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CASE REPORT
Valvular heart disease

Simultaneous transcatheter dual valve replacement (mitral and tricuspid valves): a case report

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Background Structural valve dysfunction in bioprosthetic heart valves necessitates redo replacement procedure that are associated with high mortality and morbidity. The transcatheter valve-in-valve (VIV) approach has emerged as a preferred option for patients requiring redo procedures due to structural valve degeneration. We report from India the first case of the simultaneous transcatheter dual VIV implantation (mitral valve and tricuspid valves) in a high-surgical-risk patient.

Case summary A 57-year-old female was presented with a history of rheumatic heart disease, post-mitral valve as well as tricuspid valve replacement (perimount 33 mm) 11 years back. Bioprosthetic heart valve was chosen probably due to limited life expectancy and compliance issues with monitoring of international normalised ratio (INR). She now presented with progressive dyspnoea, oedema, and palpitations (New York Heart Association Class III) for the last 6 months. The patient was scheduled for transcatheter dual valve replacement simultaneously. The procedure was successful with a favourable outcome, short hospital stays, and early recovery.

Discussion This is the first case of simultaneous transcatheter dual valve replacement reported from India, which is fluoroscopically guided and supported by TEE. It is a valuable and considerable option for patients with failing bioprosthesis valves who are at increased perioperative risk.

Keywords Bioprosthetic valve dysfunction • Transcatheter mitral valve implantation • Transcatheter tricuspid valve implantation • TAVR • TMVR • Case report

ESC Curriculum 4.9 Multi-valvular disease • 4.10 Prosthetic valves • 6.1 Symptoms and signs of heart failure

Learning points

- Bioprosthesis valve dysfunction can occur due to leaflet tear, calcification, flail, etc., which may lead to heart failure.
- Transcatheter valve-in-valve replacement is a safe and feasible procedure in the majority of cases, even in patients with severe symptoms and comorbidities.
- Chances of achieving a successful outcome are more, using percutaneous vascular access and a step-by-step guideline along with meticulous planning.

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Introduction

Rheumatic heart disease is the most common cause of valvular dysfunction in the Indian population leading to surgical valve replacement in younger age groups. There are two types of valves that can be used, i.e. mechanical valve and bioprosthetic valve. The selection of the type of valve depends on various factors. A prosthetic heart valve (PHV) is preferred over mechanical valve in the young female patient of childbearing age as the latter requires the lifelong intake of anticoagulants which have a teratogenic effect on the foetus.[1] Structural valve deterioration of the bioprosthetic valve is as high as 50% at 10 years in the younger population (<59 years)[2] requiring redo valve surgery with high surgical risk. Transcatheter valve-in-valve (VIV) implantation is relatively a safer and more effective option for these people who are poor surgical candidates for a redo procedure.[3]

Summary figure

2011	Mitral and tricuspid valves' replacement with perimount 33 mm for rheumatic heart disease with single chamber permanent pacemaker implant for post-op complete heart block
2018	Surgery for pancreatic tail mass—no records
Admission to the hospital (2021—Day 1)	Presented to the hospital with severe dyspnoea, NYHA Class III (New York Heart Association)
Day 2	Echocardiography showed severe mitral valve and tricuspid valve prosthetic valve dysfunction along with global left ventricular hypokinesia
Day 3	Stabilization and risk stratification for redo surgery
Day 4	Decongestion and stabilization in intensive care unit (ICU)—discussion with family in view of high surgical risk
Day 5	Computed tomography scan for valve assessment
Days 6 and 7	Transcatheter mitral valve and tricuspid valve replacement was performed simultaneously under general anaesthesia and was transferred to ICU after the procedure
Days 8–10	Transferred to general ward for observation and further mobilization
Day 11	A dual chamber pacemaker was implanted as previous ventricle paced, ventricle sensed and pacemaker inhibited (VVI) pacemaker needed battery replacement
Day 14	Discharge from the hospital with advised regular follow-up

Case report

A 57-year-old female was presented with a history of rheumatic heart disease, replacement of mitral and tricuspid valves (perimount 33 mm) 11 years back. Post-surgery she required a single chamber pacemaker implantation through the PHV in view of a complete heart block. She now presented with progressive dyspnoea (New York Heart Association, NYHA, Class III), oedema feet, ascites, and palpitations for the last 6 months. She also had a history of diabetes. Physical examination showed tachycardia, blood pressure of 90/60 mmHg, increased jugular venous pressure, and SpO_2 of 90% on oxygen support.

