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MERGING ADVANCE TECHNOLOGY TO IMPROVE OUTCOMES IN HEART TRANSPLANTATION - A CASE REPORT

Surgery

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ABSTRACT

One of the significant obstacles to donor heart utilization is that increasingly prolonged cold ischemic times are associated with worsened short- and long-term outcomes. As a result, most transplant centers aim to limit cold ischemic times to less than four hours. The TransMedics Organ Care System (OCS) (Trans Medics, Andover MA) is a portable ex vivo perfusion system designed to store a donor heart in a beating, metabolically active state, until it reaches the recipient, thereby allowing extended time outside the body while minimizing the effects of cold storage. We present a case of a heart transplant recipient supported with the Impella 5.5 as a bridge to transplantation who received a donation after circulatory death (DCD) heart supported by OCS. To our knowledge, this is the first report of such a case.

KEYWORDS

Transplant, Mechanical Support, DCD, Axillary, Ex-vivo, Perfusion

BACKGROUND:

One of the significant obstacles to donor heart utilization is that increasingly prolonged cold ischemic times are associated with worsened short- and long-term outcomes (1). As a result, most transplant centers aim to limit cold ischemic times to less than four hours. This limitation increases the number of donors declined due to distance or marginal clinical states (2). The TransMedics Organ Care System (OCS) (Trans Medics, Andover MA) is a portable ex vivo perfusion system designed to store a donor heart in a beating, metabolically active state until it reaches the recipient, thereby allowing extended time outside the body while minimizing the effects of cold storage (3). Further, this method of warm perfusion allows for continuous ex-vivo donor heart assessment during transport (3). By allowing for warm ischemia, OCS increases acceptance of donor hearts from farther distances (1,4)

With expanding the donor pool, strategies to optimize patients before heart transplantation have improved over the last decade. With the advent of more reliable temporary circulatory support therapies such as the Impella 5.5 with Smart Assist axillary device (Abiomed, Danvers MA), we are now approaching an era of optimizing preoperative status from both a functional and hemodynamic perspective. The Impella device is a minimally invasive percutaneous support device for the left ventricle (PVAD) that allows for optimization before definitive therapy. With increased utilization of temporary mechanical circulatory support for patients awaiting heart transplant after the change in UNOS allocation, Impella 5.5 has become an increasingly viable option for hemodynamic support of the sickest patients awaiting heart transplant (5)

We present a case of a heart transplant recipient supported with the Impella 5.5 as a bridge to transplantation who received a donation after circulatory death (DCD) heart supported by OCS. To our knowledge, this is the first report of such a case.

CASE REPORT:

A 31-year-old male with acute congestive heart failure and nonischemic cardiomyopathy was admitted with progressive symptoms of shortness of breath and chest pain. Past medical history includes hypertension, heart failure with reduced ejection fraction (HFrEF) and LV ejection fraction of 13%, NYHA class 3 symptoms, anxiety, and prior polysubstance abuse. Despite home inotropic support with milrinone 0.25 mcg/kg/min via continuous infusion and daily diuretics, the patient was refractory due to volume overload and required admission. He was initially optimized by increasing the dose of milrinone to 0.5mcg/kg/min and IV diuresis with 5mg Bumex and 500mg Diuril twice daily. An echocardiogram showed a severely dilated left ventricle (LVEDD 6.39cm), global hypokinesis, moderate mitral regurgitation, and mild tricuspid regurgitation (Figure 1). Right heart catheterization after aggressive diuretic strategy and increase of Milrinone to 0.5cmg/kg/min demonstrated an RA of 4, PA 35/23 (27), pulmonary capillary wedge pressure of 21 with a Fick cardiac output of 3.4 L/min, and cardiac index of 1.9L/min/m2 and a mixed venous saturation of 63.2%. The calculated SVR was 1770 and PVR of 1.8 woods units. Despite the change in milrinone and addition of Dobutamine 2.5mcg/kg/min, the hemodynamic evaluation showed progressive decompensation and increased arrhythmia burden limiting further medical optimization. After 24 days as an inpatient and limited response with optimal medical management on dual inotrope therapy, temporary mechanical circulatory support was recommended. Intra-aortic balloon pump was not considered to provide a sufficient increase in end-organ perfusion, and the patient did not have anginal symptoms. The patient underwent insertion of the Impella 5.5 via the right axillary approach. His surgical course was uncomplicated. He was able to ambulate well after insertion of the Impella 5.5. Pre and post hemodynamics are shown in Table 3. The patient was supported for 16 days with the Impella 5.5. He had no significant issue with hemolysis, mobility, or complications from anticoagulation during this timeframe. The patient was on the heart waitlist for 17 days before

receiving a DCD heart supported by the Trans Medics OCS. Warm ischemic time on OCS was 474 minutes. Total cold ischemic time was 41 minutes, with a total cardiopulmonary bypass time of 139 minutes. His post-operative support needs were minimal, with a vasoactive inotrope score of only 11.5. He tolerated the standard induction regimen for our institution. He was extubated 6 hours after arrival to the intensive care unit and discharged on day 14 after the transplant. At 1-year follow-up, he has had no significant rejection episodes, concern for vasculopathy, and preserved allograft function.

DISCUSSION:

We report the first DCD heart transplantation utilizing the TransMedics OCS device in a patient bridged with Impella 5.5 support. This case highlights the impact of innovation in the field of heart transplantation by both optimizing the recipient's pretransplant condition and expanding the donor pool by utilizing state-of-the-art technology. Since the change in the UNOS allocation system for heart transplant listing in 2018, there has been a clear shift in the increased utilization of temporary mechanical circulatory support. Factors limiting the broad application of axillary balloon pumps are related to vascular and hemolytic complications (5). Furthermore, the utilization of durable left ventricular assist devices in patients who survive to transplant has been limited with increased waitlist times and complication rates (6).

