Leaflet disruption of ViV-TAVI after bioprosthetic valve fracture leading to severe aortic regurgitation: a case report

Edouard Ballout 1*, Nicolas Combaret 2, Clément Riocreux 2, and Géraud Souteyrand 2

1Puy de Dome, Centre Hospitalier Universitaire de Clermont-Ferrand, 58 rue Montalembert, Clermont-Ferrand 63000, France; and 2Cardiology, Clermont-Ferrand University Hospital, 58 rue Montalembert, Clermont-Ferrand 63000, France

Received 24 January 2022; first decision 7 March 2022; accepted 22 July 2022; online publish-ahead-of-print 3 August 2022

Background
Valve-in-valve (ViV) transcatheter aortic valve implantation (TAVI) has emerged as an alternative for the treatment of degenerated bioprosthetic valves (BPVs) for high surgical risk patients. However, this procedure often results in patient-prosthesis mismatch. BPV fracture is a novel technique to address this problem. From now, complications following BPV fracture are few.

Case summary
We present the case of a 84-year-old female with history of first surgical aortic BPV replacement with a Mitroflow Sorin 23 mm due to severe aortic stenosis in 2009. In 2017, a second intervention due to bioprosthetic aortic valve stenosis valve was performed with valve-in-valve TAVI with CoreValve Evolut R 23 mm. In 2021, she was admitted with severe heart failure due to TAVI degeneration with severe stenosis in the bioprothesis. After heart team discussions, the patient was deemed inoperable for new heart surgery and considered as a candidate for BPV fracture as last possible alternative. After BPV fracture was performed, the patient suffered acute hypotension. Urgent transoesophageal echocardiography and angiogram demonstrated severe acute intra-TAVI aortic insufficiency because of probable disruption of the CoreValve leaflets. The patient was successfully treated with a ViV 23 mm SAPIEN three Edwards valve with a resolution of the aortic insufficiency and improvement of her haemodynamics. The patient remains asymptomatic after 6 months, with improvement in clinical status.

Discussion
This case demonstrates a disruption of the transcatheter heart valve leaflets causing severe aortic regurgitation as one of the complications of BPV fracture. To our knowledge, this is the first report of a TAVI in a patient who was already operated with ViV-TAVI. Although case series described few complications with improvement in clinical status, the procedure should be established with appropriate planning and careful technique.

Keywords
Transcatheter aortic valve implantation • Bioprosthetic valve fracture • Valve in valve • Bioprosthetic aortic stenosis • Case report

ESC curriculum
2.1 Imaging modalities • 2.2 Echocardiography • 4.10 Prosthetic valves • 7.4 Percutaneous cardiovascular post procedure • 7.1 Haemodynamic instability

* Corresponding author. Tel: 0687678715, Fax: 04 73 75 40 36, Email: ballout.edouard@gmail.com
Handling Editor: Giulio Russo
Peer-reviewers: Claudio Montalto; Andreas Mitsis
Compliance Editor: Sara Monosilio
Supplementary Material Editor: Jonathan Senior
© The Author(s) 2022. Published by Oxford University Press on behalf of the European Society of Cardiology.
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (https://creativecommons.org/licenses/by-nc/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com
Bioprosthetic valve fracture (BVF) is a novel technique to address this problem during ViV interventions. During BVF, a non-compliant valvuloplasty balloon is positioned within the BPV, and a high-pressure balloon inflation is performed to fracture the surgical ring of the BPV. This allows implantation of larger TAVI prosthesis with better haemodynamic performance.\(^1\)\(^,\)\(^2\)

In the clinical series published to date, complications following BVF were few.\(^1\)\(^,\)\(^3\) Damage to the prosthetic leaflets causing severe aortic insufficiency have been reported as one of the complications.\(^2\) These complications are rare but can drastically change the patient’s haemodynamics.

Here, we report a case of a severe aortic insufficiency following BVF in a patient who was already operated with ViV-TAVI.

### Learning points

- Bioprosthetic valve fracture (BVF) together with valve-in-valve transcatheter aortic valve implantation is an emerging technique for treatment of failure of surgical aortic bioprostheses.
- Disruption of transcatheter heart valve leaflet causing aortic regurgitation is a rare complication of BVF but could change the patient’s haemodynamic.
- So far, this procedure requires appropriate planning and careful technique.

### Case presentation

In August 2021, an 84-year-old female was admitted in our hospital due to progressive worsening of heart failure symptoms.

This patient had a surgical aortic valve replacement (SAVR) in 2009, using a bioprosthesis Mitrolow Sorin 23 mm. At that time, she was 73 years old. Due to moderate frailty with a 1.76% Society of Thoracic Surgeons (STS) score and a 2.85% EuroSCORE II, she was assigned for SAVR as first strategy, according to the European Guidelines. The coronary angiography did not show significant lesions, but an abnormal coronary artery connection with the right coronary artery emerging from the antero left sinus. At discharge, ejection fraction (EF) was normal (60%), and post-operative mean gradient was 10 mmHg without aortic regurgitation.