In the hospital, ECG showed paced ventricular rhythm. Echocardiography showed dysfunctional prosthetic heart valves (PHV) at the mitral position, moderate valvular mitral regurgitation (MR), PHV leaflets were thickened with restricted valve opening resulting in significant stenosis. PHV at the tricuspid position showed moderate valvular tricuspid regurgitation along with pulmonary artery systolic pressure of 50 mmHg, global left ventricular hypokinesia with a left ventricular ejection fraction of 35% (see Supplementary material online, *Video S1*). Computed tomography was done to reconfirm valve dimensions, and assessment of outflow tract. The coronary angiogram was normal and was done to delineate coronary anatomy and exclude any high-risk coronary lesion in view of diabetes. Other relevant tests like renal function tests, liver function tests, thyroid function tests, and pulmonary function tests were done prior to the surgery and were normal. Pacemaker interrogation showed a remaining battery life of <2 months.

The patient was managed with standard medications while being prepared for the procedure. In view of the high-surgical-risk society of thoracic surgeons (STS) Score (42 kg frail, with NYHA Class III, with cardiac cirrhosis, reoperation, thin chest walls, post-surgery pancreatic tail mass), surgery was ruled out as in-hospital mortality and morbidity was 57%. Her calculated Euro Score was 55%. She was planned for transcatheter mitral valve replacement (TMVR) and transcatheter tricuspid valve replacement (TTVR) followed by pacemaker battery replacement procedure. The surgical plan was discussed, explained and consent was taken.

Steps of the procedure

Preparation and vascular access

The bilateral common femoral veins were accessed with a 7 French (Fr) sheath via the Seldinger technique. A temporary pacemaker was placed in the right ventricle through the left femoral venous sheath. Agilis NxT Steerable Introducer (Abbott Laboratories, Lake Bluff, IL, USA) was advanced into the right femoral vein. Under fluoroscopy, the Agilis was positioned at the junction of the inferior vena cava (IVC) and right atrium (RA). Five thousand units of heparin were given and Mullins sheath was inserted into the RA through the right femoral vein.

Trans-septal puncture

A trans-septal needle was advanced through this sheath and the atrial septum was punctured under TEE and fluoroscopic guidance. Inoue wire was advanced into the left atrium (LA) through the sheath. The Agilis sheath was steered towards the left ventricular apex, and a pigtail catheter was advanced into the LV without wire support. This is a preferred way to cross left mitral valve as chances of going through chordae are minimal.[4] A Safari wire was advanced through the pigtail catheter, across the mitral valve, and into the apex of the LV. Over the Safari wire, a 14 Fr sheath was inserted. The interatrial septum was dilated with a 14 mm balloon.

Mitral valve deployment

The balloon was withdrawn and the Myval Transcatheter Heart Valve System was advanced into the IVC. The valve is mounted on the delivery catheter with the skirt towards the handle (opposite the direction in which it would be loaded for transcatheter aortic valve regurgitation (TAVR)).[5] After loading the valve on the balloon, the device was advanced across the atrial septum, and into the LA. However, the device was unable to cross the valve likely due to inadequate wire support and

