Case Report

# The Role of Echocardiography in the Management of Structural Valve Degeneration of Transcatheter Valves

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**ABSTRACT**

Transcatheter valve implantation in patients with aortic stenosis has evolved as an acceptable alternative to surgical aortic valve replacement in a subset of patients at excessively high risk from surgery. The structural valve degeneration (SVD) is a known phenomenon in catheter-based valves too, which was hitherto seen with surgical bioprosthetic valves. Echocardiography plays a pivotal role not only in early detection but also in the management of SVD of Transcatheter valves. The goal of this report is to agglomerate our experience of an unusual case of SVD of a catheter-based valve implanted inside the bioprosthetic aortic and mitral valve apparatus and its management with aortic and mitral valve replacement with mechanical valve prosthesis.

**Keywords:** Aortic stenosis, catheter based heart valves, echocardiography, structural valve degeneration, transcatheter valve implantation

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## INTRODUCTION

Transcatheter valve implantation in patients with aortic stenosis has evolved as an acceptable alternative to surgical aortic valve replacement in a subset of patients at excessively high risk from surgery. The structural valve degeneration (SVD) is a known phenomenon in catheter-based valves too, which was hitherto seen with surgical bioprosthetic valves. Echocardiography plays a pivotal role not only in early detection but also in the management of SVD of Transcatheter valves. The goal of this report is to agglomerate our experience of an unusual case of SVD of a catheter-based valve implanted inside the bioprosthetic aortic and mitral valve apparatus and its management with aortic and mitral valve replacement with mechanical valve prosthesis.

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## CASE REPORT

A 38-year-old female patient presented with progressive exertional dyspnea of NYHA grade III. She had undergone double valve replacement in 2006 with Carpentier-Edwards Perimount Magna valves (Edwards Lifesciences Corp, Irvine, CA, USA) size 21 and 27 mm in the aortic and mitral position, respectively. She developed stenotic degeneration of both bioprosthetic valves and became symptomatic, requiring recurrent ICU admissions during her pregnancy in 2015. Due to her clinical condition warranting the intervention for her bioprosthetic valves, she underwent transapical transcatheter valve-in-valve implantation with Sapien XT valves of 23 and 29 sizes in the aortic and mitral position respectively at 22 weeks of pregnancy [Video 1].[1]



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Four years later, the patient presented to the cardiology clinic with progressive increase in dyspnea and again diagnosed as early structural valve degeneration (SVD) of prosthetic valves.

Her transthoracic echocardiographic assessment revealed moderate mitral stenosis with a mean gradient of 6 mmHg. In addition, the aortic valve (AV) was severely stenotic with a mean gradient of 70 mmHg with moderate transvalvular aortic regurgitation (pressure half time of 420 ms) [Figure 1]. Furthermore, the estimated left ventricular ejection fraction (LVEF) was 54% and a moderate pulmonary hypertension with calculated pulmonary artery systolic pressure (PASP) of 51 mmHg, normal right ventricular dimensions and systolic function. She was initially managed with maximal tolerated anti-heart failure medications but because of her deteriorating clinical condition a re-redo double valve replacement surgery was planned.

Intraoperative transesophageal echocardiography (TEE) showed restricted opening of thickened prosthetic mitral valve (MV) with mean pressure gradient 6 mm Hg across the valve. MV area by three-dimensional (3D) quantification planimetry was 1 $cm^2$ [Figure 2 and Video 2]. Aortic valve leaflets were thickened. The shadowing artifacts from mitral and aortic bioprosthetic valve prosthesis and because of malalignment of Doppler beam across AV, Pressure gradient across AV couldn't be calculated. 3D imaging of the mitral and aortic valve revealed thickened leaflets with restricted motion [Video 3]. The mitral bioprosthetic valve ring with Transcatheter aortic valve inside was appreciated well [Figure 3]. Mild to moderate tricuspid regurgitation (TR) was seen with calculated right ventricular systolic pressure 55 mm Hg. Left ventricular ejection fraction (LVEF) was 45% with septal and inferior wall hypokinesia and preserved right ventricular function. Left atrial appendage showed spontaneous echo contrast but was free from any thrombus. A successful mitral valve replacement with mechanical 29 mm and 19 mm St. Jude valve (St. Jude Medical® Mechanical Heart Valve (SJM; St. Jude Medical Inc.; Minneapolis, Minn) at mitral and aortic position respectively was achieved [Figure 4].