In 2017, a second intervention due to bioprosthetic aortic valve stenosis was performed. She presented with Class III dyspnoea and a mean transvalvular gradient of 58 mmHg with minimal aortic regurgitation. Her surgical risk was considered prohibitive and after discussion in heart team, and ViV-TAVI was recommended. ViV-TAVI was performed with a Medtronic CoreValve Evolut R 23 mm by subclavian access. To insure a sterile procedure, subclavian access was chosen first because of skin infection in the inguinal region. A CoreValve self expanding was chosen first due to her supra-annular position which may result in a larger effective orifice area (EOA) and then minimize the potential PPM post implantation, whereas the position of the Edwards is more annular.

The immediate post-procedural mean transvalvular gradient was measured at 34 mmHg with a surface of 1.2 cm\(^2\) and a calculated valve EOA of 0.75 cm\(^2\)/m\(^2\), with a minimal aortic regurgitation and a preserved EF (60%). This value of valve EOA already made us fear a moderate PPM. Despite a simple post dilatation (18 mm), the mean transvalvular gradient remained the same, which we could only tolerate. During the hospitalization, she was implanted by a double chamber pacemaker because of an alternating bundle branch block.

In 2021, after admission, her blood pressure was 100/60 mmHg with a heart rate of 90 b.p.m. She had dyspnoea at rest. Physical examination revealed loud systolic ejection murmur radiating to the neck, diminished breath sounds in lower pulmonary fields on both sides, and bilateral leg oedema.

Echocardiography was performed and revealed TAVI degeneration with severe stenosis (maximum velocity 4.57 m/s, mean gradient 50 mmHg; Supplementary material online, Figure S1) and moderate regurgitation. Additionally, minimal primary mitral regurgitation, moderate secondary tricuspid regurgitation, and estimated systolic pulmonary artery pressure 58 mmHg were present. Left ventricle was dilated with degradation of EF (30%) and the right ventricle was slightly dilated with reduced systolic function (tricuspid annular plane systolic excursion [TAPSE] 15 mm, S’ 7 cm/s). There was no evolution on the coronary angiography.

Cardiac computed tomography ruled out the presence of a thrombus and found an important underexpansion of the CoreValve (Figure 1). Despite intravenous diuretics 125 mg/24 h during 1 week, her haemodynamic remained unstable.

The STS predicted risk of mortality was 8.7%, and after heart team discussions, the patient was deemed inoperable for new heart surgery because of old age, and considered as a candidate for BPV fracture as last possible alternative.
We proceeded using right femoral approach under local anaesthesia. Through 9F sheath, BVF was performed with a True Dilatation balloon (Bard Medical 22 mm) under rapid pacing (Figure 2). With BVF, the operator ‘cracks’ the ring of the surgical bioprosthesis by means of non-compliant transcatheter balloons. The fracture was felt by the operator as a sudden drop in the balloon pressure, a visible release of the balloon (Supplementary material online, Video S1) and an audible ‘click’.

Following BVF, the patient immediately suffered acute hypotension. Aortography and haemodynamic indicated severe aortic regurgitation. Urgent transoesophageal echocardiography demonstrated severe acute intra-prosthesis aortic insufficiency because of probable disruption of the one of the CoreValve leaflets (Figure 3).

The patient was quickly treated with a TAVI in TAVI 23 mm SAPIEN 3 Edwards valve with a resolution of the aortic insufficiency which allowed a dramatic improvement of her haemodynamics (Figure 4). Our major concern was the risk of coronary artery obstruction. We wanted to avoid an overlap of the two CoreValves, that is why we prefer implantation of Edwards, which confers also a better radial force.

At that time, echocardiography showed a mean transvalvular gradient at 33 mmHg without any aortic regurgitation (Supplementary material online, Figure S1).

The post-procedural stay was marked by a femoral pseudoaneurysm with favourable evolution after local compression.

She was discharged 13 days later in a stable condition.

Six months after procedure, the patient was asymptomatic and in NYHA functional Class 1. The echocardiography demonstrated an improvement of EF (53%), a mean transvalvular gradient stable at 31 mmHg without any aortic regurgitation, with a preserved right ventricular function (TAPSE 21 mm) and estimated systolic pulmonary artery pressure 28 mmHg.

A cardiac computed tomography at 6 months showed a good result of the implantation of the TAVI 23 mm SAPIEN 3 Edwards in TAVI without sign of thrombosis (Figure 5).

**Discussion**

In the present article, we present a case of disruption of the transcatheter heart valve (THV) leaflets causing severe aortic regurgitation as one of the complication of BVF performed at distance of the implantation. To our knowledge, this is the first report of a TAVI in TAVI in a patient who was already operated with ViV-TAVI. Furthermore, this case highlights the supply of periprocedural imaging, as the detail images acquired with transoesophageal echocardiography enabled the prompt identification of the destabilization of haemodynamic.

According to the bench testing, it is now established that all bioprostheses without metal frame and some with metal frame are feasible for BVF.\(^4\,^8\)

To date, the largest case series\(^4\) who reported the procedural and haemodynamic results of patients treated with ViV-TAVI and BVF demonstrated only few complications.

