Case Report

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Peripheral VA-ECMO with direct biventricular decompression for refractory cardiogenic shock

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Abstract

Cardiogenic shock and cardiac arrest are life-threatening emergencies that result in high mortality rates. Veno-arterial extracorporeal membrane oxygenation (VA-ECMO) via peripheral cannulation is an option for patients who do not respond to conventional therapies. Left ventricular (LV) distention is a major limitation with peripheral VA-ECMO and is thought to contribute to poor recovery and the inability to wean off VA-ECMO. We report on a novel technique that combines peripheral VA-ECMO with off-pump insertion of a trans-apical LV venting cannula and a right ventricular decompression cannula.

Keywords

VA-ECMO; ventricular assist device; cardiogenic shock; cardiac arrest; mechanical circulatory support

Introduction

Cardiogenic shock and cardiac arrest are life-threatening emergencies associated with high mortality rates.[1] The initiation of early mechanical circulatory support may be beneficial in patients refractory to standard therapies. Because it can be established outside of the operating room, veno-arterial extracorporeal membrane oxygenation (VA-ECMO) via peripheral cannulation is increasingly considered in the setting of cardiac arrest and severe cardiogenic shock.[2] However, peripheral VA-ECMO can increase afterload and can cause left ventricular distention and pulmonary oedema.[3] Central cannulation for VA-ECMO traditionally involves a full sternotomy and invasive surgery, which is inappropriate in the setting of severe haemodynamic instability and coagulopathy. We present a novel technique that combines peripheral VA-ECMO with direct ventricular decompression via a trans-apical left ventricular (LV) venting cannula and a right ventricular decompression cannula.

Case Report

A 24-year-old female with depression and ulcerative colitis presented with acute cardiogenic shock following an intentional drug overdose. She took multiple cardiotoxic drugs: her urine drug screen was positive for amphetamines and the initial blood ethanol level was 207 mg/dl. Laboratory investigations revealed end-organ injury, with evidence of liver dysfunction (aspartate transaminase 4123 IU/L, alanine transaminase 3424 IU/L), coagulopathy (International Normalised Ratio 2.7) and acute kidney injury (serum creatinine 2.5 mg/dl). An electrocardiogram (ECG) showed sinus

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tachycardia. A transthoracic echocardiogram (TTE) revealed reduced left ventricular systolic function (with an ejection fraction of 15%) as well as a moderate to severely reduced right ventricular systolic function. We intubated the patient, started her on vasopressors and inotropes and placed her on continuous renal replacement therapy (CRRT).

On hospital day 1, she developed a monomorphic ventricular tachycardia and subsequent cardiac arrest. We started cardiopulmonary resuscitation and, after the return of spontaneous circulation, we initiated VA-ECMO via peripheral cannulation. Our team placed a 19 French cannula in the right femoral vein and a 15 French cannula in the left femoral artery.

A subsequent TTE, 3 hours after VA-ECMO, revealed an aortic valve that remained closed throughout the cardiac cycle without significant aortic or mitral regurgitation and there was no spontaneous contrast or thrombus formation in the cardiac cavities or aortic root. Chest radiography revealed worsening pulmonary oedema. At this point, her ECMO flow was 4.3 L/min, she was on 15 μg/min of norepinephrine and 0.04 units/min of vasopressin. In order to improve haemodynamics and increase chances of recovery, we decided to unload the left and right ventricles via the introduction of venting cannulae into the VA-ECMO circuit.

The patient underwent a left mini-thoracotomy with trans-apical off-pump insertion of a 19 French Bio-Medicus cannula (Medtronic, Minneapolis, MN) under trans-oesophageal echo guidance. This was secured with three 3.0 Prolene purse-string sutures and secured with bioglue. She also had a two-stage 21 French IVC-SVC (inferior vena cava-superior vena cava) venous cannula placed in the right femoral vein as well as a left femoral artery cut-down, with the introduction of an 8 French Hemashield graft chimney (Maquet Holding B.V & Co. KG, Rastatt, Germany) (Figure 1). At the time, we removed all prior femoral arterial and venous cannulae/sheaths.

