How I do it: Totally Extrapericardial, Ambulatory Central Veno-Arterial Extracorporeal Membrane Oxygenation as a Bridge to Heart Transplantation

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Abstract

Ever since the adoption of the newest heart allocation system in the Fall of 2018, clinicians have grappled with the safest method of utilizing temporary mechanical circulatory support to get patients successfully to transplantation. In unique patients that do not have a durable left ventricular assist device as a therapeutic option and have not had a full work-up for transplantation consideration, the establishment of ambulatory extracorporeal membrane oxygenation is an attractive solution.

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Introduction

Historically, extracorporeal membrane oxygenation (ECMO) as a bridge to heart transplantation was utilized in less than 1% of transplant recipients and had a one-year survival of 70%[1]. Beginning in October 2018, the new heart allocation system significantly increased the usage of ECMO among heart transplant recipients from 1.6 to 6.5%[1]. This represents a critically ill cohort that is temporized on ECMO to either help recover from cardiogenic shock or to allow completion of transplant workup and final decision about transplant candidacy. This cohort requires a delicate balance between continued hemodynamic support on ECMO while minimizing the adverse effects and physical deconditioning from immobility[2]. Two case reports discuss

cannulation techniques that permit ambulation while on veno-arterial ECMO[3,4]. One report utilized the axillary artery and the other used a sternotomy and limited thoracotomy to achieve central cannulation. In our report, we present a minimally invasive approach to central cannulation that does not violate the pericardial space and allows for uninhabited planes at the time of subsequent heart transplantation.

Case Report

An institutional review board approval and informed consent were waived for this case report.

A 65-year-old male with a history of arrythmogenic right ventricular cardiomyopathy (ARVC) diagnosed 20 years ago. He was managed with anti-arrhythmics and an AICD placed for primary prevention in 2001. He presented with two month history of progressive fatigue and nausea. He had an episode of multiple AICD firings at home secondary to monomorphic ventricular tachycardia (VT). He underwent an unsuccessful VT ablation but was soon admitted to the hospital again with nausea, hypotension, and worsening right ventricular function. Patient was initially managed on a telemetry floor but developed worsening end organ perfusion with hypotension, nausea, lethargy, along with a rise in his creatinine and transaminases necessitating transfer to an intensive care unit and initiation of inotropes. Patient's heart transplant evaluation had recently started prior to this decompensation and urgent heart team discussions were held to develop a plan about his transplant candidacy. Given his rising pressor requirement and continued end organ dysfunction, the decision was made to place the patient on peripheral veno-arterial ECMO via his common femoral vessels and complete an expedited workup. His right ventricular dysfunction did not allow for any approved single ventricular durable mechanical support and a total artificial heart was not feasible given his body habitus. End organ function improved with peripheral VA-ECMO, however the patient's immobility and deconditioning set him up for aspiration pneumonitis and the decision was made to convert to an alternative approach that would allow for ambulation and physical rehabilitation.

We made a 3 cm skin incision starting at the level of the sternal notch and carried it down to the sternum. A partial upper hemi-sternotomy was made and then teed off at the second intercostal space. Particular attention was paid to remain extra-pericardial in order to avoid the risk of pericardial adhesions for his future transplant and potential tamponade on anticoagulation. The patient was then heparinized to an ACT above 300 seconds and purse-string sutures were placed proximal to the innominate artery. Next, a Seldinger technique was used to cannulate the ascending aorta and the presence of wire into the descending aorta was confirmed with fluoroscopy. The proximal end of the wire was brought out through a 1 cm stab incision above the right clavicle. The tract was serially dilated and an 18Fr EOPA cannula was placed (**Figure 1**). For the venous access, a .035" guidewire was inserted in the right internal jugular vein. The position of the wire was confirmed with fluoroscopy and the tract was serially dilated to place a 27-French Avalon catheter. Both lumens of the Avalon cannula were "Y-ed" together to provide inflow to the ECMO circuit and avoid stasis of either lumen of the cannula. After proper de-airing, the arterial and venous cannula were connected to the ECMO circuit and flow was established. The partial sternotomy was closed using two #6 sternal wires and the skin was closed in multiple layers.

Post-operatively, the patient was able to be extubated and ambulated with physical therapy. He was treated for his combined pneumonitis and pneumonia with a course of antibiotics and pulmonary toilet before being successfully transplanted after three weeks of ECMO support. Intrapericardial adhesions at the time of operation were minimal and the heart transplantation was unremarkable.

