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MINI-FOCUS ISSUE: TRANSCATHETER INTERVENTIONS

ADVANCED

CASE REPORT: CLINICAL CASE

Valve Cracking Before Valve-In-Valve Transcatheter Aortic Valve Implantation to Treat Severe Paravalvular Leak

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ABSTRACT

A patient with severe bioprosthesic patient-prosthesis mismatch, severe paravalvular leak, and symptoms of heart failure New York Heart Association functional class III was successfully treated using valve cracking followed by valve-in-valve transcatheter aortic valve implantation with excellent results at 1-year follow-up. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2021;3:875–81) © 2021 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

An 83-year-old woman presented to our hospital with atypical chest pain, heart failure New York Heart Association (NYHA) functional class III, and paroxysmal nocturnal dyspnea. On the physical examination the patient had rales heard over both lung bases, edema of the lower limbs, blood pressure was 120/60 mm Hg, and heart rate was 83 beats/min. Holosystolic 3/6 murmurs were heard on aortic and mitral positions. Estimated EUROSCORE II was 21.55%.

MEDICAL HISTORY

The patient had a history of aortic valve replacement with implantation of bioprosthetic valve Mitroflow 21 (Sorin, Italy) 12 years earlier, pacemaker above musculus rectus abdominis, and drug-eluting stent implanted in the left anterior descending artery. She also underwent quadrantectomia due to breast cancer with lymph adenectomy and radiotherapy 10 years ago.

LEARNING OBJECTIVES

- To consider ViV TAVI after BVF a viable option for treatment of PVL.
- To consider BVF for PPM avoidance.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis includes mitral stenosis, aortic stenosis and/or regurgitation, paravalvular leak, prosthesis failure, and heart failure. Echocardiography is required to make the right diagnosis.

INVESTIGATIONS

Transthoracic echocardiography showed a left ventricle ejection fraction of 42%, mild mitral valve regurgitation, aortic valve gradients were 18/12 mm Hg, and severe paravalvular leak (PVL). Transesophageal echocardiography revealed large valvular dehiscence that spanned approximately 75% of the circumference of the valve ring. The aortic regurgitation caused by the PVL was confirmed as

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ABBREVIATIONS AND ACRONYMS

BVF = bioprosthetic valve fracturing

NYHA = New York Heart Association

PPM = patient-prosthesis mismatch

PVL = paravalvular leak

RCA = right coronary artery

SHV = surgical heart valve

TAVI = transcatheter aortic valve implantation

TEE = transesophageal echocardiography

THV = transcatheter heart valve

TTE = transthoracic echocardiography

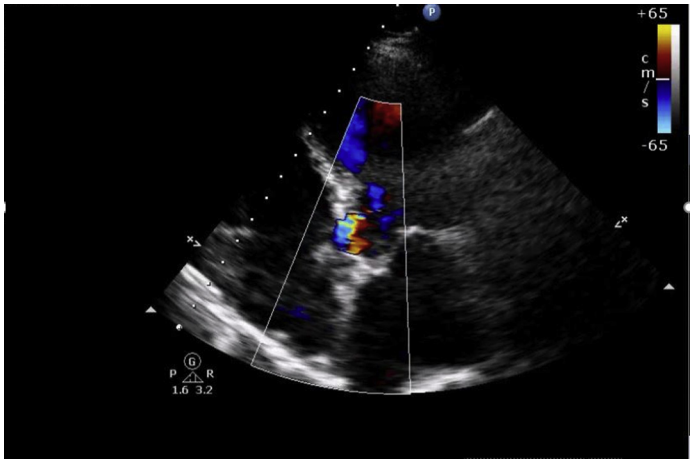
ViV = valve-in-valve

severe with deceleration time of 153 ms, and dense continuous wave Doppler signal (**Figures 1 and 2**, Video 1). Laboratory results showed elevated serum creatinine level of 264 μmol/l and elevated blood urea level of 21.3 mmol/l. Computed tomography demonstrated low ostium of the right coronary artery (RCA) and confirmed the huge PVL (**Figure 3**). Sinus of Valsalva width and height were 33 mm and 12 mm, respectively, diameter of the aorta at the level of the sinotubular junction was 30 mm, and virtual valve to coronary distance was 5 mm. Pretranscatheter aortic valve implantation (TAVI) cardiac catheterization and angiography showed no significant stenosis and severe PVL (**Figure 4**, Video 2).

