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CRITICAL PERSPECTIVE

Two birds with one stone: transcatheter valve-in-valve treatment of a failed surgical bioprosthesis with concomitant severe stenosis and paravalvular leak

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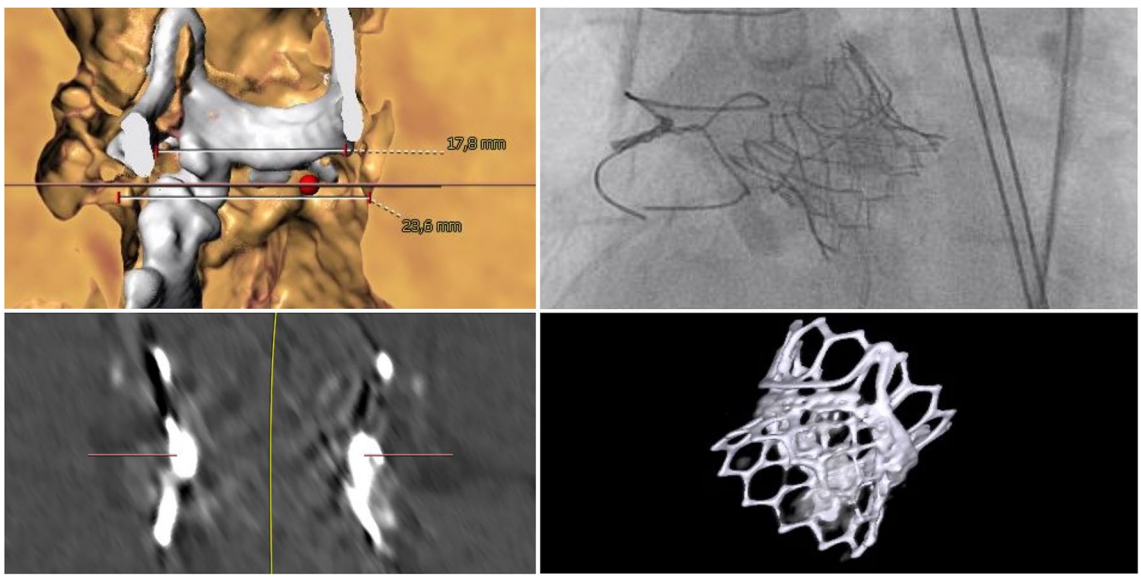
Abstract

Implantation of bioprosthetic surgical valves has been a common procedure in elderly patients with severe aortic stenosis due to patients´ preferences avoiding anticoagulation therapy. However, this valve presents sometime certain deterioration degree (i.e., dysfunction due to stenosis or regurgitation) or even paravalvular leak. Transcatheter heart valve implantation is a good alternative in high-risk patients. The valve-in-valve procedure has been shown to be a safe and effective procedure. However, the presence of the fixed sewing ring of the surgical bioprosthesis can hamper appropriate expansion of the THV. For this reason, the use of cracking balloon seems to be a safe alternative to increase the effective orifice area. We present a case of a patient with a degenerated previous implanted biological valve and paravalvular leak. We used the treatment strategy of valve-in-valve with post-dilatation with high-pressure balloon, in a way to treat both, the degenerated valve and the paravalvular leak. The use of a single percutaneous procedure was enough and safe to treat both problems without further complications.

Graphic abstract



Keywords TAVI · TAVR · Fracturing · Cracking · Paravalvular leak · Valve-in-valve

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Improvements in bioprosthetic surgical valve durability coupled to patients' desire to avoid long-term anticoagulant therapy have led, during the past decade, to a considerable

shift towards implantation of surgical bioprostheses instead of mechanical valves in patients with aortic valve disease. Consequently, increased numbers of patients presenting with failed surgically implanted bioprosthetic valves are to be expected with increasing population age. Structural valve deterioration (SVD) of surgical bioprostheses is associated with progressive haemodynamic valve dysfunction which can manifest as stenosis and/or regurgitation [1]. Contrary to intra-prosthetic regurgitation, paravalvular leak (PVL) is not strictly regarded as part of the SVD spectrum, although it can represent the principal mechanism of bioprosthetic valve failure [1, 2]. PVL of varying clinical significance is detected in 5%–18% of all implanted surgical valves, with an incidence of 2%–10% in the aortic position [3].

