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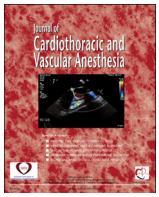

Management of Acute Mechanical Mitral Valve Thrombosis With Venoarterial Extracorporeal Membrane Oxygenation (ECMO)

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MECHANICAL PROSTHETIC VALVE THROMBOSIS (PVT) and obstruction is a life-threatening event. Due to the associated progressive presentation of heart failure symptoms and often frequent delay in diagnosis, a high mortality rate has been described.[1] In addition, surgical intervention in this setting has been associated with high perioperative risk for poor outcome that directly correlates with the degree of hemodynamic instability and a higher New York Heart Association functional class on presentation.[2] In this case report, the authors describe the management of a patient who experienced refractory cardiogenic shock from an obstructed mechanical mitral valve, in need of an urgent redo valve replacement, and underwent venoarterial extracorporeal membrane oxygenation (VA-ECMO) as a temporary rescue therapy and "bridge to definitive treatment."

Case Presentation

A 30-year-old female with a history of congenital mitral valve disease that necessitated 3 previous mitral valve replacements (most recent one 14 years prior) presented to an outside hospital with shortness of breath. Additional history included obesity with a body mass index of 36 kg/m^2, nonadherence to anticoagulation due to financial hardships, 3 prior embolic strokes with no residual deficits, atrial fibrillation status post-ablation, and a reported history of dilated cardiomyopathy.

She initially was admitted to a local hospital with symptoms of acute decompensated heart failure. She was diagnosed with non-ST segment elevation myocardial infarction, underwent a myocardial perfusion study with negative results, and was discharged on enoxaparin and warfarin. Her symptoms continued to worsen; therefore, she presented to a second hospital for worsening heart failure symptoms. A 2-dimensional echocardiogram was performed, which showed a significant mitral valve gradient of 30 mmHg and a thrombosed mitral valve leaflet (Fig 1). Fluoroscopy also confirmed an immobile leaflet. Due to her respiratory distress, inotropic support with dobutamine was administered. This subsequently was changed to milrinone due to tachyarrhythmias and was titrated rapidly up to 0.5 μg/kg/min.

She subsequently was referred to the authors' hospital for higher level of care. On arrival to the authors' hospital, she was noted to be in significant respiratory distress with an inability to speak in sentences. Her blood pressure was 50 mmHg on

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Fig 1. Thrombosed prosthetic mitral valve on echocardiogram.

palpation, and she demonstrated cold, mottled extremities. An arterial line was placed, and the patient underwent urgent intubation for airway protection and a high work of breathing. Her severe hypotension and low-cardiac-output state prompted placement of an intra-aortic balloon pump at the bedside with 1:1 augmentation and titration of milrinone, epinephrine, dobutamine, norepinephrine, and vasopressin.

A pulmonary artery catheter on insertion revealed a cardiac index of 1.9, mixed venous saturation of 40%, and a pulmonary artery pressure of 78/50 mmHg, with a mean of 57 mmHg (Table 1). A repeat echocardiogram showed a thrombosed bileaflet mechanical mitral valve prosthesis with both occluders fixed in approximately 10% of their opened position (Fig 1). The mitral valve diastolic mean Doppler gradient was 42 mmHg, and the left ventricle was small and underfilled, with an estimated ejection fraction of 55%. Severe right ventricle enlargement and tricuspid regurgitation also were noted. Likely as a result of her cardiogenic shock, she also was found to be experiencing hepatic dysfunction, a coagulopathy, and acute kidney injury.

Due to persistently worsening multiorgan dysfunction, the patient subsequently underwent femorally cannulated VA-ECMO. A longitudinal arteriotomy was performed in the common femoral artery and an 8-mm Hemashield (Maquet Holding GmbH & Co, Rastatt, Germany) side graft was sewn on to the vessel (femoral artery). The anastomosis was reinforced with BioGlue (CryoLife, Inc, Kennesaw, GA), and the graft was tunneled out through a separate stab incision more distal in the thigh. A 20-Fr arterial cannula was placed through the graft and secured with multiple ligatures. Using fluoroscopy, a 25-Fr venous cannula was inserted through the right femoral vein and successfully passed into the right atrium. Heparin anticoagulation was initiated, and an activated coagulation time of 180-to-220 seconds was maintained. Antibiotics also were commenced for possibility of sepsis and vasodilatory shock. Culture results were negative, except for bronchoalveolar lavage, which was positive for coronavirus HKU1. No treatment was recommended for this.

ECMO was maintained for nearly 72 hours, during which time the patient's hemodynamics and end-organ perfusion improved, allowing for the weaning of all inotropes, diuretics, and vasopressors (Table 1). After 3 days of hemodynamic optimization, the patient was taken to the operating room for a successful redo mitral valve replacement and decannulation from ECMO.

Intraoperatively, a moderate thrombus was discovered in the valve (Fig 2). The leaflets were stuck shut. In addition, there was an extensive organized thrombus in the hinged points of the mechanical prosthesis but no free thrombus in the atrium or the ventricle. The thrombus around the valve was removed carefully both mechanically and with suction. The mitral valve prosthesis then was excised sharply, taking care not to injure the annulus. After the valve was removed, the annulus was debrided, the left atrial appendage was oversewn, and a 27/29 mm On-X valve (On-X Life Technologies Inc, Austin, TX) was seated on the annulus without impingement on the leaflets.