Conclusion

Given the increase in the number of heart transplants off of VA-ECMO, there is a need for strategies that allow for patient optimization without further deconditioning. In fact, a protocolized approach by Coutance and colleagues resulted in equivalent outcomes between patients undergoing transplant with and without pre-transplant ECMO[5]. Not surprisingly, patients that had not finished transplant listing prior to ECMO support had a longer duration of ECMO prior to transplantation (chronic heart failure listed patients (5-8 days) versus new onset heart failure (12 days)). This suggests a longer period for optimization in new onset heart failure patients who are new to a system and have not finished up transplant candidacy decision or

have acute end organ dysfunction that needs to be temporized. We present a novel approach to ambulatory VA-ECMO with extra-pericardial aortic, via upper mini sternotomy, and venous cannulation in the internal jugular vein. Our patient had a BMI of 20 kg/m^2 with small stature and an axillary artery that was 5 mm in size. Vascular complications following ECMO is the most common cause of death with axillary cannulation strategy resulting in limb hyperemia in 15% of cases[6] and femoral cannulation in up to 20% cases. Anterior thoracotomy with aortic and right atrial cannulation is a viable strategy but can result in bleeding into pericardium leading to tamponade physiology. We present a novel strategy for VA-ECMO cannulation with central aortic cannulation above the pericardial reflection to avoid violating the pericardium. This mitigates the risk of bleeding into the pericardium and causing tamponade, especially on anticoagulation. Secondly, venous drainage in the right IJ allows greater mobility by leaving both groins free of cannulas. These advantages make this a viable approach for patients who require VA ECMO.

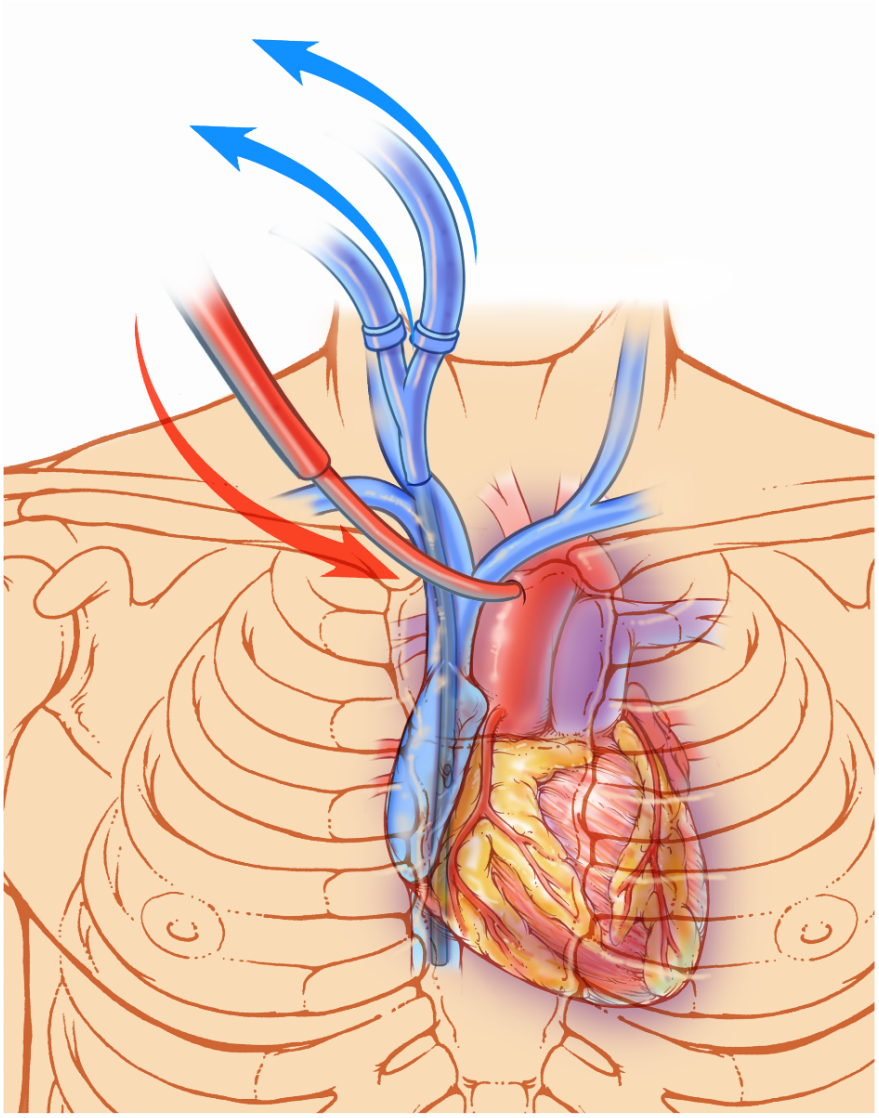

Figure 1: Demonstrates a schematic of a dual lumen catheter in the internal jugular and a tunneled aortic cannula.

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