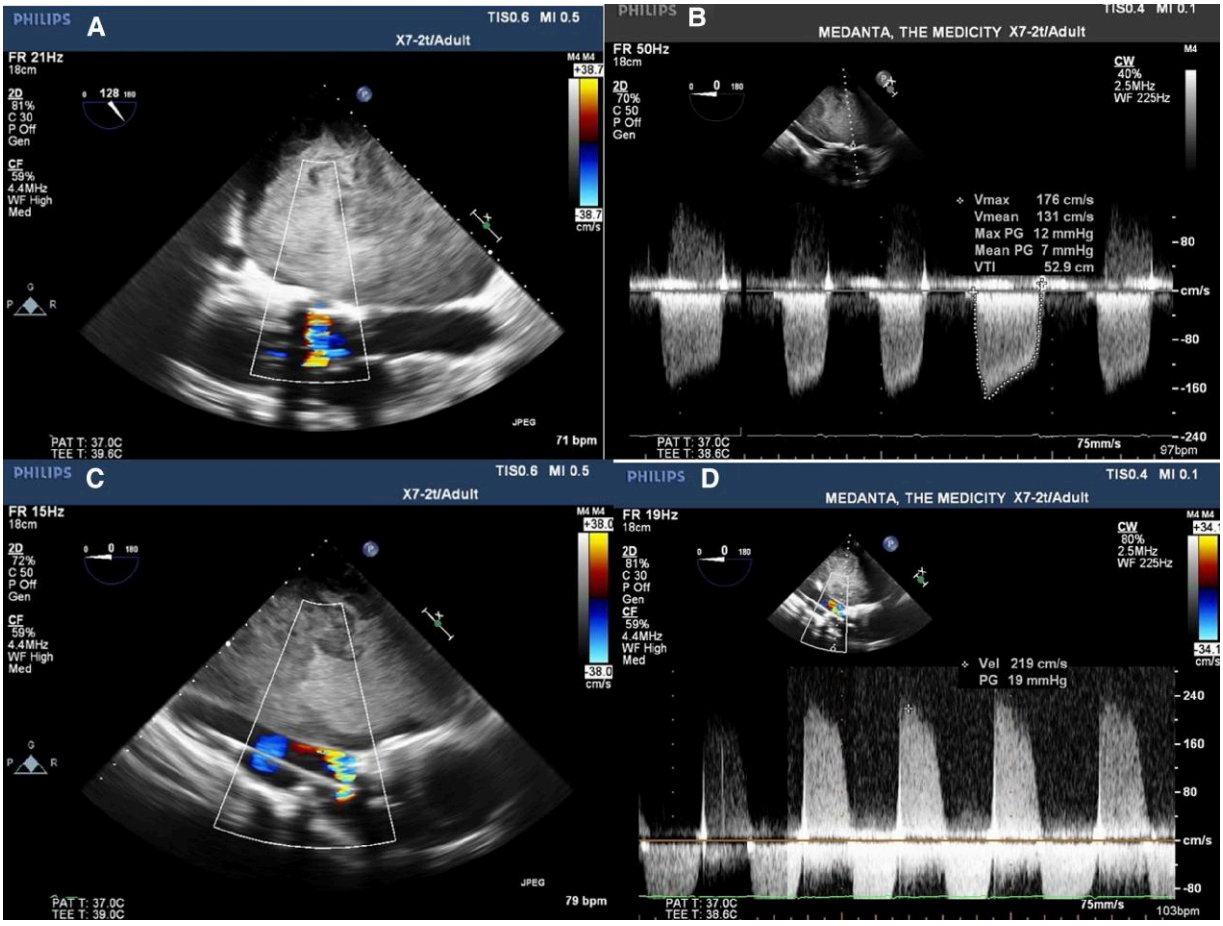

Figure 1 (*A*) Stenotic mitral bioprosthesis with severe spontaneous echo contrast and huge (12 cm) left atrium. (*B*) High peak and mean gradient across the mitral bioprosthetic valve. (*C*) Leaking tricuspid bioprosthetic valve with pacemaker lead *in situ*. (*D*) Low-pressure severe tricuspid regurgitation gradient.

abnormal orientation of the valve due to severe LA dilatation. We re-introduced the exchange length J-tip Terumo wire across the mitral valve and floated it into the descending aorta and exchanged it with a Boston stiff wire over a multi-purpose catheter. The stiff wire was held in position with a snare introduced from left femoral arterial access.

After the valve loaded on the balloon, it was manoeuvred, clockwise for 180°, to flex it rightwards (opposite of the leftward curve in TAVR) and the device was advanced across the atrial septum, and across the mitral valve. After satisfactory positioning, the valve was deployed with slow inflation under rapid ventricular pacing. Following valve deployment, transesophageal echocardiography (TEE) was used to assess valve position, trans-mitral gradients, presence of paravalvular leak (PVLs), and gradients across the left ventricular outflow tract (LVOT). Next, the temporary pacing wire, delivery system, and sheaths were withdrawn from the femoral veins (*Figure 1*).

Transcatheter tricuspid valve replacement

Initially, the transfemoral approach was tried without any success. The transjugular approach was preferred (with 7 Fr sheath), as the curve to enter the tricuspid valve was steeper and anchoring was technically not possible in the tricuspid position. J-tip Terumo wire was used on an multipurpose (MP) catheter to cross the tricuspid valve and exchange it with a super stiff wire. After serial dilations, a 14 Fr python delivery system was introduced. The delivery system was tracked over the wire and the valve was aligned with the previous bioprosthetic valve in a coaxial position. A MyVal transcatheter heart valves (THV) was slowly deployed and anchored in the previous calcified leaflets and ring. The delivery system and sheaths were withdrawn, and a subcutaneous figure of eight stitches was placed to secure haemostasis.

