Urgent Transcatheter Mitral Valve-In-Valve Replacement With Venoarterial Extracorporeal Membrane Oxygenation Support: Case Report and Review of the Literature

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Abstract

Critical mitral valve stenosis due to a failed bioprosthetic valve is associated with significant morbidity and mortality, with the transcatheter Valve-in-Valve (ViV) approach becoming a popular treatment option. We present a case of cardiogenic shock secondary to a stenotic mitral bio-prosthetic valve. The Heart team was consulted, and the patient was a high-risk surgical candidate for valve replacement. He required venoarterial extracorporeal membrane oxygenation as a bridge to definitive therapy. The patient underwent a successful urgent transcatheter mitral ViV procedure with a trans-septal approach. Follow-up echocardiography showed significant improvement in mitral valve dynamics. Recently emerging transcatheter approaches for mitral ViV implantation after balloon valvuloplasty into a failed mitral valve prosthesis is a technically feasible approach in the high-risk patient population and should be considered over re-operative mitral valve surgery.

Keywords: severe mitral stenosis, cardiogenic shock, failed bioprosthetic valves, mechanical circulatory support, mitral valve-in-valve replacement

Introduction

Mitral valve disease is one of the most common valvular heart diseases, with more than 20,000 mitral valve replacement procedures performed each year in the US [1]. Due to their limited durability, reoperation on bioprosthetic mitral valves is an unavoidable trajectory in one-third of patients and is associated with significant morbidity and mortality [2]. To mitigate the high surgical risk associated with reoperation, the concept of mitral Valve-in-Valve (ViV) was introduced in 2007 and showed favorable results [3]. Transcatheter mitral ViV is associated with low complication rates and lower-than-predicted mortality rates [4]. Here, we describe a case of severe mitral stenosis in a patient with a failed bioprosthetic mitral valve, resulting in cardiogenic shock requiring venoarterial extracorporeal membrane oxygenation (VA-ECMO). The patient underwent a successful urgent transcatheter transseptal mitral ViV procedure. This case was presented as a complex clinical case abstract at the American College of Cardiology Annual Scientific Meeting in April 2022.

Case Presentation

A 73-year-old male with medical history of atrial fibrillation, congestive heart failure, hypertension, peptic ulcer disease, chronic kidney disease stage III, and nonrheumatic mitral stenosis status post bioprosthetic mitral valve replacement (MVR) x2, in 2015 using a 27 mm bioprosthetic valve (Medtronic, Minneapolis, MN) and redo MVR in 2017 using a 25 mm bioprosthetic valve (St. Jude Medical, St. Paul, MN). The patient is active at baseline with a New York Heart Association (NYHA) functional class of II. The patient presented to our hospital with 1 week of worsening shortness of breath and lack of energy. His admission NYHA functional Class was III. On physical exam, the heart rate was 65 beats per minute, the respiratory rate was 22 breaths per minute, the oxygen saturation was 85% while breathing ambient air, and the blood pressure 116/61 mmHg. The patient was tachypneic but not in acute distress. Examination of the heart and lungs revealed an apical diastolic murmur, bibasilar crackles, and trace leg edema. Abnormal labs on admission include a creatinine of 1.74 (baseline 1.3 mg/dL) and a brain natriuretic peptide (BNP) of 2416 pg/ml (reference range < 100). Chest x-ray on admission showed mild cardiomegaly and pulmonary venous congestion. Transthoracic echocardiogram (TTE) showed an ejection fraction of 75–80%, a bioprosthetic mitral valve with critical mitral stenosis, and moderate mitral regurgitation (Figure 1, Video 1).
FIGURE 1: Spectral Doppler waveform prior to mitral valve in valve replacement. Mean pressure gradient across the mitral valve is 17.19 mmHg indicating severe mitral stenosis.

VIDEO 1: Transthoracic echocardiography showing severe prosthetic mitral valve stenosis.

View video here: https://youtu.be/IR6G4rFxBzA

The patient was admitted to the medical floor and was started on intravenous diuretics with furosemide. The patient’s clinical condition deteriorated over the following few days; his oxygen requirement increased from 2L on admission to requiring a heated high-flow nasal cannula. He also developed cardiogenic shock, requiring transfer to the intensive care unit. His blood pressure was closely monitored via an arterial line in the right brachial artery, as Swan-Ganz catheter was not used. The patient was started on vaspressors and inotropic therapy (norepinephrine, vasopressin, and dobutamine). The patient’s Society of Cardiovascular Angiography and Interventions (SCAI) shock grade was D. His cardiogenic shock was complicated with shock liver, worsening hypoxia, coagulopathy, and worsening kidney function. The patient’s condition continued to deteriorate, and so did his oxygen requirement, so he was intubated and started on VA-ECMO through a left femoral access. The patient was started on argatroban for anticoagulation, heparin products were not used due to a concern of heparin induced thrombocytopenia. The heart team consisted of structural cardiology and cardiothoracic surgery, evaluated the patient, and decided to perform an urgent mitral ViV procedure. He was not a candidate for a third redo mitral valve surgery due to extremely high surgical risk, with a society of thoracic surgeons predicted risk of mortality score of 28% with combined mortality and morbidity of 87%. Pre-procedural chest computed tomography angiography showed a bioprosthetic mitral valve in place with mild noncalcified thickening of the leaflets. The TTE conducted after the patient’s admission to the hospital revealed severe bioprosthetic mitral valve stenosis. It was also noted that the patient had a history of severe bioprosthetic mitral valve stenosis from previous studies and follow-ups with our clinic. Therefore, we did not deem it necessary to perform transesophageal echocardiography (TEE) as we believed it would not add any value to the diagnosis. However, a TEE was performed during the ViV procedure.

