysis)[5].

PATIENT'S PERSPECTIVE

The patient diligently attended her scheduled follow-up appointments, where she underwent routine laboratory assessments and chest radiography. Fortunately, her post-discharge progress was marked by a lack of noteworthy events or complications.

LEARNING POINTS

Extracorporeal Membrane Oxygenation (ECMO) finds its application across a spectrum of medical conditions, with notable prominence in cases involving cardiogenic shock, massive pulmonary embolism, and acute respiratory distress syndrome.

The primary objective of ECMO therapy is to circumvent the malfunctioning cardio-pulmonary system during acute crises, accomplished through the utilization of an inflow cannula, which directs blood into the ECMO machine, and an outflow cannula, which returns oxygenated blood to the patient's circulatory system. The ECMO machine effectively facilitates blood circulation and oxygenation.

When considering the deployment of ECMO, careful evaluation of the risk of thrombosis must be balanced against the risk of bleeding. Notably, the ECMO circuit itself carries a substantial risk of thrombosis, leading major guidelines to advocate for the concurrent use of anticoagulant agents. Among the most commonly employed anticoagulants are unfractionated Heparin and Direct thrombin inhibitors such as bivalirudin, argatroban, and desirudin.

Comprehensive contingency plans for addressing potential machine malfunctions must be established, encompassing scenarios where routine cannula flushing proves insufficient. Such preparedness is essential to ensure the safety and efficacy of ECMO procedures.

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