Follow-up

Post-implant transthoracic echocardiography showed no valvular/PVL along with low mitral and tricuspid gradients (*Figure 2*; Supplementary material online, *Videos S2, S3, and S4*). *Table 1* shows the comparison of pre-procedural and post-procedural echocardiographic findings of mitral and tricuspid valves. On follow-up a week later, the patient complained of palpitations, and a single chamber permanent pacemaker (by looking at the real-time lead position via echocardiography) was implanted for Tachy-Brady syndrome with chronic atrial fibrillation. The patient improved with no complications.

Discussion

Since the first transcatheter heart valve implantation on a failing bioprosthetic aortic valve in 2007,[6] the VIV has become a feasible alternative for patients at increased risk for redo heart surgery. Patients

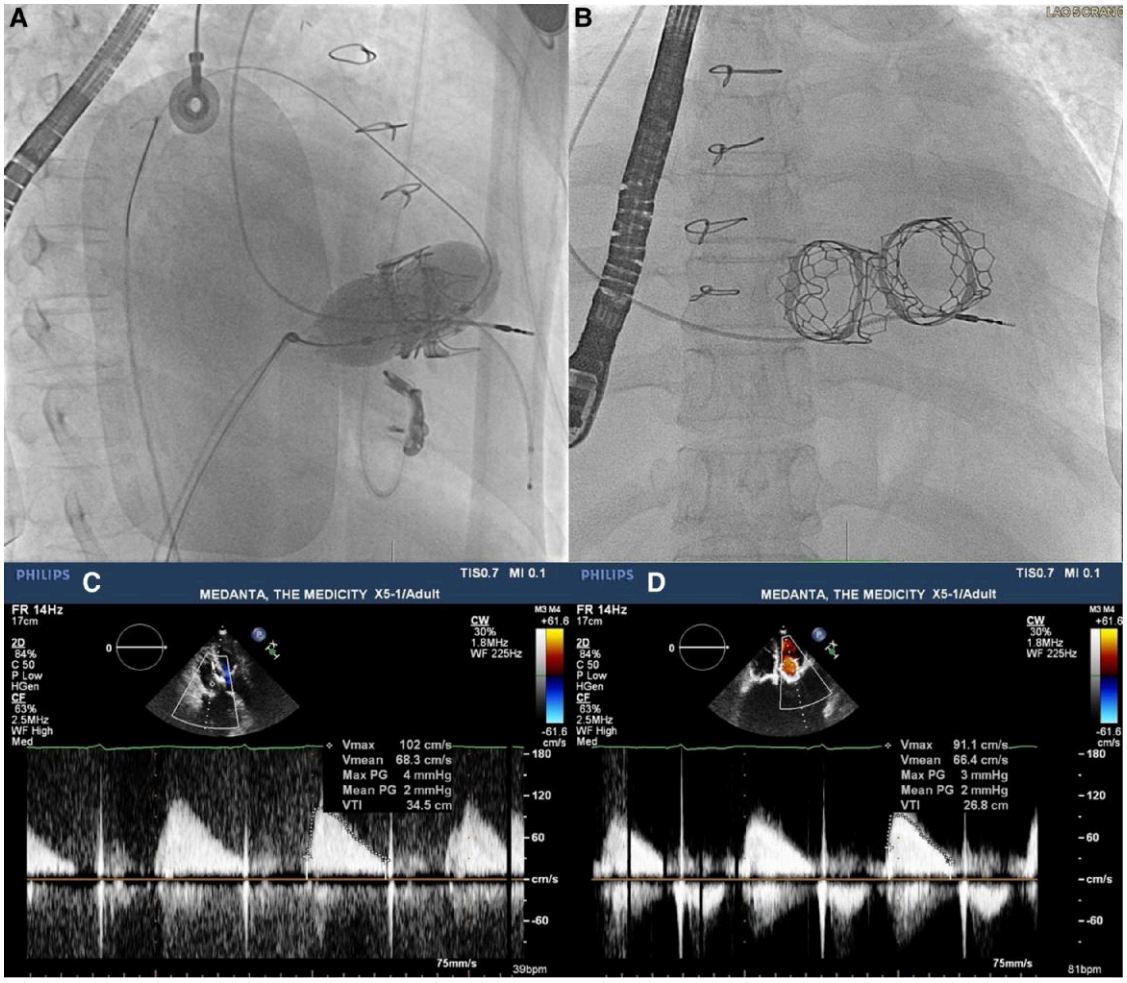

Figure 2 (*A*) Balloon-expandable valve implanted in mitral position with support from snared support wire in descending aorta through the aortic valve. (*B*) Two balloon-expandable valves in mitral and tricuspid prosthetic valves *in situ* with pacing lead going in-between bio prosthesis frame and implanted balloon-expandable valve frame. (*C*) Normal inflow Doppler across tricuspid prosthesis with no leak. (*D*) Normal inflow Doppler across mitral prosthesis with no leak.