Due to the non-negligible operative mortality of repeat surgical procedures, transcatheter heart valve (THV) implantation inside failed surgical bioprostheses has been introduced as an alternative treatment option. Valve-in-valve (VIV) transcatheter aortic valve implantation (TAVI) has been shown to be a safe and effective procedure [4, 5]. However, the presence of the fixed sewing ring of the surgical bioprosthesis can hamper appropriate expansion of the THV, leading to lower effective orifice area and a risk of patient-prothesis mismatch (PPM) with suboptimal transvalvular gradients [6]. Patients with small surgical bioprostheses (label size ≤ 21) represent a particularly challenging subgroup, since pre-existing PPM can coexist with SVD in a significant proportion of patients. Bioprosthesis valve fracture (BVF) has emerged as an effective technique to address high residual gradients present in a substantial proportion of patients following VIV TAVI [7, 8]. Whereas deterioration of surgical valve leaflets is readily amenable to TAVI, the presence of a significant PVL has generally been regarded as a contraindication for TAVI [9]. Instead, percutaneous PVL repair, using an occluder device, represents an alternative to surgery for patients who are considered to be at high surgical risk, with reported technical and procedural success rates of 86.5% and 76.5%, respectively [10].

We report the case of an 82-year-old male patient (178 cm, 70 kg, BSA: 1.87 m^2) with a previous history (15 years earlier) of surgical aortic valve replacement (21 mm Carpentier–Edwards Perimount; Edwards Lifesciences, Irvine, CA), who was admitted in our department with left ventricular failure. Echocardiography showed SVD with severe stenosis [mean gradient: 37 mmHg, effective orifice area (EOA): 0.75 cm^2, indexed EOA: 0.40 cm^2/BSA] as well as severe PVL (effective regurgitant orifice area: 35 mm^2; regurgitant volume 70 ml) due to a partial detachment in the region of the non- and right-coronary sinuses (Fig. 1—Panel a–d and Fig. 2—Panel a). Coronary angiography excluded relevant coronary stenoses. Due to advanced patient age, previous thoracotomy, chronic obstructive pulmonary disease, and a logistic EuroSCORE of 24.0%, the heart-team consensus was to attempt a percutaneous treatment of the failed bioprosthesis.

To achieve secure anchoring, adequate annulus sealing, and larger orifice of the partially detached 21 mm Perimount surgical valve, the following strategy was chosen: following initial high-pressure dilatation (24 atm) and ring fracture with a 22-mm non-compliant balloon (Atlas Gold, C.R.