MANAGEMENT

Bioprosthetic valve fracturing (BVF) followed by implantation of transcatheter heart valve (THV) was performed. First, under conscious sedation and local anesthesia, the RCA was secured and a temporary pacemaker was placed. Then, under rapid pacing (180 beats/min) a semi-compliant Z-Med II 22/40 mm (NuMed, Inc., Hopkinton, New York) balloon was inflated to 12 atm in the aortic valve and a loud distinctive popping sound was heard followed by balloon pressure decrease and disappearance of the waist of the balloon (**Figures 5 and 6**, Video 3). Evolut R 26 (Medtronic, Dublin, Ireland) was placed intentionally slightly deeper than the ideal position to secure the patency of the RCA ostium and to seal the paravalvular leak. After implantation there was only a slight residual aortic regurgitation (**Figures 7, 8, and 9**, Video 4). Echocardiography immediately after the procedure showed diminished regurgitation and preserved mitral valve function without conflict between the THV and the anterior mitral leaflet (**Figures 10 and 11**, Video 5). In the following days, the patient's symptoms subsided considerably, reclassifying her from NYHA functional class III to NYHA I with improvement in her kidney function too. Urea and creatinine levels reduced more than twice in the next 10 days.

FIGURE 1 Transthoracic Echocardiography at Initial Presentation



Transthoracic echocardiography showing aortic paravalvular leak.

DISCUSSION

A study involving 45 consecutive patients with failed Mitraflow valves and valve-in-valve (ViV) TAVI with CoreValve (Medtronic) and Evolut R valves showed favorable early outcomes with TAVI for degenerated Mitraflow bioprosthesis. This procedure provided an important gateway to avoiding high-risk redo surgery and is now a potential option for degenerated surgically implanted aortic Mitraflow valves (1) A study, involving 3,940 patients comparing balloon-expandable valves and self-expandable valves in ViV procedures, showed larger post-procedural effective orifice area with self-expandable valves, but also higher post-procedural pacemaker implantation necessity (2). Our patient already had a pacemaker implanted so we decided to use an Evolut R valve.

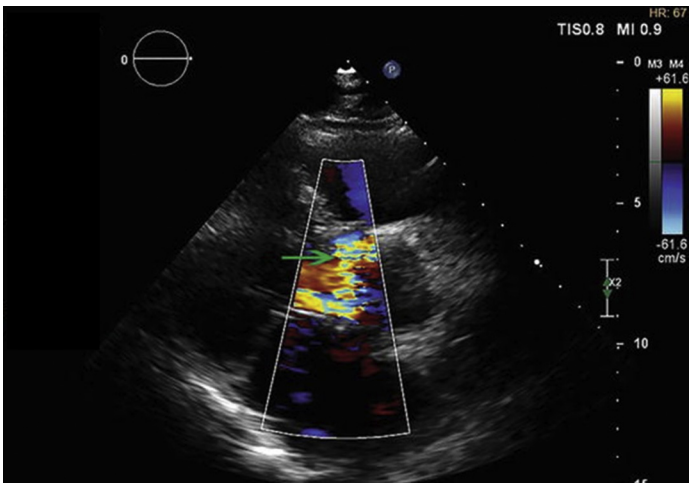
Percutaneous occluder was discussed by the Heart Team but the anatomic findings were considered a contraindication because of the large circumference of the leakage (75%). The common opinion is that paravalvular leak is a contraindication for ViV TAVI. After meticulous research of the literature, only 2 similar cases of paravalvular leak treated with ViV TAVI were found, one by Loyalka et al. (3) and the other by Alvarez-Covarrubias et al. (4). After the Heart Team discussion, we decided that optimal results would be achieved using a similar method, BVF followed by TAVI. In our case, the procedure has a few specific and crucial details: determination of the true inner diameter of the surgical heart valve (SHV), the positions of the coronary ostia, the presumable effective orifice area after the implantation, and the so-called "Russian doll effect".

Establishing the true inner diameter of the SHV is crucial because it often is different from the label size of the valve, and, therefore, it is the most important measurement for ViV sizing (5–7). In our case, the true

inner diameter was 17.0 mm. The size of the balloon required to fracture the SHV had to be at least equal to the label size (7). Considering the results of a few previous studies involving the Mitroflow 21, we expected that, after cracking the valve ring, the diameter would expand to >20 mm, which would allow the implantation of a bigger valve, preventing patient-prosthesis mismatch (PPM) and providing better isolation of the PVL (8,9). In this case, the BVF was mandatory even from a formal point of view, because size 21 Mitroflow is considered as contraindication for the ViV procedure. The main concern of BVF is the eventual risk of annular injury and rupture, which has been described but not reported (10). We considered the risk of native annulus rupture to be low because of the undersized balloon diameter in relation to the native annulus size and the protective role of the biological valve ring itself.

