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CASE REPORT

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Leaving obstacles aside: Antegrade paravalvular leakage closure after transcatheter aortic valve replacement

Javier Martinez[1] | **Alberto Alperi**[1,2] | **Iria Silva**[1] | **Isaac Pascual**[1,2,3] | **David Ledesma**[1] | **Rut Alvarez**[1] | **Marcel Almendarez**[1] | **Pablo Avanzas**[1,2,3] | **Raquel del Valle**[1,2] | **Cesar Moris**[1,2,3]

[1]Hospital Universitario Central de Asturias, Oviedo, Spain

[2]Instituto de Investigación Sanitaria del Principado de Asturias, ISPA, Oviedo, Spain

[3]University of Oviedo, Oviedo, Spain

Correspondence
Alberto Alperi, University Hospital of Asturias, Avenida de Roma s/n, Oviedo, Asturias 33011, Spain.
Email: alberto.alperi.garcia@hotmail.com

Abstract

Paravalvular leakage (PVL) is yet a potential and serious complication after transcatheter aortic valve replacement. Percutaneous PVL closure may be the treatment of choice upon failure of balloon postdilation in patients with excessive surgical risk. If the retrograde approach fails, an antegrade strategy might provide the solution.

KEYWORDS

acute heart failure, aortic valve, paravalvular leak, transcatheter aortic valve replacement, valve replacement

1 | INTRODUCTION

Transcatheter aortic valve replacement (TAVR) is a well-established therapy for patients with symptomatic severe aortic stenosis across the whole range of surgical risks.[1] However, this therapy associates some downsides, and the risk of paravalvular leakage (PVL) has been one of its main pitfalls. The detrimental effects of PVL have been described since the beginning of the TAVR era, and its appearance was associated with higher rates of mortality and heart failure admissions.[2] The incidence of moderate or severe PVL after TAVR has decreased with the use of new-generation transcatheter heart valves (THV),[3,4] but its prognostic is still ominous. Controversy exists regarding management of significant PVL after TAVR, as many patients are poor surgical candidates. Recently, late balloon-valvuloplasty has been suggested as a feasible and effective strategy for treating THV dysfunction due to PVL.[5] Furthermore, a retrograde approach for percutaneous PVL closure after TAVR has also been described.[6] We present a case in which an antegrade approach guided by prior cardiac computed tomography (CCT) planning was performed in a patient with refractory heart failure related to severe PVL after TAVR.

2 | HISTORY OF PRESENTATION

A 77-year-old woman with symptomatic severe aortic stenosis and high surgical risk based on obesity and interstitial lung disease was planned for TAVR. The patient had severe left ventricle outflow tract (LVOT) calcification at pre-procedural angio-CCT exam (Figure 1). A self-expandable 29-mm Evolut PRO + valve (Medtronic, Dublin, Ireland) was implanted using the cusp-overlap view (Video S1). Significant aortic regurgitation was observed at the post-implant angiography (Video S2), though the patient was hemodynamically stable and the procedure was terminated. However, patient's clinical evolution was torpid, with persistent congestive heart failure. Transesophageal echocardiography (TEE) demonstrated

