ESC European Society of Cardiology

European Heart Journal - Case Reports (2023) **7**, 1–4
https://doi.org/10.1093/ehjcr/ytad427

CASE REPORT
Structural intervention

Trans-catheter mitral valve-in-valve replacement in a patient on venoarterial extracorporeal membrane oxygenation: a case report

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Received 12 April 2023; revised 24 June 2023; accepted 30 August 2023; online publish-ahead-of-print 1 September 2023

Background Bioprosthetic mitral valves on average have a median durability between 8 and 10 years. After the failure of a bioprosthetic valve, surgical replacement is often indicated. However, the options for those patients at high or prohibitive surgical risks are limited. Here, we describe a case of a successful trans-catheter mitral valve-in-valve (TMViV) replacement on venoarterial extracorporeal membrane oxygenation (VA-ECMO).

Case summary We describe a case of a 39-year-old female with a history notable for systemic lupus erythematosus, severe pulmonary arterial hypertension (now mixed pre and post) thought to be secondary to prior substance use, and infective endocarditis complicated by severe mitral stenosis status post-bioprosthetic mitral valve replacement who presented with symptoms of acute hypoxic respiratory failure secondary to severe bioprosthetic mitral valve stenosis. The patient had a prolonged hospital course complicated by a pulseless electrical activity arrest, (continuous renal replacement therapy) for acute renal failure, and hypertonic saline due to cerebral oedema. Due to her significant co-morbidities and haemodynamic instability with acute kidney injury and recent neurologic insult, the patient was thought not to be a good surgical candidate. However, given her young age and overall improved neurologic status, it was thought the patient could benefit from a TMViV with bi-ventricular support given her right- and left-sided heart failure and was placed on VA-ECMO in anticipation of a TMViV procedure for circulatory support. The patient underwent a successful TMViV replacement using a trans-septal approach with a 26 mm SAPIEN 3 valve and atrial septal defect closure with a 14 mm Amplatzer device on hospital Day 12. The patient was successfully de-cannulated from VA-ECMO on hospital Day 13. The patient had a prolonged hospital course but eventually had renal recovery and tracheostomy de-cannulation. A trans-thoracic echocardiogram prior to discharge was notable for a well-functioning valve and normal ejection fraction. The patient was discharged to a nursing home for further rehabilitation.

Discussion The gold standard for bioprosthetic mitral valve stenosis is surgical replacement of the valve. However, the options for those at high or prohibitive surgical risk are lacking. Recent studies have demonstrated TMViV is a safe alternative to surgical mitral valve redo cases in high-risk patients. To our knowledge, there are limited data on trans-catheter valve placement while on VA-ECMO. Successful implantation in our patient suggests that TMViV in a stenotic bioprosthesis is feasible in very high-risk patients with the use of VA-ECMO to support haemodynamics.

Keywords Trans-catheter mitral valve replacement • VA-ECMO • Interventional cardiology • Mitral stenosis

ESC curriculum 4.4 Mitral stenosis • 4.10 Prosthetic valves • 6.1 Symptoms and signs of heart failure • 7.1 Haemodynamic instability • 7.3 Critically ill cardiac patient

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Handling Editor: Krishnaraj Rathod
Peer-reviewers: Annagrazia Cecere
Compliance Editor: Lavanya Athithan

Learning points

- Trans-catheter mitral valve-in-valve replacement with venoarterial extracorporeal membrane oxygenation is a durable solution for bioprosthetic valve dysfunction in high or prohibitive surgical risk patients.
- To highlight the technical considerations of trans-catheter mitral valve replacements.

Introduction

Bioprosthetic mitral valves on average have a median durability between 8 and 10 years.[1] After the failure of a bioprosthetic valve, surgical replacement is often indicated. However, patients are generally older and frail with significant co-morbidities and high-risk surgical candidates. The options for those patients at high or prohibitive surgical risks are limited. The relative limitations to the widespread adoption of mitral valve device therapies include the inherent anatomic and physiologic challenges of mitral valve disease. Here we describe a case of a successful trans-catheter mitral valve-in-valve (TMViV) replacement on venoarterial extracorporeal membrane oxygenation (VA-ECMO).