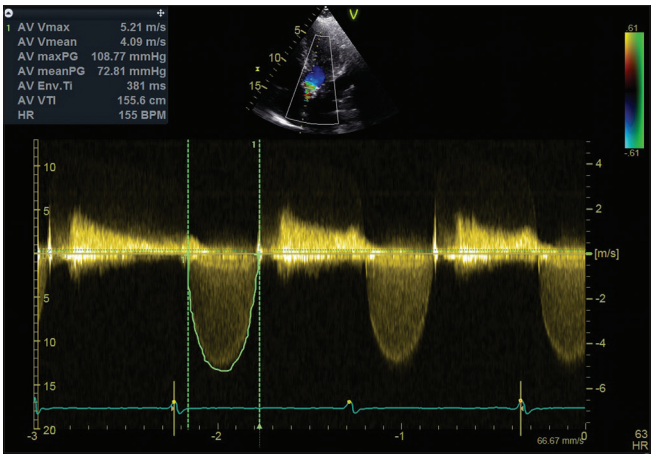


**Figure 1:** Two -dimensional transthoracic echocardiography apical long axis view measuring pressure gradient across the transcatheter aortic valve

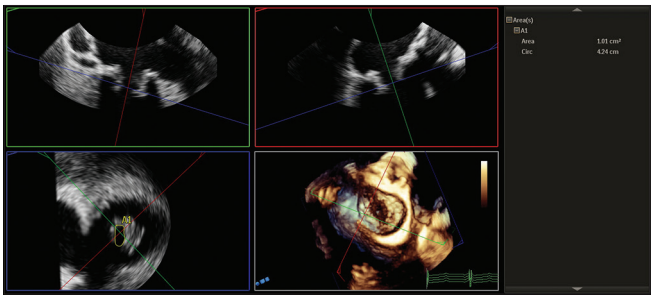

**Figure 2:** Three- dimensional multiplanar reconstruction of catheter based mitral valve to calculate actual mitral valve area

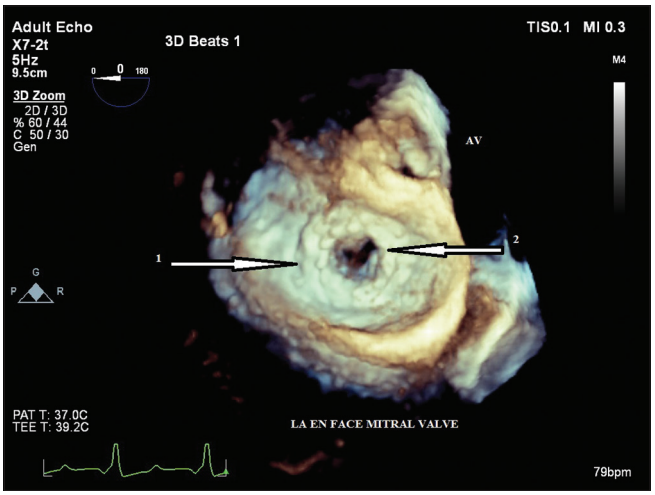


**Figure 3:** Left atrial en face view of three dimensional transesophageal echocardiography showing rings of Bioprosthetic surgical valves and catheter based valves inside them. (1 - Ring of surgical bioprosthetic valve, 2- Ring of catheter based valve)

## DISCUSSION

Tissue valves form a preponderance among cardiac surgical implants and currently used in all transcatheter aortic valve replacement (TAVR). These bioprosthetic valves offer advantages in terms of lower thrombogenicity and freedom from long-term anticoagulation. However, these are prone to structural valve degeneration (SVD), resulting in limited long-term durability.

SVD usually manifests as stenotic lesion with leaflet calcification, however regurgitation may develop because of flail or torn leaflets. Factors influencing SVD include type of bioprosthesis (porcine vs. pericardial), area of implantation (aortic vs mitral) and patient related factors

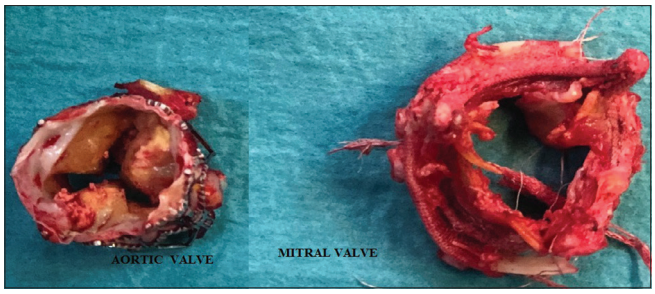


**Figure 4:** Surgically resected Mitral and Aortic Prosthesis with catheter based valves inside

such as young age, renal failure, patient-prosthesis mismatch, body surface area, smoking and abnormal calcium metabolism.[1,2] It is now evident that SVD is more common in younger patients and at mitral position.[3]

TAVR has gained ground as an acceptable alternative to the surgically implantable valve in patients with severe aortic stenosis, who are at high risk for surgical aortic valve replacement (SAVR). Our patient had opted for a trans-catheter double valve replacement for the management of bioprosthetic valve becauseof precious pregnancy and to avoid potential chances of fetal loss in open heart surgery.[4] During this surgery the decision to replace the valves with mechanical valves was adjudicated by her clinical condition and the young age.