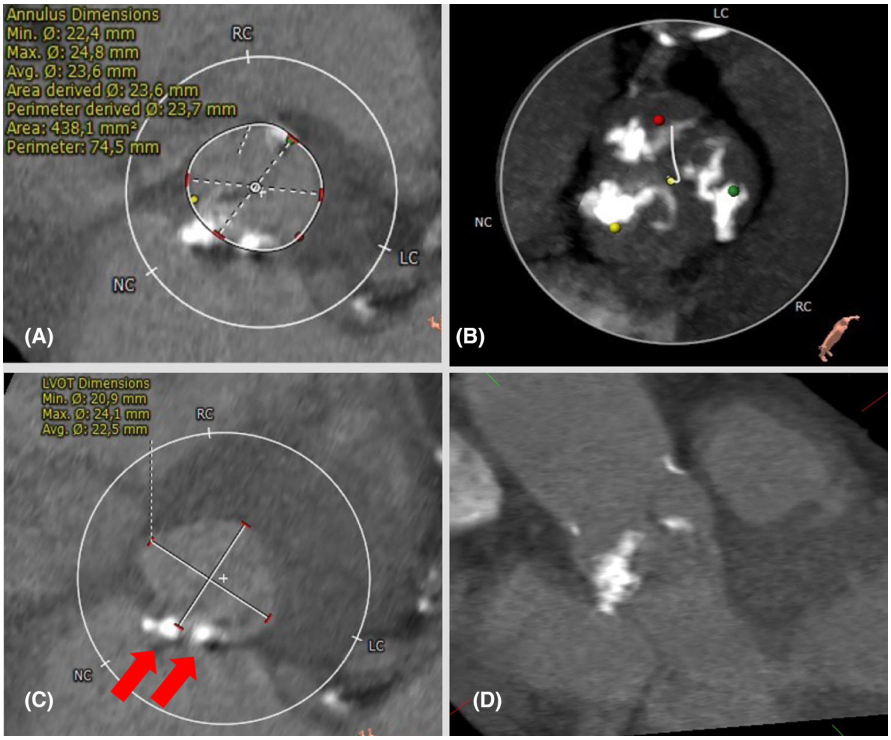

FIGURE 1 Pre-TAVR multi-slice CCT showing (A) annular sizing, (B) valve calcification, (C) short-axis view of the LVOT with two calcific nodules (red arrows), (D) long-axis view of the LVOT. CCT: cardiac computed tomography. LVOT: left-ventricle outflow tract.

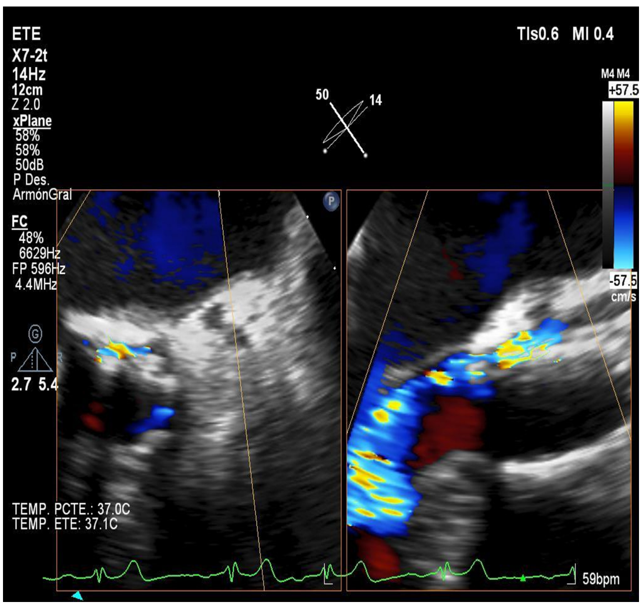

FIGURE 2 TEE X-plane color-Doppler image of the aortic prosthetic valve demonstrating severe PVL posteriorly located. TEE: transesophageal echocardiography. PVL: paravalvular leakage.

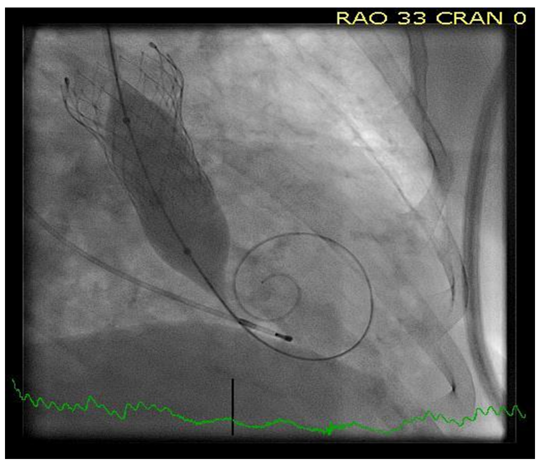

FIGURE 3 Balloon-valvuloplasty with a 25-mm Balt balloon.