Summary figure

Day 0	*Symptoms: shortness of breath and volume overload*
	Diagnosis: acute decompensated heart failure in the setting of severe bioprosthetic mitral valve stenosis
	Echocardiography: severe pulmonary artery systolic pressure and elevated trans-mitral gradient of 24 mmHg
	Treatment: furosemide drip and resumption of home pulmonary hypertension medications
Day 2	*Symptoms: progressive hypotension and hypoxia resulting in PEA arrest*
	Treatment: CPR x 7 rounds followed by initiation of vasopressors, amiodarone, continuous renal replacement therapy, and intubation for airway protection
Day 2	*Symptoms: fixed and dilated left pupil*
	MRI Brain: Diffuse cerebral edema
	Treatment: hypertonic saline and mannitol
Day 5	*Intervention: VA-ECMO cannulation*
Day 12	*Treatment: Successful transcatheter mitral valve-in-valve placement using a tarns-septal approach with a 26-mm SAPIEN 3 valve and ADS closure with 14mm Amplatz device on VA-ECMO*
Day 13	*Treatment: Successfully decannulated from VA-ECMO*
Day 31	*Treatment: Tracheostomy decannulated*
Discharge	*Improvement in renal function. Neurologic improvement. Discharged to rehab Echocardiography: mitral valve inflow gradient improved with normal LVEF*

Case report

A 39-year-old female with a history notable for systemic lupus erythematosus (SLE), severe pulmonary arterial hypertension (now mixed pre and post), and infective endocarditis complicated by severe mitral stenosis status post-bioprosthetic mitral valve replacement in 2013 presented to our medical centre for symptoms of acute decompensated heart failure in the setting of severe bioprosthetic mitral valve stenosis. Prior to admission, she was admitted to an outside hospital for similar symptoms. There, she had a cardiac workup that was notable for an echocardiogram that demonstrated right ventricular systolic pressure of 139 mmHg, right ventricular volume overload, a normal ejection fraction of 65%, and a thickened mitral valve prosthesis. She was diuresed; however, she did not feel better so she left against medical advice and came to our institution.

The patient was admitted to the medical intensive care unit (MICU) and had a difficult ICU course including a pulseless elective activity (PEA) arrest thought to be secondary to hypoxia, acute renal failure requiring continuous renal replacement therapy (CRRT), and diffuse cerebral oedema. However, on hospital Day 5, the patient had improved neurologic status and reactive pupils but remained haemodynamically unstable. Given improvement in neurologic and clinical status, the patient was considered for a TMViV procedure using haemodynamic support. Venoarterial extracorporeal membrane oxygenation was chosen as the mode of circulatory support given her history of right ventricular failure with elevated pulmonary artery pressures and likely needed for bi-ventricular support. On hospital Day 5, the patient was placed on VA-ECMO in anticipation of a TMViV procedure for circulatory support. The patient underwent a successful TMViV replacement using a trans-septal approach with a 26 mm SAPIEN 3 valve and atrial septal defect closure with a 14 mm Amplatzer device on hospital Day 12 (*Figures 1* and *2* and Supplementary material online, *Videos S1–S3*). The patient was successfully de-cannulated from VA-ECMO on hospital Day 13. The patient successfully had her tracheostomy de-cannulated on hospital Day 31 and had continued improvement in renal and neurologic function. A trans-thoracic echocardiogram prior to discharge was notable for a mitral valve inflow gradient of 3 mmHg, left ventricular outflow tract (LVOT) gradient of 23 mmHg, mild paravalvular leak, and a normal ejection fraction of VA-ECMO. The patient was discharged to a nursing home for further rehabilitation.

Discussion

Mitral valve disease has a high prevalence and is associated with significant morbidity and mortality. The gold standard for mitral valve disease refractory to guideline-directed medical therapy (GDMT) is surgical repair or replacement of the valve. However, the options for those patients at high or prohibitive surgical risks are limited. Unlike trans-catheter aortic valve replacement which has become a promising alternative to surgical replacement in patients with severe aortic stenosis, trans-catheter mitral valve replacement (TMVR) and other mitral device therapies are still in their infancy. The relative limitations to the widespread adoption of mitral valve device therapies include the inherent anatomic and physiologic challenges of mitral valve disease. Some of these challenges include the functional nature of the mitral valve that requires close attention to the annular size, valve size, calcifications, and dimensions of the left ventricle to name a few.[1] Most notably, patients with mitral valve disease often have other significant valvular lesions and concomitant heart failure making them high-risk patients. Particularly, those patients who have a failed mechanical or bioprosthetic mitral valve are at an even higher surgical risk than non-redo cases.[2]