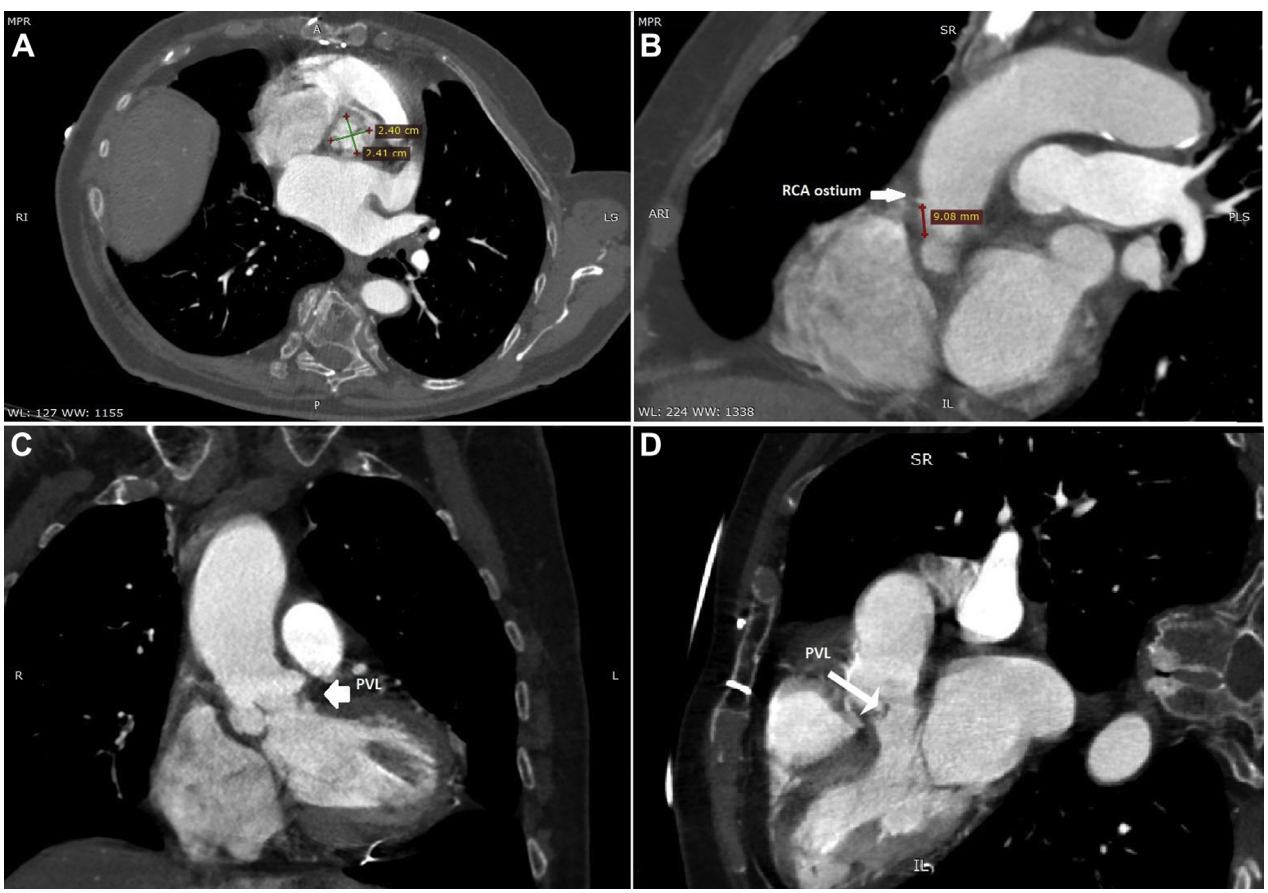
Regarding the RCA ostium protection, we considered BASILICA (bioprosthetic or native aortic scallop

FIGURE 2 Transesophageal Echocardiography at Initial Presentation



Transesophageal echocardiography showing paravalvular leak.