a severe PVL posteriorly located (Figure 2, Video S3). The patient was then scheduled for post-TAVR balloon valvuloplasty, which was performed through the right femoral artery with a 25-mm Z-med balloon (B. Braun, Mesulgen, Germany) (Figure 3, Video S4). Unfortunately, the intervention did not decrease the extent of paravalvular regurgitation, which was still severe based on angiography (Video S5) and TEE (Video S6). The patient remained highly symptomatic and dependent on intravenous diuretics. She was deemed inoperable after Heart Team's re-evaluation, and percutaneous PVL closure was then decided as a last resort.

3 | INVESTIGATIONS

Angio-CCT was performed to guide PVL closure intervention. PVL was located between two calcific masses involving the posterior aspect of the aortic annulus and

LVOT, and it measured 4.9 mm in its maximal diameter (Figure 4A). Reaching this anatomical objective without entering the THV frame was deemed impossible based on the expansion of the THV toward the ascending aortic wall (Figure 4B). Hence, the best THV stent frames to be crossed were selected, based on their upper and straight location in regards to the leakage point (Figure 4C). Besides, a fluoroscopic working-view aiming to isolate the PVL on the left-screen side was calculated (Figure 4D).

4 | OUTCOME AND FOLLOW-UP

PVL closure was carried out under general anesthesia and TEE and fluoroscopy guidance. Right femoral access was obtained, and the Evolut frame was crossed into the native non-coronary sinus of Valsalva through the upper and posterior THV cells with a hydrophilic 0.035-inch Terumo Glidewire (Terumo, Tokyo, Japan). This guidewire was retrogradely advanced into the left ventricle (LV) through the PVL defect by gentle manipulation (Figure 5). Owing to the lack of support, a buddy-wire technique using a second Glidewire passing through the leakage was necessary to advance a four-F catheter across the valve frame and the defect (Figure 6). However, not an Amplatzer TorqVue™ Delivery Sheath nor a Cook Flexor Shuttle Delivery Sheath were able to cross the Evolut frame neither over a high-support Safari wire (Boston Scientific, Marlborough, Ma., USA) nor over an extra-support Lunderquist DC guidewire (Cook Medical, Bloomington, In, USA) (Figures 7 and 8, Video S7). Upon failure of the retrograde approach, an antegrade attempt was decided. The guidewire retrogradely

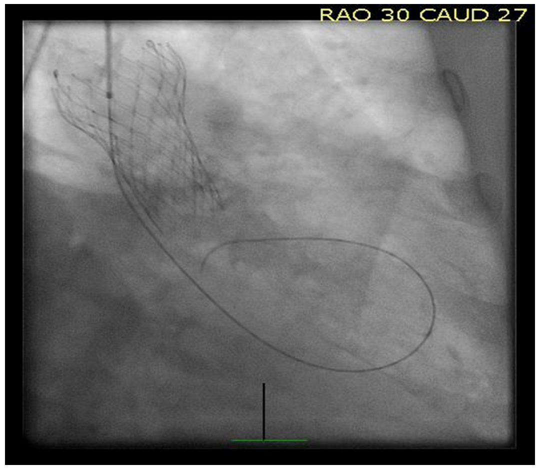

FIGURE 5 Retrograde passage of the guidewire across the THV stent frame and into the left ventricle through the PVL. THV: transcatheter heart valve. PVL: paravalvular leakage.