There is limited expertise in TMViV replacement globally with some of the largest registries only having a few hundred patients.[3] However, data from recent studies have demonstrated TMViV is a safe alternative to surgical mitral valve redo cases in high-risk patients.[4–6] To our knowledge, there are limited reports on patients undergoing a TMViV placement while on ECMO. We found two case reports—one of rescue mitraclip for severe functional MR and another of TMVR in a prior

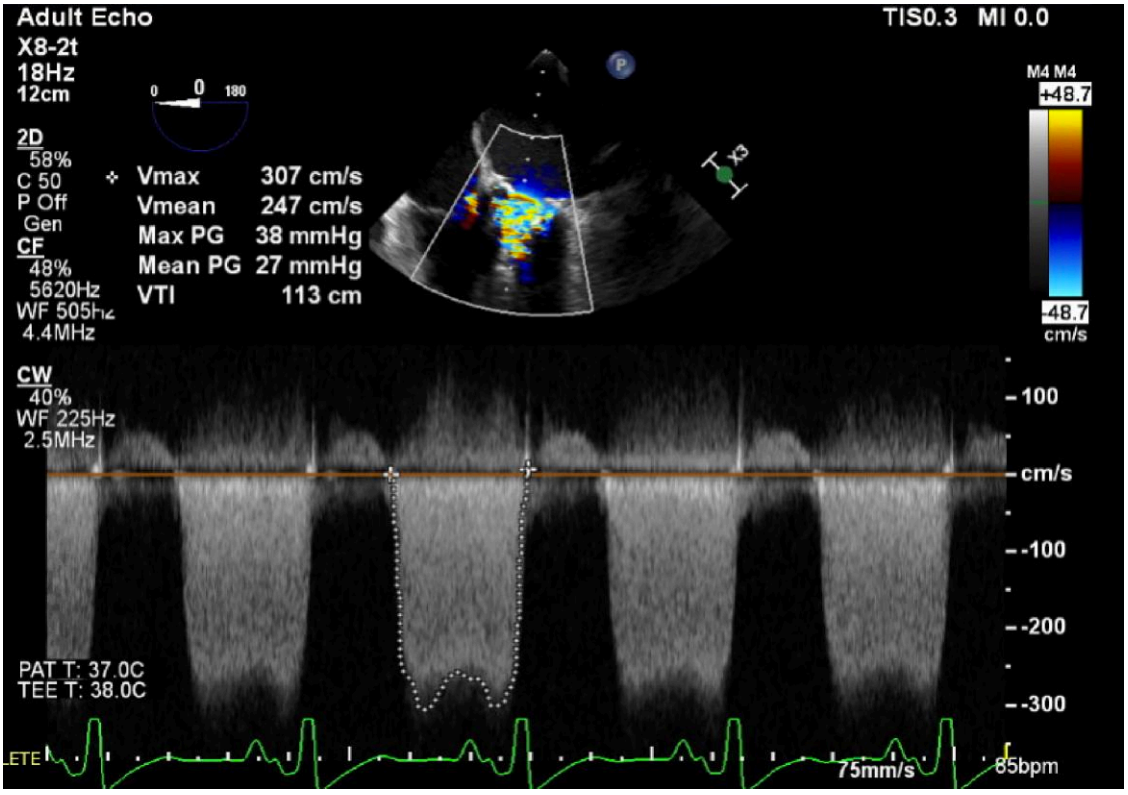

Figure 1 Pre-operative trans-oesophageal echocardiogram showing a mean gradient of 27 mmHg through the bioprosthetic mitral valve.