When choosing the type of prosthesis, the patient's social factors were a consideration. Ultimately, the superiority of a mechanical valve weighed in her favor, provided that her compliance could be corrected with adequate medical follow-

Table 1
Temporal Changes in Vital Signs and Laboratory Parameters Before and After ECMO and After Surgery

	On Admission to the ICU (Before Intubation and ECMO)	After ECMO	Before Definitive Treatment (~72 h of ECMO)	After Redo MVR and ECMO Removal
SvO_2	40%	71%	73%	68%
HR	129	120	96	75
BP (MAP)	64/43 (56)	81/51 (63)	103/73 (86)	111/66 (78)
PAP (PAM)	77/56 (64)	66/48 (55)	73/45 (54)	41/18 (28)
PCWP	50			
CVP	20	11	9	11
RR	21	10 (MV)	10 (MV)	14 (MV)
SpO_2	69%	98%	100%	100%
BUN (mg/dL)	69	54	15	19
Creatinine (mg/dL)	2.4	1.9	0.8	1.0
Na (mmol/L)	119	128	140	145
Lactate (mmol/L)	3.6	2.1	0.7	

Abbreviations: BP, blood pressure; BUN, blood urea nitrogen; CVP, central venous pressure; ECMO, extracorporeal membrane oxygenation; HR, heart rate; ICU, intensive care unit; MAP, mean arterial pressure; MV, on mechanical ventilation; MVR, mitral valve replacement; Na, serum sodium; PAM, mean pulmonary artery pressure; PAP, pulmonary artery pressure; PCWP, pulmonary capillary wedge pressure; RR, respiratory rate; SvO_2: central venous oxygen saturation; SpO_2, arterial oxygen saturation.

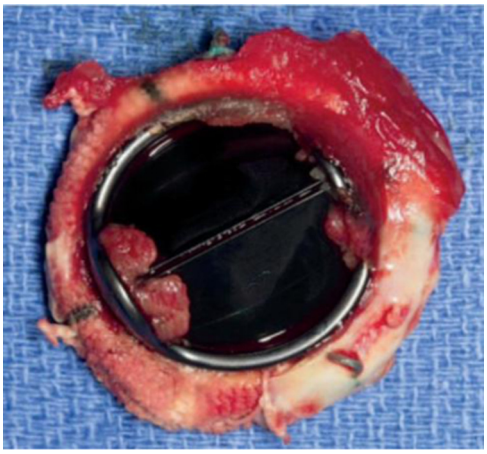

Fig 2. Valve thrombosis, ventricular side.

up and financial support. Overall, the patient tolerated the surgery well, and her airway was extubated on postoperative day 3. She suffered no further complications and was discharged home on postoperative day 13 with follow-up care established through the county public health system. She had no further compliance issues at 1 year follow-up.

Discussion

The incidence of obstructive PVT for mechanical valves varies between 0.3% to 1.3% patient-years.[3] For mitral prostheses, a mean gradient > 8 mmHg and an effective area < 1.3 cm^2 are indicative of PVT. Risk factors for PVT include left atrial dilation, atrial fibrillation, hypercoagulability, and low cardiac output.[4] Obstruction of a mechanical prosthesis requires aggressive treatment (surgery or fibrinolysis) because anticoagulant treatment usually will be insufficient.[5]

Because of the lack of randomized studies, there are few recommendations in the literature concerning PVT management (level 2 recommendations when available). According to the 2014 American College of Cardiology/American Heart Association guidelines,[3] surgery is the preferred treatment for left-sided PVT. VA-ECMO has been indicated in refractory cardiogenic shock as a bridge to recovery from a potentially reversible underlying insult and as a bridge to cardiac transplantation or ventricular assist device placement.[6] Rarely has VA-ECMO been used as a bridge to surgical replacement of a thrombosed prosthetic valve.[7,8]

In the case presented here, the patient arrived in cardiogenic shock and multiorgan failure in the middle of the night, and after several multidisciplinary discussions among cardiac surgery, heart failure cardiology, and critical care providers, emergency valve replacement was deemed too high risk in the setting of multiorgan failure. The decision was made to medically optimize the patient with VA-ECMO for a short period before definitive surgery. Management of the patient using ECMO preoperatively presented a safer option than did emergency surgery and potential postoperative ECMO, which would submit the patient to possible further complications, including rethrombosis of the new prosthesis. Thrombolytic therapy was not considered due to coagulopathy in the setting of liver dysfunction. In the only previously reported case in which VA-ECMO was used in a postpartum patient with PVT, surgery was performed after a 3-day period of stabilization.[8]

This unique case of a patient with an unstable condition in multiorgan failure who needed an urgent fourth redo sternotomy, cardiotomy, and valve replacement suggests a potential subset of patients who may benefit from ECMO therapy as a temporary measure. Early transfer to an ECMO center is recommended to avoid worsening multiorgan failure, which would render any further surgical options as futile. In the case presented here, despite delays, the patient did not require renal replacement therapy and experienced resolution of hepatic dysfunction and coagulopathy once she was medically optimized using VA-ECMO. In the setting of multisystem dysfunction and high perioperative risk, extracorporeal life support may present a viable option for providing temporary hemodynamic optimization before definitive treatment.

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