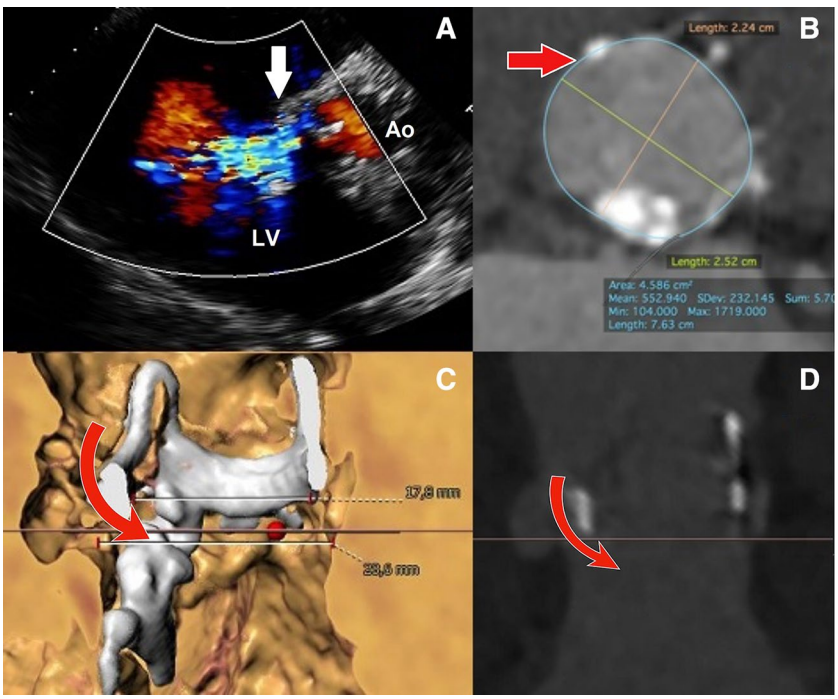

Fig. 1 **a** TTE showing the aortic paravalvular leak (*Ao* aorta, *LV* left ventricle); **b** CT image showing the measurement of the native annulus below the bioprosthesis (minimal diameter 22.4 mm, maximal 25.2 mm, mean diameter 23.8 mm, area 458.6 mm^2) as well as PVL localization (red arrow); **c** 3D-CT reconstruction showing the bioprosthetic valve and the paravalvular leak location (red arrow); **d** CT showing the location of the paravalvular leak (red arrow). *TTE* transthoracic echocardiography, *CT* computed tomography, *PVL* paravalvular leak