The patient's haemodynamics enhanced rapidly, with improved tissue perfusion and we weaned the patient off the ECMO system after 24 hours. She was successfully titrated off vasopressor and inotropic support and subsequently extubated. A TTE showed a significantly improved biventricular function (with an ejection fraction of 70%) and normal right ventricular systolic function. An ECG revealed a sinus rhythm with a normal QRS duration. She did not experience any surgical complications, such as major bleeding, pericardial tamponade or infection of the ECMO cannulas. Due to the complete resolution of her liver and kidney function, we were able to discharge the patient to a psychiatric facility 22 days after admission.

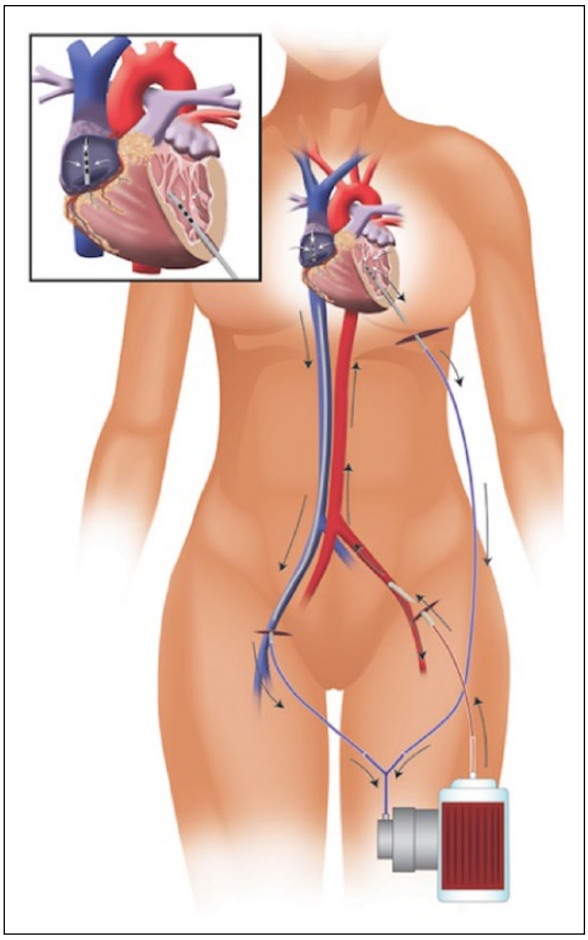

Figure 1. A trans-apical left ventricular draining cannula spliced with IVC-SVC venous cannula connected to the ECMO circuit with blood pumped directly into the left femoral artery. ECMO: extracorporeal membrane oxygenation.

Discussion

LV distention leading to increased left atrial and pulmonary capillary wedge pressure and pulmonary oedema is a major limitation of peripheral VA-ECMO due to retrograde flow support and increased afterload.[3] This is particularly pertinent in the setting of severe LV systolic dysfunction, where the aortic valve remains closed throughout the cardiac cycle, risking the possible development of a thrombus and eventual thromboembolic stroke.[4]

LV decompression during peripheral VA-ECMO has been attempted using a variety of methods, including atrial septostomy[5] and trans-aortic catheter venting,[6] as well as an increasing trend to the use of percutaneous LV assist devices (LVADs) (e.g. Impella®, Abiomed, Danvers, MA).[7] The use of percutaneous LVADs for LV venting in VA-ECMO, however, is restricted by the pump motor size, as the Impella® 5.0 catheter cannot be used in conjunction with an ECMO

circuit. This, in turn, limits the device-generated cardiac output and the level of haemodynamic support. Left ventricular apical venting offers an alternative method for LV venting and has been described in the setting of challenging sternal re-entry.[8,9]

Conclusion

The off-pump insertion of a trans-apical venting cannula in conjunction with a right ventricular decompression cannula is a viable option for biventricular unloading during peripheral VA-ECMO.

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Declaration of Conflicting Interests

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