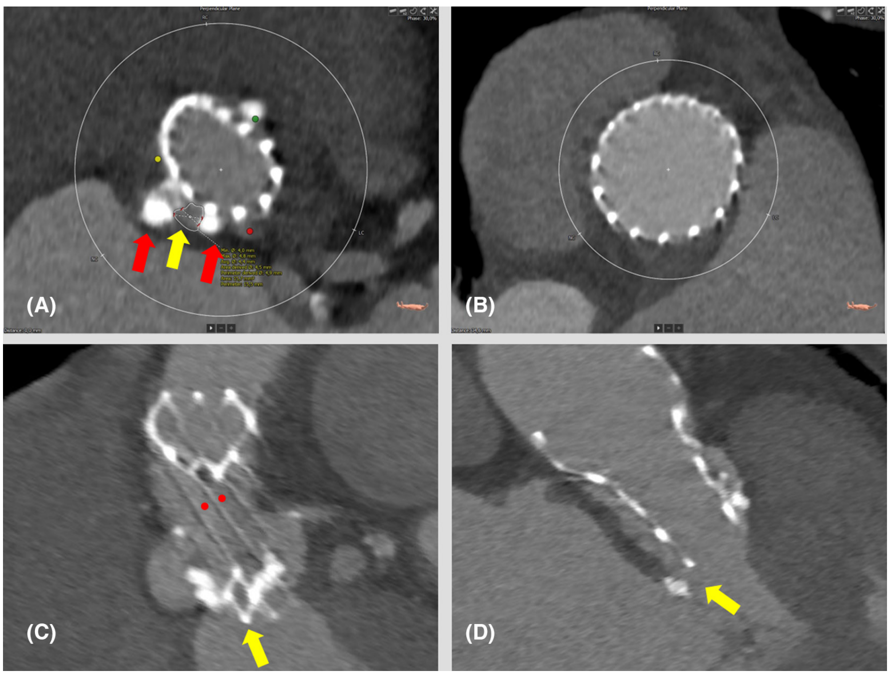

FIGURE 4 Multi-slice CCT images for PVL closure planification showing (A) short axis of the PVL (yellow arrow), which is located between two calcific nodules (red arrows) at the native-valve annular level; (B) complete apposition of the THV stent frame to the ascending aortic wall, preventing the passage of catheters and guidewires out of the THV stent frame; (C) en-face view of the posterior aspect of the THV, LVOT, native aortic valve and ascending aorta with a centred PVL (yellow arrow) highlighting the 2 spaces aimed for crossing the THV stent frame (red points); (D) fluoroscopic working-view (RAO 30°–CAU 25°) which isolates the PVL (yellow arrow) to the left side. CAU: caudal. CCT: cardiac computed tomography. LVOT: left ventricle outflow tract. PVL: paravalvular leakage. RAO: right anterior oblique. THV: transcatheter heart valve.

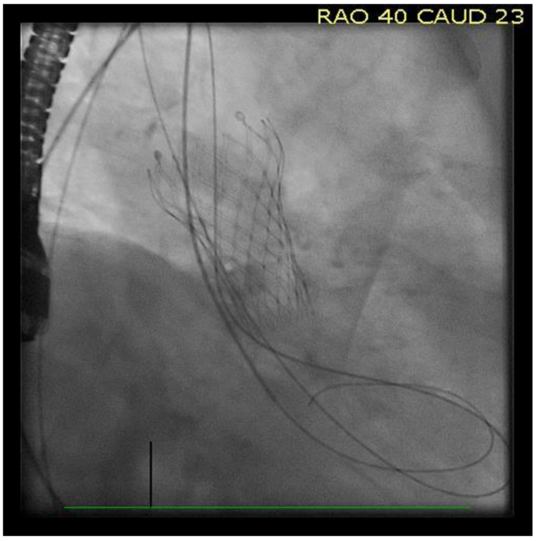

FIGURE 6 Buddy-wire technique (two parallel guidewires) allowing for catheter advancement across the PVL. PVL: paravalvular leakage.