Table 1 Comparison of pre-procedural and post-procedural echocardiography findings

Valve type	Mitral valve	Mitral valve	Tricuspid valve	Tricuspid valve
Time of echo	Pre-procedure	Post-procedure	Pre-procedure	Post-procedure
Mean gradient	12 mmHg	2 mmHg	5 mmHg	2 mmHg
Peak gradient	19 mmHg	4 mmHg	11 mmHg	3 mmHg
Severity of MR	Mod MR	Nil	Mod TR	Nil
Ejection fraction	35%	35%	35%	35%

MR, mitral regurgitation; TR, tricuspid regurgitation.

with structural valve degeneration may require repeat surgical valve replacement, which is a high-risk operation associated with high mortality and major complications. But this served as an advantage too as the annulus of the degenerated ring acts as an anchoring point for the transcatheter valve.[5] Our patient had multiple risk factors like older age, female gender, NYHA Class III, reoperation, thin chest wall, and pericardium sealed to the sternum making the surgical approach very high risk. TMVR and TTVR are comparatively less invasive approaches.

Several transcatheter mitral valve repair technologies have emerged over the last decade as an alternative to surgery for the treatment of MR in patients at high or prohibitive surgical risk.[7] TMVR with the

new TMVR system resulted in the correction of MR in symptomatic patients deemed to be at high or extreme risk for open-heart surgery.[8] The VIV is also globally growing in numbers for failed bioprosthesis in the mitral and, to a lesser extent, the pulmonary and tricuspid positions.[9] For transcatheter tricuspid valve implantation, the process was similar to mitral valve implantation and it had put less strain on the patient by undergoing both the valve replacement in a single setting.

However, patient selection plays a vital role as those with a small LVOT and a long, calcified anterior mitral valve leaflet may not be a good candidate as they are at increased risk for LVOT obstruction, which is the most feared and potentially life-threatening complication associated with TMVR. Projected neo-LVOT area $\leq 1.7\ cm^2$ carries high sensitivity and specificity for post-procedural LVOT obstruction. The presence of endocarditis, severe PVL, thrombosis, or dehiscence of the bioprosthesis contraindicate this procedure. Special precautions during the procedure: (i) valve to be loaded in opposite direction for both mitral and tricuspid positions in comparison to TAVR, (ii) delivery catheter is to be positioned at 180° to TAVR to facilitate left word banding (opposite the TAVR), and (iii) valve to be positioned with 70–80% valve towards the ventricular side of the previous PHV frame.[10]

The main challenges of transcatheter therapies are mitral valve position, valve sealing, the proximity of LVOT, complex anatomy, delivery system, valve thrombogenicity, long-term durability, prosthesis anchoring, and annular retention.[11] In our case, the main challenges were crossing the valve due to dilated LA and malrotation of the valve facing away from the septum.

Conclusion

This is the first case of simultaneous transcatheter dual valve replacement reported from India, which is fluoroscopically guided and supported by TEE. It is a valuable and considerable option for patients with failing bioprosthesis valves who are at increased peri-operative risk. Transcatheter VIV replacement is a safe and feasible procedure in the majority of cases, even in patients with severe symptoms and comorbidities. Thus, the chances of achieving a successful outcome are more, using percutaneous vascular access and a step-by-step guideline along with meticulous planning.

Lead author biography

Nagendra Chouhan has done super specialization in cardiology and post-doctoral fellowship of National Board in Interventional Cardiology & Electrophysiology. He has gained further experience in complex coronary intervention at Mayo Clinic and Cedar Sanai Hospital, USA. He also gained experience in implantable cardiac defibrillator (ICD) and cardaic resynchronization therapy defibrillator (CRTD) implantation in China and Singapore. He has 15 years of experience in teaching undergraduates, postgraduates and fellows in cardiology and interventional cardiology. He is a keen researcher with 20 international and 30 national publications and is a principle investigator in various international trials. He is reviewer for *HEART*, *International Journal of Cardiology*, and *Indian Heart Journal*.

Supplementary material

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

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Conflict of interest: None declared.

Ethics approval: The authors declare that no experiments were performed on humans or animals for this study. The authors declare that they have followed the protocols of their work centre on the publication of patient data and that all the patients included in the study received sufficient information and gave their written informed consent to participate in the study.

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Data availability

The data underlying this article are available in the article and in its online supplementary material.

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