Transcatheter mitral valve-in-valve explant: Lessons learned

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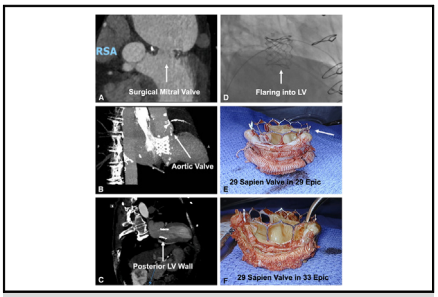


Mitral valve-in-valve CT images and explanted valves in an en bloc technique.

CENTRAL MESSAGE

Transcatheter mitral valve-in-valve explant is feasible and best performed in an en bloc manner with both valves removed at the same time.

Video clip is available online.

Transcatheter mitral valve replacement (TMVR) in degenerated surgical valves (MViV) was approved by the Food and Drug Administration for high-risk patients in 2017.[1] According to Mack and colleagues,[2] 3597 patients were treated with TMVR between 2014 and 2020. In 2019 alone, 1120 patients underwent TMVR with 78% of those as MViV. Based on a thorough search of the literature, only 1 report of valve-in-valve explant has been published.[3] We describe our technique and lessons learned from 3 MViV explants. This report was approved by our institutional review board with a waiver of consent (#2023123 37; December 14, 2023).

CASE 1

A 66-year-old male patient with Von Willebrand disease status post bioprosthetic mitral valve replacement with a 29 Epic valve (Abbott Cardiovascular Inc) presented with shortness of breath due to structural valve deterioration (Table 1). After heart team discussion, the patient underwent transcatheter MViV replacement with 26 mm Sapien 3 valve (Edwards Lifesciences) +2 mL inflation volume. A 26-mm valve was chosen due to concern for a left ventricular outflow tract (LVOT) obstruction with the use of a larger valve.

However, he continued to have symptoms with elevated gradients. After further investigation, a patient–prosthesis mismatch (PPM) was suspected, and a surgical referral was made for surgical valve replacement.

During surgery, we noted that the transcatheter valve was extremely difficult to mobilize from inside of the surgical valve. Once the surgical valve cuff was released, the transcatheter frame was found embedded into the myocardium. The frame was shaved off and both valves explanted en bloc.

CASE 2

A 74-year-old male patient after mitral valve replacement with a 29-mm Epic valve and coronary artery bypass grafting presented with shortness of breath and structural valve deterioration (Table 1). After heart team discussion, the patient underwent MViV with a 29-mm Sapien 3 + 2 mL above standard inflation volume. His 1-year echocardiogram showed a gradient of 10 mm Hg with recurrent symptoms. A thrombus on the valve was ruled out by computed tomography and a surgical referral was made. PPM was suspected and a valve explant was recommended.

Removal of the MViV with the same en bloc technique as in the previous case was performed. The frame was flared

TABLE 1. Time line and characteristics of each patient course

Patient characteristics	Case 1	Case 2	Case 3
Age at first surgery	56	66	60
First surgical valve	29 Epic*	29 Epic*	33 Epic*
Associated procedure	None	CABG × 2	None
Mode of surgical valve failure	Severe regurgitation	Severe stenosis	Severe regurgitation
Mean surgical valve gradient (mm Hg)	5	2	3
Time to MViV therapy (y)	10	8	11
Heart team decision re: TMVR vs SMVR	Von Willebrand disease; redo sternotomy TMVR was advised	Redo sternotomy, patent grafts, advanced age (74 y); CKD TMVR was advised	Acute regurgitation, pulmonary edema, decompensation heart failure; redo sternotomy advanced age (71 y); TMVR was advised
Transcatheter valve	26 Sapien† + 2 mL	29 Sapien† + 2 mL	29 Sapien†
Neo-LVOT area projected (mm^2)	201	588	430
LVOT gradient post implant (mm Hg)	4	9	12
Mitral valve gradient (mm Hg)	10-12	8	5
Time	At 30 d postoperative	At 30 d postoperative	At 30 d postoperative
BSA (m^2)	2.21	2.06	1.83
Decision to explant	Symptomatic gradient at rest 10 mm Hg Dobutamine echocardiogram at 20 μg/kg/min mitral gradient 15 mm Hg and LVOT gradient 14 mm Hg	At 1 y, gradient increased to 10 mm Hg CTA with no valve thrombus return of symptoms, a-fib and multiple CHF admissions	Endocarditis with recurrent bacteremia on antibiotic therapy
Time to mitral valve-in-valve explant (y)	1	2	2.5
Reason for explant	PPM	PPM	Endocarditis
Second surgical valve	ON-X‡ mechanical 27/29 valve	33 Epic Plus*	33 Epic Plus*
Postoperative gradient (mm Hg)	5	4	4
Postoperative complications	None	Acute kidney injury with return to normal	None
Last follow-up since explant	3 y	3 mo	3 mo