FIGURE 7 Inability to advance the plug delivery-system across the THV frame over a Safari guidewire. THV: transcatheter heart valve.

crossing the defect was advanced into the ascending aorta across the THV leaflets and, after gaining left femoral arterial access and with the use of a snare, a femoral-femoral loop was placed (Figure 9). The TorqVue delivery system crossed the valve leaflets into the LV and, as a result of the lower friction, it was advanced through the defect with slight manipulation (Figure 10). The hydrophilic 0.035-inch Terumo Glidewire guidewire was left in place to maintain access through the defect, and an 10-5 mm Amplatzer Vascular Plug III (Abbot, Chicago, Il, USA) was advanced in parallel and anterogradely implanted (Figure 11, Video S8). Mitral valve function and residual

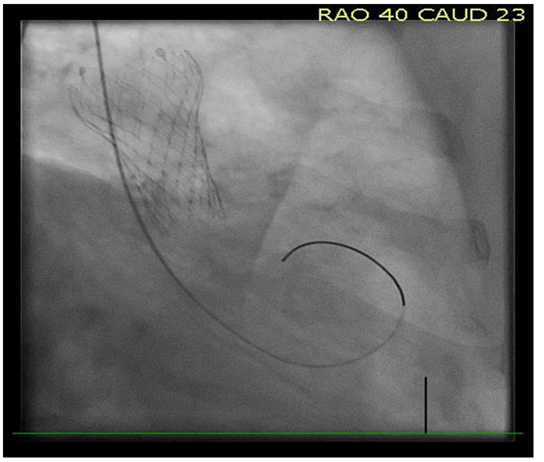

FIGURE 8 Inability to advance the plug delivery-system across the THV frame over a Lunderquist guidewire. THV: transcatheter heart valve.

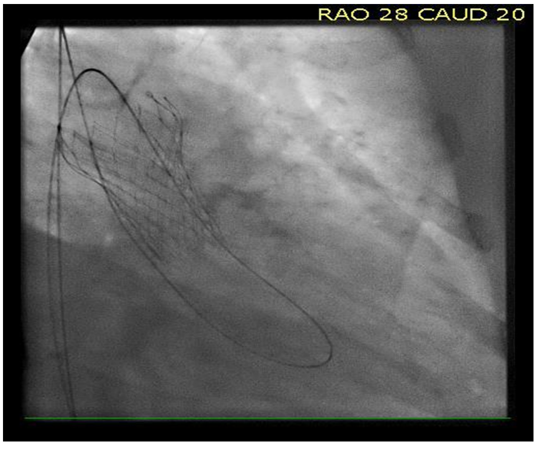

FIGURE 9 Bi-femoral arterio-arterial loop formation.

FIGURE 10 Antegrade crossing of the Plug delivery-system through the THV leaflets into the left ventricle and further on across the PVL. PVL: paravalvular leakage. THV: transcatheter heart valve.

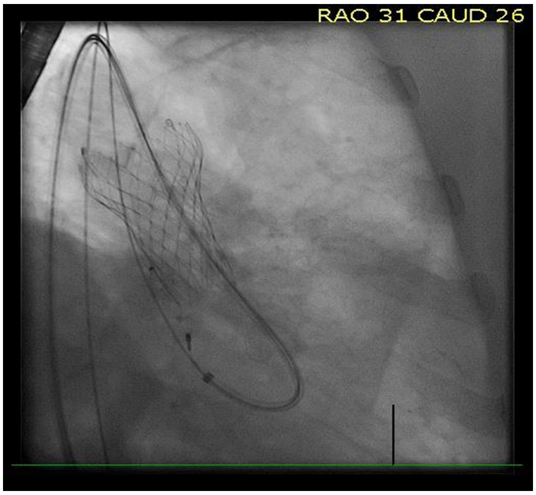

FIGURE 11 Amplatzer Vascular Plug III implantation while unsheathing.