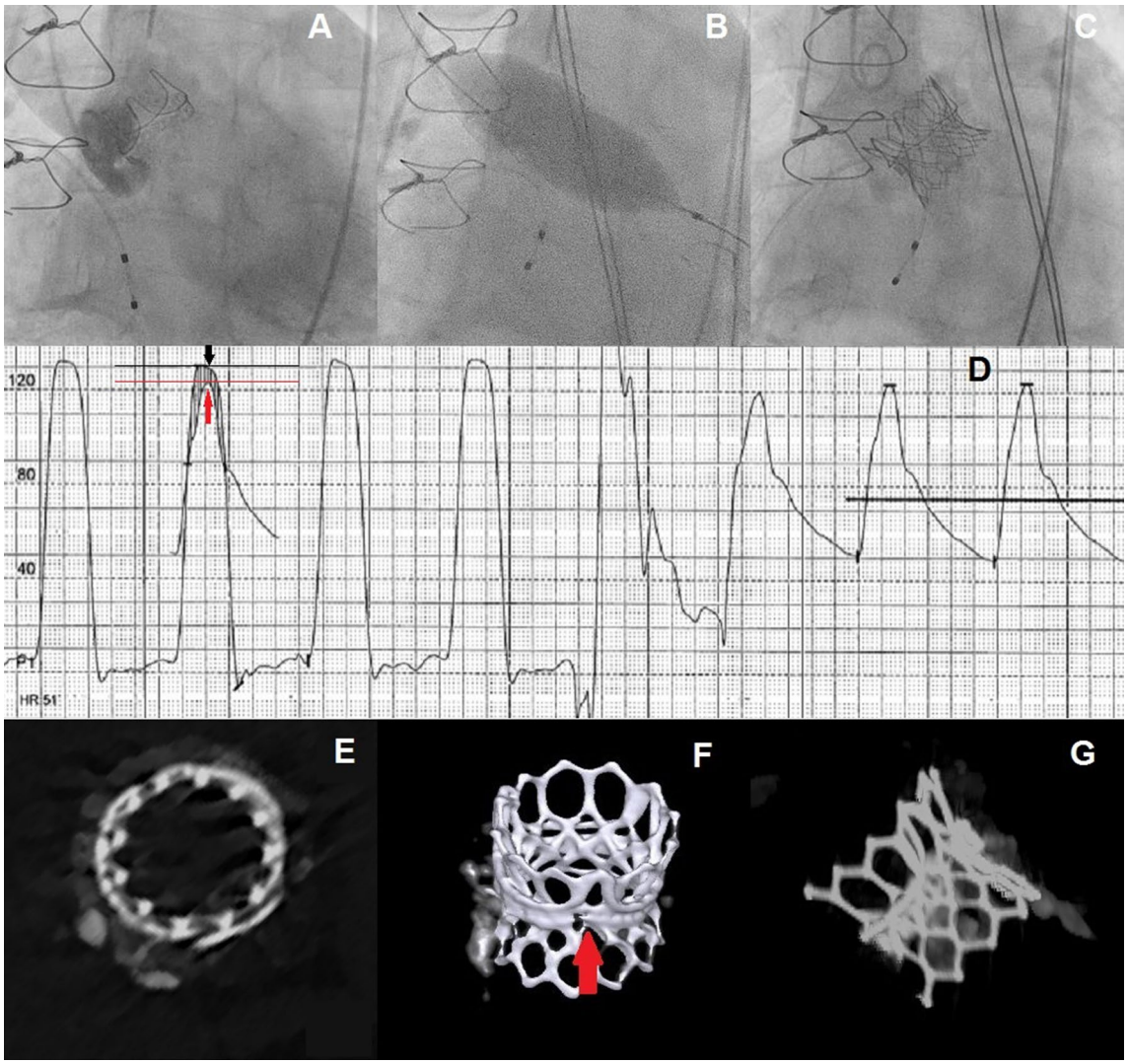

Fig. 2 **a** Angiographic image showing severe paravalvular leak; **b** predilatation and fracture with a 22 mm non-compliant balloon (24 atm); **c** final angiographic result following postdilatation of the surgical valve ring with a 24 mm non-compliant balloon (18 atm) showing optimal expansion of the THV frame within the sewing ring, and flaring of the inflow portion of the THV with minimal residual paravalvular regurgitation; **d** pressure measurement showing reduction of the trans-prosthetic gradient with final peak–peak gradient of 7 mmHg; **e** 3-D CT axial view of the S3 valve implanted; **f**, **g** 3-D CT reconstruction of the fractured surgical bioprosthesis (red arrow). *CT* computed tomography, *atm* atmospheres

Bard, Murray Hill, NJ) (Fig. 2—Panel b), a significantly oversized 26-mm Sapien 3 THV (Edwards Lifesciences, Irvine, California) was implanted within the failed bioprosthesis. To achieve flaring of the inflow part and improve the deployment of the Sapien 3 valve, post-dilatation with a 24-mm non-compliant balloon (TrueDilatation, C.R. Bard, Murray Hill, NJ) up to 18 atm (balloon burst) was performed (Fig. 2—Panel c). Final hemodynamic and echocardiographic assessment confirmed a significant reduction of the transvalvular gradient (peak-to-peak gradient: 7 mmHg) with minimal residual paravalvular regurgitation (Fig. 2—Panel d). Computed tomography images confirmed fracture of the surgical valve ring and flared expansion of the THV in the LVOT (Fig. 2—Panel e–g). Pre-discharge transthoracic echocardiography showed a mean transvalvular gradient of 15 mmHg with no intra- or paravalvular leak. The patient had an uncomplicated recovery and was discharged on the second post-procedural day.

We describe a case of successful percutaneous treatment of a failed surgical bioprosthetic valve presenting with both severe stenosis and haemodynamically relevant PVL. As noted previously, the presence of relevant PVL has been usually regarded as a contraindication for TAVI, and to the best of our knowledge, no descriptions of TAVI for the treatment of failed surgical bioprostheses with relevant PVL have been reported so far. The small size (21 mm) of the surgical

bioprosthesis represents an additional critical factor in the present case; careful measurements of the native annulus size (mean diameter: 23.8 mm) confirmed the presence of a significantly undersized surgical bioprosthesis and thereby of PPM. Oversizing and high-pressure dilatation of the Sapien 3 valve, served two primary goals: (i) fracture of the surgical valve ring and optimal expansion of the transcatheter valve with further reduction of transvalvular gradient and (ii) flaring of the inflow portion of the valve in the LVOT, with consequent sealing of the PVL. The structural features of the Sapien S3 THV—in particular the presence of the external polyethylene terephthalate sealing cuff—are important contributing factors that allowed successful sealing of the paravalvular leak. Besides carrying an additional procedural risk, initial percutaneous PVL repair was deemed to be associated with low probability of success due to the large detachment area of the surgical bioprosthesis.

To conclude, with careful patient selection and preprocedural planning, a VIV procedure can represent an optimal treatment option for failed surgical bioprostheses even in the presence of paravalvular leaks, whose presence should not preclude "a priori" a VIV procedure.

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Compliance with ethical standards

Conflict of interest A. M. Kasel is proctor and consultant for Edwards Lifesciences. The other authors have no conflicts of interest to declare.

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