CABG, Coronary artery bypass grafting; *MViV*, mitral valve-in-valve; *TMVR*, transcatheter mitral valve replacement; *SMVR*, surgical mitral valve replacement; *CKD*, chronic kidney disease; *LVOT*, left ventricular outflow tract; *BSA*, body surface area; *CTA*, computed tomography angiography; *a-fib*, atrial fibrillation; *CHF*, congestive heart failure; *PPM*, patient–prosthesis mismatch. *Abbott. †Edwards. ‡Artivion.

significantly out of the surgical valve such that separate removal of either valve alone was not possible (Figure 1, *E*).

CASE 3

A 71-year-old male patient status post mitral valve replacement presented with acute severe regurgitation and pulmonary edema from structural valve degeneration (Table 1). The patient underwent surgery with a 29-mm Sapien 3 valve with nominal inflation volume inside a 33-mm Epic valve urgently. Two years later, the patient developed recurrent bacterial endocarditis and surgical explant was indicated. The valves were removed in the same en bloc technique as in the previous 2 cases (Video 1). The transcatheter valve was slightly flaring outside of the surgical valve (Figure 1, *F*).

DISCUSSION

Transcatheter MViV procedures are being performed more frequently with equivalent 1-year mortality as redo mitral valve replacement.[1] This will lead to more implants and the need for explant once complications happen. We discuss above 3 cases of explanted MViV. Two cases likely due to PPM and the third case due to persistent bacterial endocarditis. In the first case, the patient had a body surface area of 2.21 and a 26 Sapien valve inside a 29 Epic valve. PPM was confirmed with a dobutamine stress echocardiogram. In the

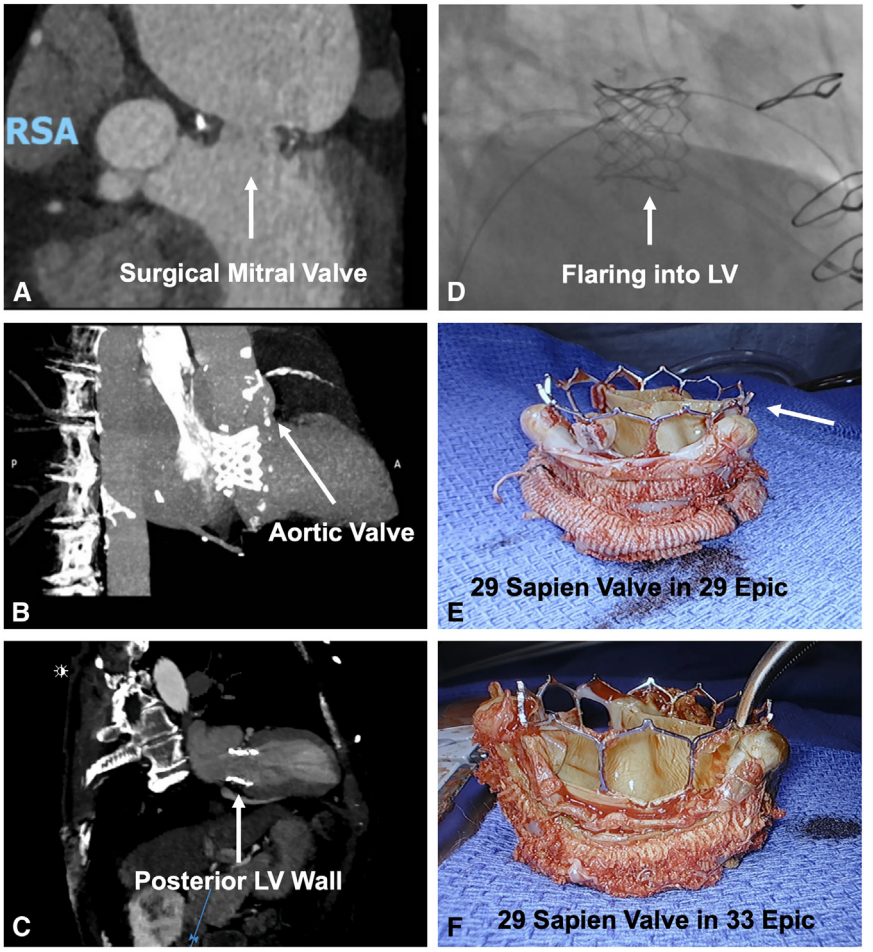
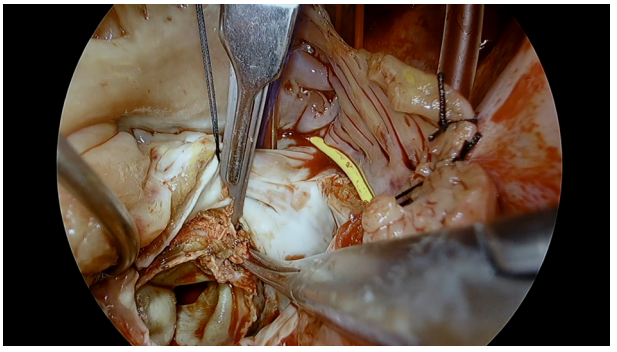