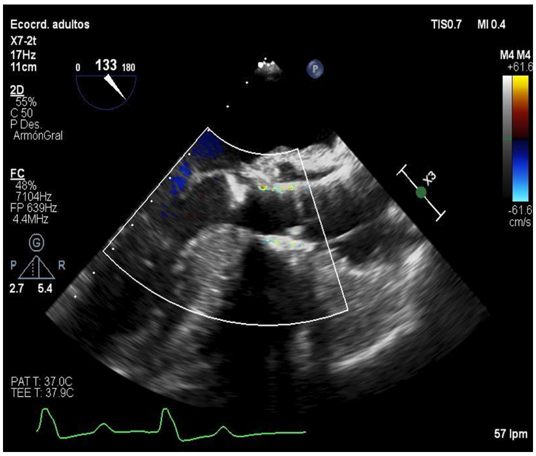

FIGURE 12 TEE color-Doppler image at 133° centred on the THV and LVOT demonstrating absence of significant (trace) PVL. LVOT: left ventricle outflow tract. PVL: paravalvular leakage. TEE: transesophageal echocardiography. THV: transcatheter heart valve.

AR were assessed before final release. After deployment PVL decrease to trace both on TEE (Figure 12, Video S9) and angiography (Video S10). The patient was discharged 72 h after the procedure under low dose of oral diuretics. She had no further hospitalizations for heart failure at 6-month follow-up.

5 | DISCUSSION

The likelihood of paravalvular regurgitation after TAVR has decreased over the years on account of THV iterations and growing operator experience. However, its prognosis may be fatal when it leads to refractory heart failure or hemolytic anemia. Several anatomic features could determine the appearance of PVL after native-valve TAVR, and LVOT calcification has constantly been an independent risk factor for this complication.[7] In our case, the presence of two adjacent calcific nodules protruding deep into the LVOT had a crucial role in PVL occurrence after TAVR.

Recently published data proved THV valvuloplasty useful and effective in reducing PVL after native-valve TAVR.[5] Nevertheless, this strategy was fruitless in our case, probably due to the inability to expand the THV frame through the space between the two calcific LVOT nodules.

Surgery must always be considered for treating severe symptomatic PVL, as this is yet the strategy of choice according to current guidelines for the management of valvular heart disease.[8] Nonetheless, transcatheter PVL closure has gained momentum based on the optimal safety profile and growing effectiveness of this intervention. Besides, percutaneous PVL closure might be the last therapeutic option in high-risk and inoperable patients. The presence of aortic THVs, namely those systems with high and bulky stent frames, pose distinctive anatomic challenges for percutaneous PVL closure. For instance, crossing the THV struts to reach the leakage point might be necessary for a retrograde approach, which translates into troublesome delivery system advancement. Upon inability to retrogradely close the leak, an arterio-arterial loop formation for antegrade crossing might serve as a bail-out strategy. Gentle and cautious catheter manipulation is mandatory when traversing the THV leaflets and the LVOT with the delivery system to avoid leaflet damage or THV misplacement. However, on the other hand, the lack of interaction with the THV frame facilitates the passage of the plug delivery system across the leak.

In conclusion, PVL after TAVR could lead to refractory heart failure. CCT planning is essential for aortic percutaneous PVL closure. The retrograde approach might be unsuccessful, and a bail-out antegrade strategy must be considered in such cases.

AUTHOR CONTRIBUTIONS

Javier Martinez: Writing – original draft; writing – review and editing. **Alberto Alperi:** Conceptualization; supervision; validation; writing – review and editing. **Iria Silva:** Resources; software; writing – review and editing. **Isaac Pascual:** Writing – review and editing. **David Ledesma:** Writing – review and editing. **Rut Alvarez:** Writing – review and editing. **Marcel Almendarez:** Writing – review and editing. **Pablo Avanzas:** Supervision; visualization; writing – review and editing. **Raquel Del Valle:** Supervision; writing – review and editing. **Cesar Moris:** Supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors have nothing to disclose in regards to the content of this manuscript.

DATA AVAILABILITY STATEMENT

All data regarding this case has been reported in the manuscript. Please contact the corresponding author if you are interested in any further information.

CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

ORCID

Alberto Alperi https://orcid.org/0000-0002-9939-8949
Pablo Avanzas https://orcid.org/0000-0002-4958-6108
Raquel del Valle https://orcid.org/0000-0001-7891-2913

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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