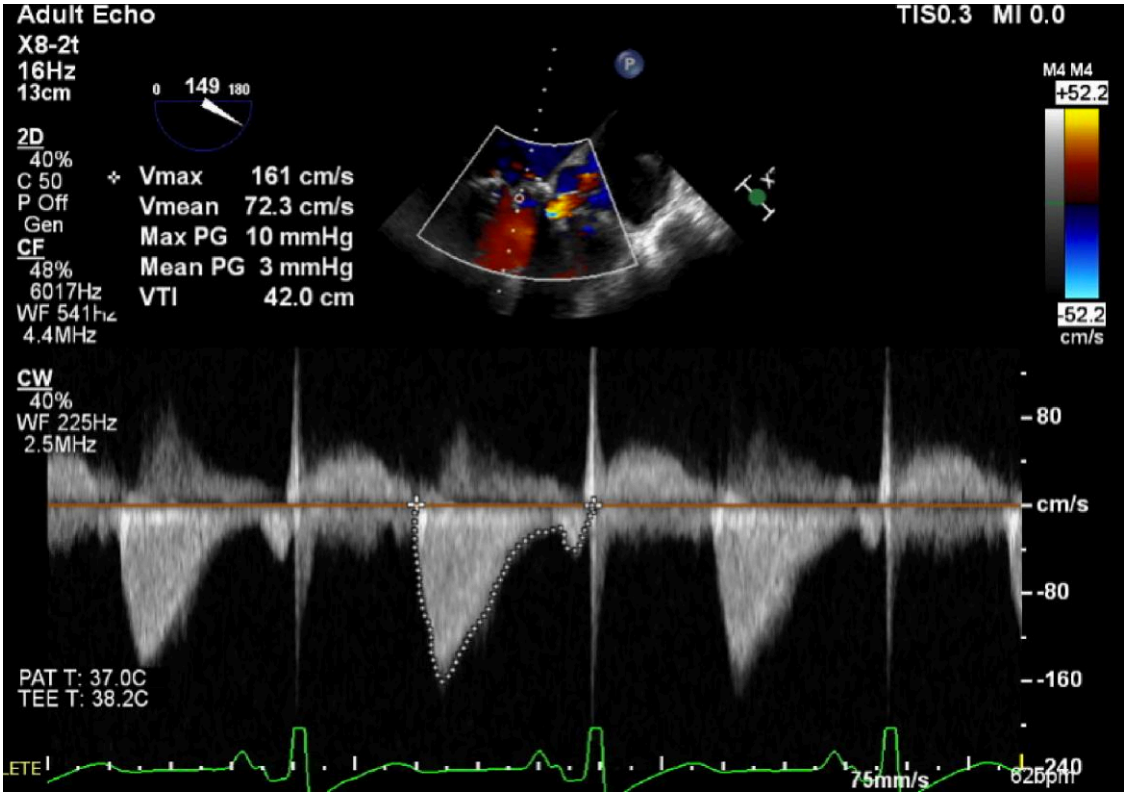

Figure 2 Post-operative trans-oesophageal echocardiogram showing a mean gradient of 3 mmHg through the mitral valve in valve.

mitral ring on ECMO and one TMViV on VA-ECMO but requiring paravalvular plugging.[7–9]

Our patient was particularly high risk because of her acute illness and baseline severe pulmonary arterial hypertension, right ventricular overload, and a partially obstructing bioprosthetic mitral valve prosthesis, which resulted in dynamic LVOT obstruction. Given her initial neurologic insult, acute kidney injury, and overall shock, the patient was deemed to be a prohibitive surgical risk. However, given her young age, it was felt it was worth attempting a TMViV with bi-ventricular support given her bi-ventricular failure. The patient was then placed on VA-ECMO for support and underwent a successful TMViV procedure via a trans-septal approach with good results. Successful implantation in our patient suggests that TMVR in a stenotic bioprosthesis is feasible in very high-risk patients with the use of VA-ECMO to support haemodynamics.

Conclusion

Bioprosthetic mitral valves on average have a median durability between 8 and 10 years.[10] After the failure of a bioprosthetic valve, surgical replacement is often indicated. However, patients are generally older and frail with significant co-morbidities and often high-risk surgical candidates. In the appropriate setting, TMViV replacement with a trans-septal approach with VA-ECMO for circulatory support is a feasible option.

Lead author biography

Jassimran Bainiwal is a Cardiology Fellow at Harbor-UCLA Medical Center. His main clinical interests include cardiovascular imaging, congenital heart disease, and valvular heart disease.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports*.

Consent: Ethics approval and consent to participate: Consent by the patient's guardian was obtained. Written and verbal consent was obtained. There was compliance with the COPE guidelines.

Conflict of interests: None declared.

Funding: There was no funding for this case report.

Data availability

The data underlying this article were accessed from *the UCLA Medical Center electronic medical record.* The derived data generated in this research will be shared on reasonable request to the corresponding author.

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