FIGURE 3 Computed Tomography



(A) Aortic annulus size; **(B)** low right coronary artery (RCA) ostium; **(C and D)** paravalvular leak (PVL).

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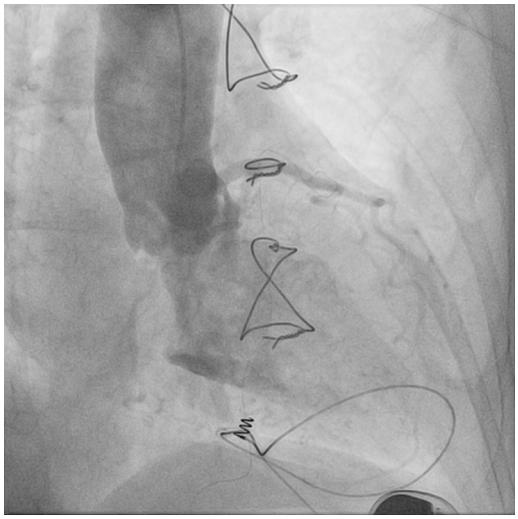
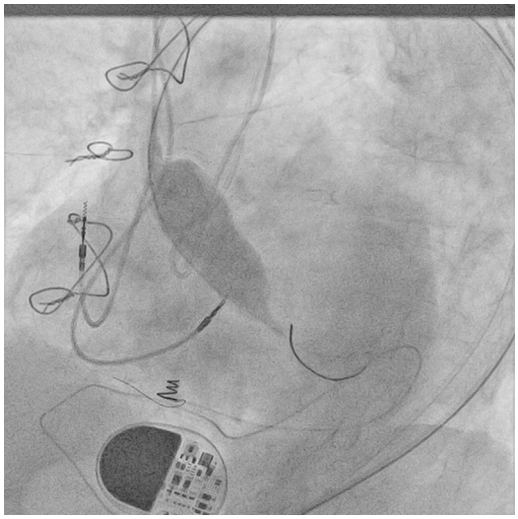
FIGURE 4 Pre-Procedure Aortography



Aortography showing severe aortic regurgitation

FIGURE 6 Balloon Valve Cracking

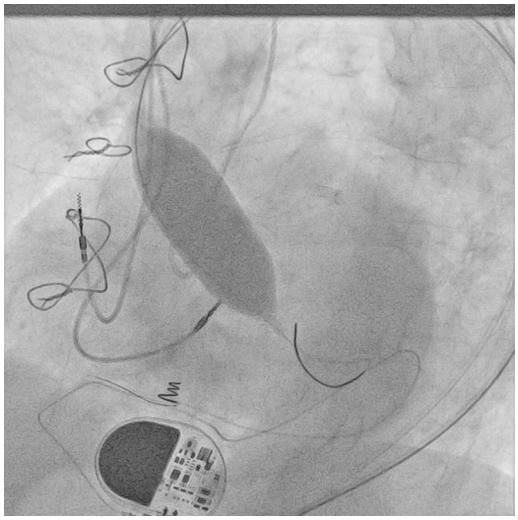


The waste of the balloon disappears after successful valve cracking.

intentional laceration to prevent iatrogenic coronary artery obstruction) or Chimney techniques before the implantation due to the wide-enough sinuses of Valsalva and the planned subannular THV implantation we deemed protective guiding catheter and guidewire in RCA as sufficient.

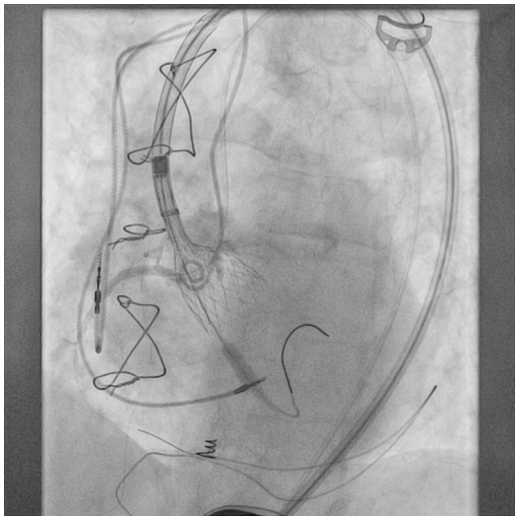
By cracking the SHV we ensured that we can implant the new prosthesis in a subannular position, while both leaving the RCA patent and achieving subannular sealing. It is a feasible strategy for treating paravalvular leak. The deployment of the THV

