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Heart Procurement From A Donor On Veno-Venous ECMO Support

Gopal Singh, MD¹, Masaki Tsukashita, MD, PhD², Mauer Biscotti, MD¹, Joseph Costa, DHSc, PA-C¹, Daniel Lambert, BS¹, Matthew Bacchetta, MD¹, and Hiroo Takayama, MD, PhD²

¹Section of Thoracic Surgery, Columbia University Medical Center, New York, NY10032

²Division of Cardiothoracic Surgery, Columbia University Medical Center, New York, NY10032

Abstract

We report the case of a 37 year-old woman with acute respiratory distress syndrome and became a candidate for organ donation following anoxic brain injury and was on a Veno-Venous extracorporeal membrane oxygenation support (VV ECMO). On preoperative evaluation and gross examination the donor's heart was acceptable for heart transplantation to a 62 year-old female patient with a history of non-ischemic cardiomyopathy with a Heart mate II mechanical assist device. Orthotopic heart transplantation was successfully performed in the recipient.

We report a case that suggests that the procurement of a heart from a donor on ECMO support can potentially expand the donor heart pool in carefully selected patients.

Keywords

Orthotopic Heart Transplantation; Extracorporeal Membrane Oxygenation; Organ donation

Introduction

Heart transplantation remains the best therapeutic option for patients with end-stage heart disease, with current median survival reported at 11 years overall and 13 years for those surviving the first year [1]. Estimates show that more than 20,000 patients could benefit from this life-saving procedure each year, but surprisingly only 1949 heart transplants were performed in the United States in 2011, with a contemporaneous waiting list mortality of 12.4 per 100 waitlist years [2]. The severe and ongoing shortage of donor organs limits the availability of donor hearts for transplantation. Despite this severe donor organ shortage, only one in three available donor hearts is currently accepted for transplantation, which greatly limits the rate of heart transplantation. Many reasons exist for rejecting donor hearts, including clinical and demographic factors, primarily cardiac dysfunction, (left ventricular

Corresponding Author: Hiroo Takayama MD, Assistant Professor of Surgery, Division of Cardiothoracic Surgery, Columbia University Medical Center, 177 Fort Washington Avenue, New York, NY 10032, ht2225@cumc.columbia.edu, Phone: 2123056380, Fax: 2123423520.

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hypertrophy, left ventricular dysfunction) demographic (older age, small size), existing comorbidities (hypertension, diabetes) [3].

Patients who have consented to organ donation and are placed on VV ECMO for respiratory compromise may provide a pool for donor hearts. We report the case of a patient that received a heart from a donor who was on VV ECMO at the time of heart procurement.

Case Report

The donor was a 37 year old woman admitted to an outside hospital after consuming Acetaminophen/Hydrocodone and hitting her head. The patient's condition subsequently declined and she was admitted to the intensive care unit for further management. She was diagnosed with metabolic acidosis secondary to acetaminophen toxicity and intubated to protect her airway, over the next 3 days she had difficulty oxygenating and was diagnosed with ARDS. At this point she was placed on Veno venous extra corporeal membrane (VV ECMO) support by cannulating her right internal jugular vein with a dual-chamber cannula (Avalon Laboratories, Rancho Dominguez, CA, USA) to manage her respiratory compromise. The patient was placed on a standardized ECMO protocol which involves continuous infusion of heparin with adjustment of the PTT in the range of 60-80 seconds. Five days after placement on VV ECMO the patient declined further and became areflexic. A neurological exam, apnea test and cerebral perfusion scan were consistent with brain death. Our cardiac transplant program was notified of a potential donor, and cardiac parameters were evaluated and the donor and recipient were size matched (Donor height: 63 inches, weight: 134 pounds) and (Recipient height: 63 inches, weight: 145 pounds). The preoperative cardiac parameters for the donor are shown in (Table 1).

The procurement team was activated, and on opening the chest the procurement surgeon evaluated the heart and found that it was grossly normal and devoid of palpable aortic and coronary calcification. Further exam revealed no septal dyskinesia/hypokinesia, wall motion abnormalities and no left ventricular dysfunction on visual exam. The heart was determined to be acceptable for transplant and we proceeded to cannulate the aorta in preparation for the heart procurement. Prior to placement of the aortic cross clamp the ECMO circuit was shut off, the venous cannula clamped and the heart was recovered without difficulty and transported to our institution. Notably the heart and kidneys were also procured for transplant from this donor.

The recipient was a 64 year old woman with a history of non-ischemic cardiomyopathy who had a left ventricular assist device for 11 months and was a status 1A recipient because of her severe biventricular dysfunction and device thrombosis. Orthotopic heart transplantation was performed using cardiopulmonary bypass according to standard methods, the ischemic time was 1 hour and 57 minutes. The chest was left open due to right ventricular dysfunction and the patient was closed on post-operative day 3. She was diagnosed with Grade 3 cellular/humoral graft rejection which was treated with IVIG and steroids and she continued to improve and was discharged home on post-operative day 30.

