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Salvage Extracorporeal Membrane Oxygenation prior to “bridge” Transcatheter Aortic Valve Replacement

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Abstract

We describe a patient who presented in profound cardiogenic shock due to bioprosthetic aortic valve stenosis requiring salvage ECMO followed by a “bridge” valve-in-valve transcatheter aortic valve replacement (TAVR).

Introduction

For patients at prohibitive surgical risk, transcatheter aortic valve replacement (TAVR) has been shown to improve 5-year survival over medical management.(1) Prophylactic institution of extracorporeal circulation has been used in high-risk TAVR candidates with impaired ventricular function.(2,3) Furthermore, valve-in-valve TAVR has been utilized for patients with structural valve degeneration (SVD) of surgical bioprosthetic aortic valves.(4) We describe a patient presenting in cardiogenic shock requiring salvage extracorporeal membrane oxygenation (ECMO) prior to valve-in-valve TAVR.

Patient Profile

IRB approval was obtained for the reporting of this patient. A 33-year old male had previously undergone aortic valve replacement (AVR)—29mm Mosaic porcine bioprosthesis (Medtronic, inc., Minneapolis, Minnesota)—in 2005 for bicuspid aortic stenosis. He had refused a mechanical valve to avoid anticoagulation given his competitive motorcycle racing. He did well for the subsequent 9 years with minimal follow-up but presented to the emergency department with a 6-week history of progressive dyspnea. He was urgently intubated for respiratory distress. Due to critical restenosis of his aortic bioprosthesis, the patient was in cardiogenic shock with refractory hypotension despite initiation of

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norepinephrine, vasopressin, neosynephrine, and epinephrine infusions. The patient was transported by helicopter to our institution.

On arrival, transthoracic echocardiogram (TTE) showed severe bioprosthetic aortic valve stenosis: mean gradient was 64 mmHg, and peak velocity was 5.1 m/s (Figures 1A – C). Biventricular function was severely reduced with a left ventricular ejection fraction (LVEF) of 19%. The ascending aorta measured 4.6 cm by TTE, similar to a previous computed tomographic angiogram. Given multi-system failure, he was cannulated for ECMO in the intensive care unit (ICU) with a 27Fr multi-stage Medtronic Bio-Medicus venous cannula via the common femoral vein and a 22Fr Medtronic EOPA femoral arterial cannula via the right common femoral artery. These were connected to a Cardiohelp ECMO circuit (Maquet Holding B.V. & Co. KG, Rastatt, Germany). Inhaled epoprostenol was initiated for severe pulmonary hypertension (mean pulmonary artery pressure was 68). His transaminitis and renal failure improved over the ensuing seven days. Re-sternotomy for replacement of the valve and ascending aorta at this stage was deemed to be associated with prohibitive risk due to his multi-system failure despite ECMO support. The decision was made to proceed with extreme-risk TAVR as a “bridge” to therapy.

In the hybrid catheterization laboratory, the left common femoral artery was accessed percutaneously and two 6 Fr ProGlide perclose devices (Abbott Vascular, Santa Clara, CA) were deployed. Crossing the stenotic bioprosthesis required temporarily decreasing the ECMO flow to allow the valve to open. Balloon valvuloplasty was performed with a 20mm x4cm Z-Med valvuloplasty balloon (B. Braun Interventional Systems, Inc., Bethlehem, PA) during rapid ventricular pacing, and a 26mm Edwards Sapien-XT valve (Edwards Lifesciences, Inc., Irvine, California) was advanced into position with transesophageal echocardiographic (TEE) and fluoroscopic guidance (Figures 2A and B). Using rapid ventricular pacing, the valve was deployed. TEE demonstrated trace paravalvular leak. In the ICU, ECMO was weaned with the aid of inotropic and vasopressor support; the patient was decannulated in the operating room on post-operative day (POD) #1 and was extubated on POD #2. Sildenafil therapy was initiated, and inhaled epoprostenol was weaned. Inotropic support was weaned, and the patient was transferred to the stepdown unit on POD #7. He was discharged home on POD #9 on aspirin and clopidogrel. Pre-discharge TTE showed improved biventricular function: LVEF was 46%, Right Ventricular Systolic Pressure (RVSP) was 41 mmHg, and mean gradient across the aortic valve prosthesis was 33 mmHg. One month postoperatively, his exercise tolerance was improving; TTE demonstrated LVEF of 40% and mean transvalvular gradient of 26mmHg. The patient was last seen 12 months postoperatively doing well. TTE revealed LVEF of 50%, mean gradient across the aortic valve prosthesis of 24mmHg, and stable trace paravalvular leak. The patient will continue heart failure therapy and routine surveillance. He is considering when he will return for elective open redo surgical AVR with a mechanical prosthesis and graft replacement of his aorta as we do not expect the SAPIEN-XT bioprosthesis to function for long in this young man.

Comment

Intraprocedural use of extracorporeal support—either cardiopulmonary bypass or ECMO—has been described in TAVR. Emergent institution of extracorporeal support can be used for salvage following intraprocedural complications, though mortality in this population is high. (3) Indications for prophylactic use of ECMO include: cardiogenic shock, severely reduced ejection fraction, and pulmonary hypertension with right ventricular dysfunction, and the reported results have been good.(2,3) Our patient presented in cardiogenic shock with multi-system failure, and institution of ECMO served as an effective means of end-organ resuscitation prior to extreme-risk valve-in-valve TAVR. Pre-operative ECMO support may not only improve outcomes of emergent TAVR but also broaden the pool of eligible patients.

Deo et al. used extracorporeal support with balloon aortic valvuloplasty as a “bridge” to open surgical aortic valve replacement demonstrating the potential benefit of extracorporeal support for resuscitation prior to intervention.(5) The risk of cusp rupture has tempered our enthusiasm for balloon valvuloplasty of bioprostheses, but this ensured that the TAVR device was able to cross the degenerated porcine bioprosthesis, a challenging process without valvuloplasty in our previous experiences with valve-in-valve TAVR. The potential negative consequences of aortic insufficiency—further amplified by extracorporeal support—necessitated rapid correction with TAVR implantation.

There is a growing trend to use bioprostheses in patients aged 50 – 69,(6) and this may be because valve-in-valve TAVR is viewed as a viable option for SVD.(4) Currently available TAVR devices in the U.S. are not designed for valve-in-valve applications. Medium-term results of valve-in-valve TAVR do not exist, and the durability of TAVR in a young patient is unknown but likely limited. In this patient, expeditious ECMO support allowed us to use valve-in-valve TAVR as a “bridge” to open surgical AVR.

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Figure 1.

Pre-operative TTE: (A) *left*: parasternal short axis demonstrating severe prosthetic aortic valve stenosis, *right*: color doppler; (B) aortic valve, parasternal long axis; (C) color doppler, aortic valve, parasternal long axis.

Figure 2.

Intra-operative images: (A) fluoroscopy demonstrating appropriate positioning of the TAVR V-in-V; *red arrow*: radiopaque eyelets demonstrating the upper margin of bioprosthesis struts; (B) mid-deployment of TAVR V-in-V.

Abbreviations: transthoracic echocardiogram, TTE; transcatheter aortic valve replacement, TAVR; valve-in-valve, V-in-V.