Echocardiography plays an epochal role in many aspects for this subset of patients. As per current recommendations, transthoracic echocardiography (TTE) is the primary modality used for follow-up of the SAVR and TAVR valves. Periodic TTE at 12 months and then annually is advised for the assessment of functional and degenerative changes of TAVR valves. High clinical suspicion of SVD can be easily screened with TTE and might be very useful, as was in this patient. Bioprosthetic valve thrombosis and SVD is common in transcatheter valves as seen in bioprosthetic valves. The risk of leaflet thickening is higher with TAVR valves than SAVR valves which may upsurge the risk of SVD with TAVR valves.[2] The SVD course of TAVR valves after being implanted inside bioprosthesis, as done in valve in valve (ViV) is still unclear.

Evaluation of bioprosthetic valve degeneration is dependent on comparison of baseline hemodynamic parameters of the specific valve in that specific patient after implantation to the current state.[2] Transesophageal echocardiography (TEE) is quintessential in the management of patients with SVD. When TTE is not optimal, TEE is a reliable alternative for imaging. In clinical conditions with high suspicion of SVD of TAVR valves, such as, a change in mean gradient >10 mm Hg or clinical events such as stroke, persistent or recurrent heart failure, decreased ejection fraction or new paravalvular leak, 4 dimensional CT (4D CT) scan is advisable but if 4D CT is not feasible then TEE is recommended.[2]

TEE can be advantageous over 4D CT in the diagnosis of SVD, as it offers simultaneous assessment of morphology and hemodynamicity of TAVR valves unlike 4D CT, which will yield information about morphology of the valves only. TEE can be more precise compared to TTE in the assessment of TMVR valves because of proximity of TEE probe with mitral valve apparatus.

As a current standard of practice, to avoid the complication of coronary artery obstruction during trans-catheter procedure, evaluation of the coronary artery location and the accurate measurement of aortic annulus by cardiac computed tomography (CT) is mandatory. 3D TEE may provide a promising alternative to CT for precise measurement of aortic annulus.[5] The aortic annulus-left main coronary ostia distance and left coronary cusp length measurements are comparable to CT by 3D multiplanar reconstruction.[6]

These patients with SVD of transcatheter valves can undergo either valve in valve Transcatheter procedure (ViV) or surgical valve replacement. Intraprocedural or intraoperative TEE is potentially critical in identifying the cause of hemodynamic instability in the hybrid procedural suit or operating room.

Intraprocedural TEE is very useful in assessing post ViV TAVR leaks, mainly paravalvular aortic regurgitation (AR) can be effectively assessed with 3D with color flow Doppler and multiplanar reconstruction to locate exact origin and the severity of paravalvular leak. This might be crucial and may be warranting further procedures to reduce it.[5,6] TEE reduces contrast media use during the procedures which can be potentially beneficial in patients with preexisting renal dysfunction.[5] Intraprocedural TEE plays a pivotal role in immediate assessment of emergency situations such as aortic dissection, cardiac tamponade, and severe LV dysfunction because of coronary occlusion.[6] Patient prosthesis mismatch, high residual transvalvular gradients and valve thrombosis, malposition associated with ViV TAVR can be addressed early with TEE.[7,8]

As useful in our patient, intraoperative TEE during surgical management of SVD valves will assist, in ruling out undiagnosed pathologies before SVR and post-SVR immediate assessment of prosthetic valve leaflets motion, pressure gradient across the valve, para or perivalvular leaks.

TAVR valves can cause drop out artifacts as it was noticed in our patient; which might create challenges in the assessment of pressure gradient across the degenerative aortic valve and paravalvular leak. 2D along with 3D echocardiography and preoperative TTE along with intraoperative TEE can help clinicians to reach the precise diagnosis and patient management.

## CONCLUSION

Structural deterioration of transcatheter heart valves, especially when implanted within a previously degenerated bioprosthesis is an emerging clinical entity and the heart team should be prepared to deal with these complications in the future. This case demonstrates that structural valve degeneration of catheter based valves is expected early in young patients than the elderly population. Echocardiography plays an important role in early diagnosis and management of SVD. TEE can be instrumental when TTE is suboptimal. Perioperative TEE is not only useful in the confirmation of diagnosis but also in the assessment of SVD, biventricular function, intracardiac masses, shunts or thrombi, valvular or paravalvular leaks before and after the catheter based intervention or surgery. This manuscript aims to highlight the challenges associated with diagnosis and the decisive role of comprehensive echocardiography imaging during the arduous management of SVD in catheter based implantable valves.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initial s will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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