FIGURE 5 Balloon Valve Cracking



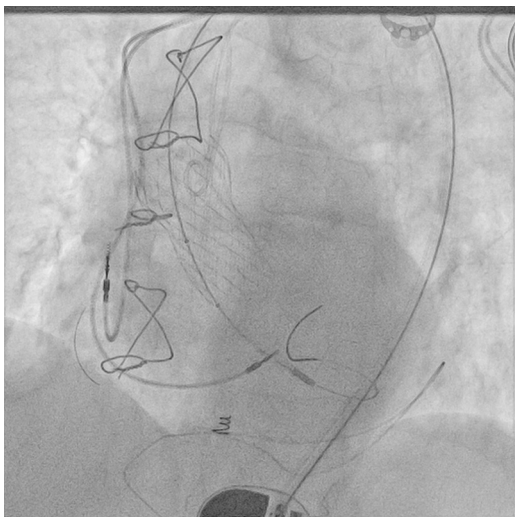
The waist of the balloon is still visible just before the cracking of the valve.

FIGURE 7 Transcatheter Heart Valve Positioning



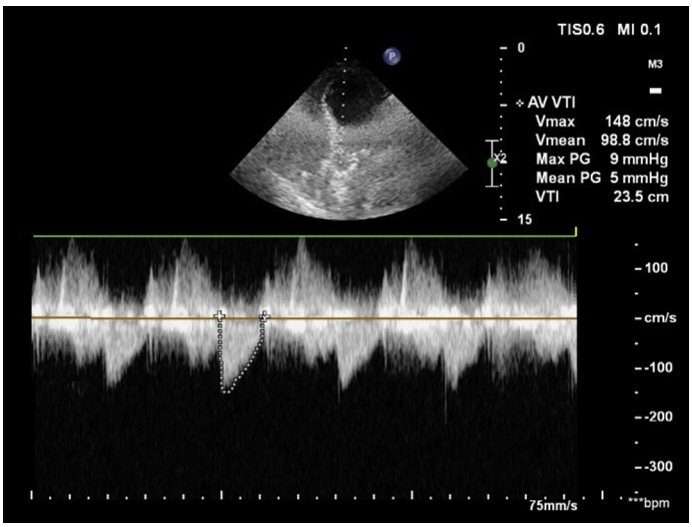
Right coronary artery injection confirming its patency.

FIGURE 8 Fully Expanded Transcatheter Heart Valve



Transcatheter heart valve expanded slightly under the aortic annulus.

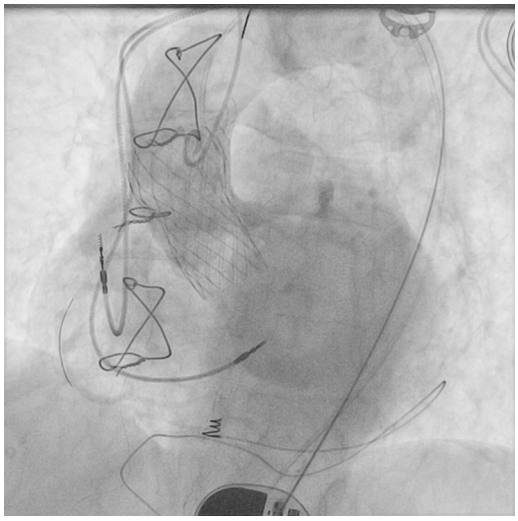
FIGURE 10 Aortic Gradients



Aortic gradients are reduced immediately after the procedure.

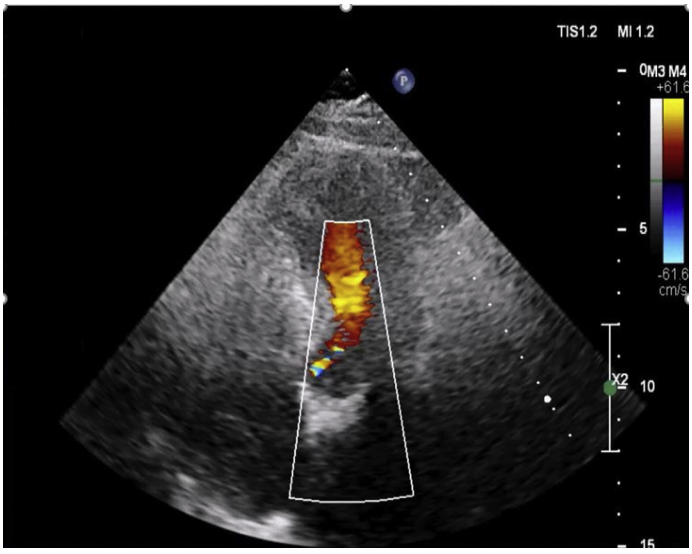
lower than recommended allows the inferior edge of the THV to flare radially outward into the left ventricle outflow tract, thereby sealing the PVL at its flow exit point even if the anatomic defect was present at the level of the annular suture line. Second, by cracking the surgical ring, the superior part of the transcatheter valve can be expanded completely and the radially expansile forces obliterate the anatomic space of the PVL (3). However, the subannular implantation requires caution not to interfere