FIGURE 1. A, Computed tomography scan with surgical mitral prostheses in place. B and C, Transcatheter valve with proximity to the aortic valve and posterior left ventricle wall. D, Implant of a 29 Sapien valve (Artivion) in a 29 Epic valve (Abbott) with flaring into the left ventricular cavity (*arrow*) outside the surgical frame. E, A 29 Sapien valve inside a 29 Epic valve + 2 mL inflation volume; *arrows* show the flaring outside the surgical frame. F, A 29 Sapien valve inside a 33 Epic valve with normal inflation; minimal flaring is noted compared with E.

second case, a 29 Sapien valve inside a 29 Epic valve had high gradients leading to readmission with congestive heart failure. Valve thrombosis was ruled out because the valve gradients initially were lower (Table 1). Our third patient developed MViV endocarditis with recurrent bacteremia despite antibiotic therapy, and the decision was made to explant the valve.



VIDEO 1. Case 3 explant of 29 Sapien valve (Edwards) with normal inflation volume in a 33 Epic valve (Abbott). We show the en bloc explant technique of valve removal. Video available at: https://www.jtcvs.org/article/S2666-2507(24)00136-6/fulltext.

When explanting a valve-in-valve, a surgeon has 2 options. First, the transcatheter valve can be removed separately, followed by the surgical valve. A second option is removing both valves simultaneously en bloc. For a transcatheter valve-in-valve in the aortic position, removing the transcatheter valve first allows for better visualization of the surgical valve. The transcatheter frame is easily accessible, and its presence hinders access to the surgical valve. A strategy for transcatheter valve removal separately followed by surgical valve removal is feasible in the aortic position. In the mitral position, the transcatheter frame is not directly seen because it is mostly inside the LV cavity, but the surgical cuff is adequately visualized and accessed. Flaring of the transcatheter mitral valve into the ventricle is inevitable in situations of a larger

transcatheter valve compared with the surgical prostheses. This flaring helps prevent valve migration but makes separate removal of the transcatheter valve challenging. Also, flaring could push the frame into the ventricular wall and surrounding structure, as in our first case and in the case described by Sukioka and colleagues.[3] In their report, the transcatheter mitral valve was attached to the aortic valve leaflets through the LVOT and required shaving off the leaflets and subsequent aortic valve replacement. The inability to visualize the transcatheter valve frame through an atriotomy makes removal of the transcatheter valve separately a blind procedure that could lead to damage to surrounding structures. Releasing the surgical valve cuff first allows for retracting both prostheses into the atrium gradually and releasing areas of contact under direct vision, as shown in Video 1. Alternatively, the frame can be visualized directly through the aortic valve accessed by an aortotomy if needed, as described in the case by Sukioka and colleagues.[3]

In our case series, we found that certain characteristics can predict a more difficult explant, including the larger the size of the transcatheter valve compared with the surgical valve, use of more inflation volume during the TMVR, and a smaller neo-LVOT area. A large transcatheter valve and the use of more inflation volume both lead to valve flaring into the LV cavity as shown in Figure 1, *D* and *E*. A smaller LVOT and LV cavity may lead to the transcatheter valve frame attaching to surrounding structures as described in Case 1.

In the future, more percutaneous mitral valves will be implanted, some with apical attachments and some with larger profiles. Different explant techniques will be required for each system. The focus of percutaneous valve design is related to valve stability, LVOT obstruction, and durability. These are important issues; however, ease of explant should also be considered, especially when this technology is utilized for low-risk patients with longer longevity. Surgeons describing and sharing these techniques is important because use of TMVR will increase.

This is the first case series describing MViV surgical explant. Because this is only a 3-patient series, more data and experience are needed to confirm generalizability of our findings.

CONCLUSIONS

Mitral valve-in-valve explant is technically feasible. We recommend en bloc removal of both valves as the safest method of valve explant.

Conflict of Interest Statement

Dr Horowitz has received grant funding from Edwards LifeSciences, Boston Scientific, Medtronic, and Gore Medical. All other authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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