The main periprocedural concerns of ViV-TAVI remain valve malpositioning, coronary artery obstruction, and high remaining transvalvular gradients. The BVF exposes the patient to the risks of ViV-TAVI itself; however, some of which may be increased by the BVF procedure such as annular rupture procedure, iatrogenic VSD, high-degree AV block,
and structural damage to the frame or leaflets if performed after valve implantation, as in our case.

From now, we reported only one similar case of severe aortic insufficiency following a BVF performed after implantation of a ViV-TAVI 26 mm Medtronic CoreValve Evolut R. This complication was successfully treated with a second 26 mm CoreValve Evolut R.7

The procedure should be established with appropriate planning and careful technique, since the clinical experience with BVF is being early.

In our case, we performed 2 years later with caution the BVF with a 22 mm Bard Medical but our position may have been not optimal.

By knowing the haemodynamic benefit of BVF, we should have considered the BVF earlier and immediately after the second intervention, considering the possible PPM and high residual transvalvular gradients (34 mmHg) and the underexpansion of the CoreValve into the bioprosthesis Mitroflow showed by the cardiac computed tomography.

We did not perform a BVF in 2017 because of the poor literature at that time and the lack of evidence about the safety of the procedure.

However, whether BVF is optimally performed before or after implantation of the TAVI prosthesis remains unknown. Some operators choose to avoid this potential complication by performing BVF prior to THV implantation; this approach exposes the degenerated BSV to a high-pressure balloon inflation which may also result in leaflet disruption, acute aortic insufficiency, and haemodynamic instability.

Based on our experience, we recommend that operators exercise caution with careful positioning when sizing valvuloplasty balloons at the upper limits of anatomical constraints, especially if high-pressure inflations are planned.
Conclusion

We presented a case of a disruption of the THV leaflets causing severe aortic regurgitation as one of the complications of BVF performed at distance of the implantation. Although the case series described few specific complications to the BVF procedure, they can drastically change the patient’s haemodynamic.

Lead author biography

Edouard Ballout is a fourth-year resident in cardiology. Currently he is in the university hospital of Clermont-Ferrand in France, and he is specializing in cardiac imaging.

Supplementary material

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

References

1. Dvir D, Webb JG, Bleiziffer S, Pasic M, Waksman R, Kodali S, Barbanti M, Latib A, Schaefer U, Rodés-Cabau J, Treede H, Piazza N, Hildick-Smith D, Hambert D, Watther T, Hengstenberg C, Nissen H, Bekeradjian R, Presbitero P, Ferrari E, Segov A, de Weger A, Windecker S, Most NE, Napolano M, Wilbrin M, Cerillo AG, Brecker S, Tcheste D, Leefere T, De Marco F, Fiorina C, Petronio AS, Teles RC, Tuesta L, Laborde J-C, Leon MB, Kornowski R. Transcatheter aortic valve implantation in failed bioprosthetic surgical valves. JAMA 2014;312:162–170.
2. Dvir D, Webb JG. Transcatheter aortic valve-in-valve implantation for patients with degenerative surgical bioprosthetic valves. Circ J 2015;79:695–703.
3. Chhatriwalla AK, Allen KB, Saxon JT, Cohen DJ, Aggarwal S, Hart A, Baron S, Hart AJ, Baron S, Davis JR, Pak AF, Dvir D, Borkon AM. Bioprosthetic valve fracture improves the hemodynamic results of valve-in-valve transcatheter aortic valve replacement. Circ Cardiovasc Interv 2017;10:e005216.
4. Allen KB, Chhatriwalla AK, Cohen DJ, Aggarwal S, Hart A, Baron S, Davis JR, Pak AF, Dvir D, Borkon AM. Bioprosthetic valve fracture to facilitate transcatheter valve-in-valve implantation. Ann Thorac Surg 2017;104:1501–1508.
5. Allen KB, Chhatriwalla AK, Saxon JT, Cohen DJ, Nguyen TC, Webb J, Loyalka P, Bavry AA, Rovin JD, Whisnant B, Dvir D, Kennedy KF, Thourani V, Lee R, Aggarwal S, Baron S, Hart A, Davis JR, Borkon AM, Janarthanan S, Beaver T, Karimi A, Gory D, Lin
6. Saxon JT, Allen KB, Cohen DJ, Chhatriwalla AK. Bioprosthetic valve fracture during valve-in-valve TAVR: bench to bedside. Interv Cardiol Rev 2017;13:20–26.

7. Saxon JT, Allen KB, Cohen DJ, Whisenant B, Ricci J, Barb I, Gafoor S, Harvey J, Dvir D, Chhatriwalla AK. Complications of bioprosthetic valve fracture as an adjunct to valve-in-valve TAVR. Structural Heart 2019;3:92–99.

8. Nielsen-Kudsk JE, Andersen A, Therkelsen CJ, Christensen EH, Jensen KT, Krusell LR, Tang M, Terp KA, Klaaborg K-E, Greisen JR, Nørgaard BL, Andersen HR. High-pressure balloon fracturing of small dysfunctional Mitroflow bioprostheses facilitates transcatheter aortic valve-in-valve implantation. EuroIntervention 2017;13:e1020–e1025.