In addition to increased waitlist times, limited donor availability and more declined offers limit transplant potential. Options for using OCS to procure marginal or extended criteria donors, such as DCD, from further distances can increase the rate of organ utilization in sicker patients sooner - given that higher UNOS status at the time of transplant has been directly associated with poorer outcomes (7).

Our patient has survived one year after heart transplantation without any significant episodes of rejection or infection. We feel that this case highlights the need to embrace newer technological options in advanced centers, explicitly focusing on improvement in bridge to transplant support and organ procurement devices that may improve donor utilization and decrease waitlist times while providing similar outcomes to traditional DBD organs. In summary, shorter waitlist times with better pre-transplant optimization will improve short- and long-term survival.

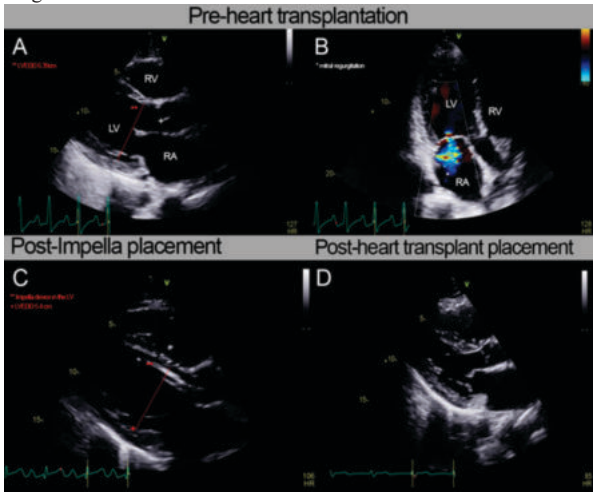

Figure 1: A: Parasternal long axis view pre-impella. B: Apical 4-chamber view pre-impella. C: Post-impella parasternal long axis. D: Post-transplant para sternal long axis. LVEDD = left ventricular end diastolic dimension. LV = Left ventricle. RV = Right ventricle. RA = Right atrium.

Table 1: Recipient Characteristics

Baseline patient characteristics	
Age (years)	31
Weight (kg)	73.1
Height (cm)	170
BMI (kg/m^2)	25.29
ABO group	O
Hemoglobin A1C (%)	5.9
LVEF (%)	22
Hematocrit (g/dL)	37.1
eGFR (mL/min/BSA)	90
Creatinine (mg/dL)	0.68
HLA Class I (%)	0
HLA Class II (%)	39

Table2: Donor Characteristics

Donor characteristics	
Age (years)	36
Weight (kg)	61.4
Height (cm)	168
BMI (kg/m^2)	21.7
ABO group	O
LVEF (%)	68
Distance (miles)	1,016
Sequence number	2
Cause of death	Blunt head trauma
Predicted heart mass	0.89
Aortic root ratio (donor/recipient)	0.68

Table 3: Perioperative Characteristics

	Baseline (Pre-impella)	**Post-Impella (Day before transplant)**	**Immediate Post-transplant**
Hemodynamics			
CVP	15	5	9
Pulmonary artery (PA) pressure (systolic/diastolic) mmHg	38/25	39/20	39/18
Mean PA pressure (mmHg)	29	26	25
Pulmonary capillary wedge pressure (mmHg)	31	12	18
Fick Cardiac output (L/min)	3.69	4.5	5.8
Fick Cardiac index (L/min/m^2)	1.86	2.36	3.1
Systemic vascular resistance (dynes/cm-5)	1627.2	1226	1200
Pulmonary vascular resistance	0.54	3.1	1.21
Pulmonary artery pulsatility index (PAPi)	0.87	3.8	2.33
CVP/PCWP	0.48	0.42	0.5
Vasoactive support			
Dobutamine (mcg/kg/min)	-	2.5	5
Milrinone (mcg/kg/min)	0.5	0.5	-
Epinephrine (mcg/kg/min)	-	-	0.01
Norepinephrine (mcg/kg/min)	-	-	
Vasopressin (units)	-	-	0.04
Inhaled nitric oxide (ppm)	-	-	20
Patient Labs			
Hematocrit (g/dL)	37.1	34.5	35.2
eGFR (mL/min/BSA)	90	90	90
Creatinine (mg/dL)	0.68	0.85	0.79
SVO2 (%)	52	58	73

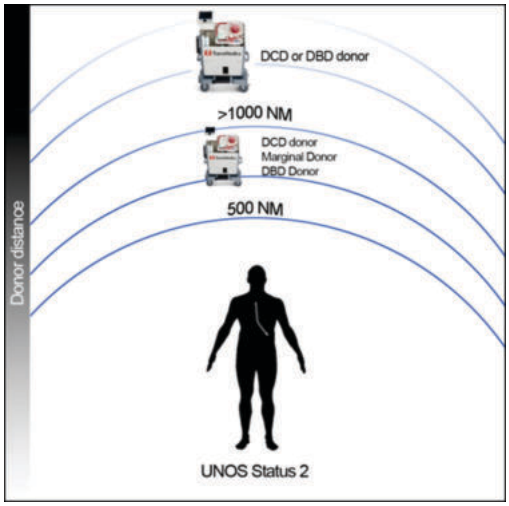

Figure 2: Options Based On Donor-recipient Distance

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