The donor was mechanically ventilated with a pulmonary end expiratory pressure (PEEP) of 15 mm H₂O which may have resulted in a marginally increased pulmonary artery pressure (31/18/23) and right ventricular pressure (34 /16) at the time of procurement. In the recipient there was right ventricular dysfunction post operatively which resolved on post-op day 3, and this patient was weaned of vasopressors / inotropes on post op day 11. On post op day 7 the recipient developed supra ventricular tachycardia and vasoplegia, an endomyocardial biopsy was obtained and rejection (ISHLT grade 2R/3A ACR) was diagnosed. The cardiac rejection was treated with IVIG and pulse steroids for 5 days. She had 2 other episodes of rejection (ISHLT grade 1R/1B) at 6 weeks and 8 weeks post op which were treated with steroids, and followed up with a endomyocardial biopsy at 12 weeks post op which was negative (ISHLT grade 0). At present the patient is in her 17th post-operative week and is doing well with no further episodes of rejection.

Discussion

Despite significant improvements in mechanical circulatory support, orthotopic heart transplantation remains the gold standard treatment for patients with advanced heart failure, leading to the best long-term outcome [4]. Unfortunately the number of patients with end stage heart disease awaiting heart transplantation is tenfold greater than the availability of donor hearts available for transplantation.

Venovenous extracorporeal membrane oxygenation (VV ECMO) in acute respiratory distress syndrome (ARDS) is used as supportive therapy, providing only respiratory support and not hemodynamic support, therefore while evaluating a donor heart for transplant, it is imperative to closely monitor the donor's hemodynamic status. The procurement of hearts from such "extended criteria" donors will only help offset the demand and availability in the short term while long term strategies are developed and implemented. Recently other groups have reported the successful recovery of liver, kidneys and lungs from donors on ECMO support [5, 6].

In our UNOS region there are an estimated 2 donors a year on VV ECMO from which hearts could be procured which translates to 22 potential donors across the country given the 11 UNOS regions in the US.

Presently, the criteria for acceptance of donor hearts for transplantation remain inadequately studied and standardized, and have not addressed procurement of hearts from donors on mechanical support such as VV ECMO. Procurement of hearts from donors on VV ECMO whose cardiac parameters are within acceptable limits may be considered for transplantation.

We would like to reiterate that donor heart must be comprehensively evaluated prior to the procurement to avoid post implant complications. An increase in pulmonary artery pressure due to hypoxia will increase the afterload on the right ventricle (RV) which may influence the diastolic function of the RV after implantation, thus in such donors appropriate flow rates need to be maintained through the ECMO cannulas. In addition ischemic time should be kept to a minimum to avoid profound pro inflammatory response due ischemia/reperfusion

injury, which would elicit an innate immune response thus activating a cellular response against the graft. Pre implant RV diastolic function is another important parameter that should be carefully evaluated as post-transplant RV dysfunction has been shown to be an independent predictor of mortality in heart transplant recipients in the first year [7].

This is a unique case as it is the first report of a heart being procured from a donor on VV ECMO support.

Conclusion

We report our experience with a successful adult orthotopic heart transplant from an organ donor on VV ECMO support.

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Table 1

Preoperative evaluation of the heart from a donor placed on VV ECMO based on hemodynamic parameters, electrocardiogram, cardiac enzymes and echocardiogram.

Donor Characteristics	
Age	37
Sex	Female
Height	63 inches
Weight	134 lbs
HR	74 bpm
BP	124/67 mm Hg
EKG	Sinus Tachycardia
Cardiac Enzymes	
CPK	16 u/l
CPK-MB	1.2ng/ml
Troponin I	0.02ng/ml
Preoperative ECHO	
Ejection Fraction	55%-65%
Mitral valve Regurgitation	None
Aortic valve regurgitation	None
Tricuspid valve regurgitation	Mild
Pulmonic valve regurgitation	Mild
Wall Motion Abnormality	None
Septal Dyskinesia	None
Right Ventricular Pressure	36/16 mmHg
Right Ventricular Size and Wall Thickness	Normal
Left Ventricular Pressure	92/22 mm Hg
Left Ventricular Size and Wall Thickness	Normal
Pulmonary Artery Pressure	S/D/M 31/18/23
Ventilator Settings	Mode/Rate/Tidal Vol/PEEP AC /15bpm /100ml/15mm H2O
Mode of ECMO	Veno-Venous

Table 2

Postoperative evaluation and follow up.

Recipient Post Operative Characteristics				
Echocardiogram Findings	Post Implant	2 Month Follow Up	3 Month Follow Up	4 Month Follow Up
Left Ventricle				
Overall Description	LVH	Normal Size	Normal Size	Normal Size
Regional Wall Motion	No abnormality	No abnormality	No abnormality	No abnormality
Ejection Fraction	> 55%	> 55%	> 55%	> 55%
Other Findings	Flattening of intraventricular septum	Mild septal hypertrophy	None	None
Right Ventricle				
Global Function	Decreased	Normal	Normal	Normal
Size	Dilated	Normal	Normal	Normal
Other Findings	RV hypertrophy – thickness 8.8mm	Normal	Normal	Normal
Rejection				
Endomyocardial Biopsy	ISLHT 2R/3A	ISHLT IR/1B	ISHLT 0	ISHLT 0