The patient was brought to a hybrid room. Access was obtained through the right groin. Through a 6-French sheath in the right femoral vein, a transvenous pacemaker was placed in the right ventricle. Then, through
an 8-French sheath, a Lunderquist wire was placed in the superior vena cava. This wire was used to insert a 14-French Edwards eSheath. Through this sheath, an Agilis wire in an Agilis catheter was placed. The transseptal puncture was then performed, followed by the advancement of the Agilis catheter. Through the Agilis catheter, the mitral tissue bioprosthesis was crossed with a JR4 catheter and a wire was exchanged over exchange length J wire for a pigtail. Left Ventricle End Diastolic Pressure (LVEDP) obtained through the pigtail was measured at 16 mmHg. The pigtail was exchanged for a Lunderquist wire. A 16 mm balloon was advanced over the wire into the mitral bioprosthesis. Under fluoroscopy and TEE guidance (Video 2), balloon valvuloplasty of the mitral tissue bioprosthesis was performed. The mean gradient dropped from 30 mmHg to 13 mmHg post-valvuloplasty. The 16 mm balloon was used to perform septal dilatation. A 26 mm SAPIEN 3 valve (Edwards Lifesciences, Irvine, CA) and delivery device were then advanced through the sheath over the wire across the interatrial septum and across the mitral valve. Once in position and under rapid pacing of the heart, the new transcatheter heart valve was deployed. Once the valve deployment was completed, there was under expansion of the new valve. So, the surgical valve was fracked using a 25 mm balloon on a second rapid pacing of the heart with full inflation of the new valve (Video 3). Intra-procedural TEE showed a well-seated ViV bioprosthesis with no significant mitral regurgitation or paravalvular leak (Video 4). The mean mitral valve gradient dropped to 4 mmHg (Figure 2). There was a significant shunt in the interatrial septum, which was closed with an Amplatzer septal occluder device (Abbott, Chicago, IL) with very good results and minimal flow through the defect (Video 5). The patient tolerated the procedure well, and it was followed by an immediate favorable outcome. The patient did remain on VA-ECMO support throughout the case between 3.5-4 L flow. After the deployment of the mitral valve, the patient’s hemodynamics showed a significant improvement. Prior to the procedure, the patient’s mean arterial pressure (MAP) was 55-60 mmHg while on maximum doses of Norepinephrine, Vasopressin, and Dobutamine. However, following the deployment, the MAP improved to 65-70 mmHg, and the patient required only minimal doses of norepinephrine. Moreover, the patient was weaned off vasopressin completely within 15-20 minutes of the mitral valve deployment. The following day, the patient was successfully weaned off norepinephrine and dobutamine.

FIGURE 2: Transesophageal echocardiography showing mitral valve hemodynamics post Valve in Valve. Mean pressure gradient dropped to 4.25 mmHg.

VIDEO 2: Transesophageal echocardiography showing severe
prosthetic mitral valve stenosis.

View video here: https://youtu.be/RdC2AbYI9Oo

VIDEO 3: Successful deployment of the 26 mm SAPIEN 3 valve.

View video here: https://youtu.be/VqgZbg9R27Q

VIDEO 4: Transesophageal echocardiography post ViV showing well seated ViV bioprosthesis with no significant mitral regurgitation.

View video here: https://youtu.be/QqN_P-Mwer8

VIDEO 5: Fluoroscopic video showing mitral bioprosthesis (middle of the screen) and atrial septal defect closure device (left of the screen) in place.

View video here: https://youtu.be/fM-P9cBxK2I

TTE done on postoperative day one showed improved left ventricular function with an ejection fraction of 60%. TTE, after four days of the procedure, showed excellent valve function with significant improvement in mitral valve hemodynamics; the mean pressure gradient dropped to 7 mmHg.

Discussion

Transcatheter mitral valve replacement (TMVR) is a valuable treatment option in patients with failed surgical bioprostheses with a high or prohibitive surgical risk [4]. Recent studies have shown that mitral ViV procedure is associated with low complication rates and better than predicted 30-day mortality rates [4]. The transseptal mitral ViV approach, though more technically challenging than the transapical approach, is less invasive and is associated with better outcomes and shorter lengths of hospital stay [4]. The transseptal approach utilizes a small septostomy balloon and was developed to avoid complications associated with the
Transcatheter transseptal mitral valve-in-valve procedure is a practical intervention in critically ill patients due to a failed mitral bioprosthesis. Mechanical circulatory support using VA-ECMO should not preclude these patients from undergoing this life-saving intervention. Long-term follow-up studies are necessary to evaluate the intervention's outcomes in critically ill patients.

**Conclusions**

Transcatheter transseptal mitral valve-in-valve procedure is a practical intervention in critically ill patients due to a failed mitral bioprosthesis. Mechanical circulatory support using VA-ECMO should not preclude these patients from undergoing this life-saving intervention. Long-term follow-up studies are necessary to evaluate the intervention’s outcomes in critically ill patients.

**Additional Information**

**Disclosures**

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