FIGURE 9 Post-Procedural Aortography



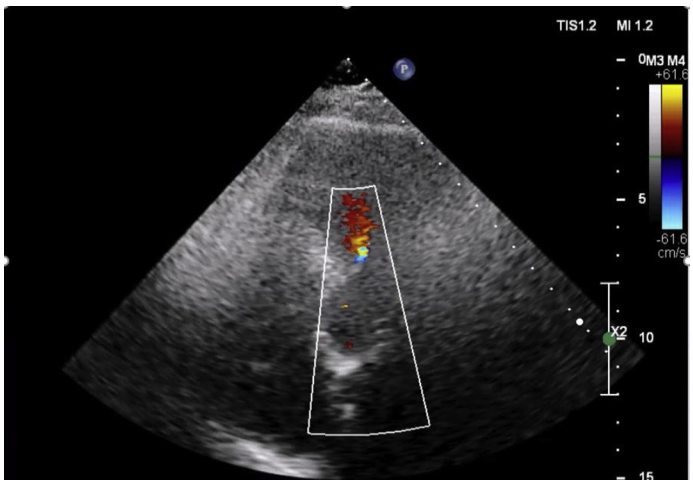
Proper transcatheter heart valve positioning, right coronary artery patency, and paravalvular leak reduction are confirmed.

FIGURE 11 Transthoracic Echocardiography Immediately After Procedure



Reduced paravalvular leak is seen immediately after the procedure.

FIGURE 12 Transthoracic Echocardiography 1 Month After Procedure



Only trivial paravalvular leak is seen.

with the mitral valve function (anterior leaflet movement and mitral valve area).

Another interesting topic for discussion is whether to perform the BVF before the TAVI or after it. Performing it before provides a real possibility to implant a proper-size THV without causing PPM and lowers risk of valve displacement during implantation. Balloon fracturing after ViV implantation has the risks of damaging the leaflets, embolization, or acute hemodynamic decompensation (10). In our case, BVF after TAVI also carried the risk of eventual THV pop-up, which could have been fatal because of the low RCA origin and, therefore, we performed BVF before valve implantation. Moreover, this allowed us to implant Evolut R 26 instead of Evolut R 23 with optimal result.

Azadani et al. (11) published a study showing superior transvalvular gradient is expected with the 26-mm Evolut R rather than the 23-mm Evolut R in ViV procedures with Hancock II (Medtronic) with a true internal diameter >17.5 mm regardless of the implantation depth. Considering the similar true inner diameter of Hancock 25 and cracked Mitraflow 21, we expected similar results. Finally, using this technique of implanting well-matched THV in a slightly subannular position, we balanced the high risk of coronary obstruction and benefits of PVL sealing (11).

FOLLOW-UP

At the 1-month follow-up, the aortic regurgitation had reduced even more (**Figure 12**, Video 6) At the 1-year follow-up, the patient had neither symptoms nor clinical events.

CONCLUSIONS

Cracking a prosthetic aortic valve cracking followed by a ViV transcatheter valve implantation is a rather new procedure that requires further investigation but shows promising results in a selected group of patients with high operative risk requiring treatment because of failed bioprosthesis and/or paravalvular leaks. With this case we demonstrated that with valve cracking a properly sized ViV TAVI can be performed, avoiding the "Russian doll" effect and efficiently sealing the paravalvular leak. It is a safe and effective intervention when performed by experienced operators in high-volume centers. Pre-procedure preparation and careful THV size selection are crucial to achieve favorable results.

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KEY WORDS balloon valve fracturing, paravalvular leak, transcatheter aortic valve implantation, valve cracking, valve-in valve

APPENDIX For supplemental videos, please see the online version of this paper.