Transcatheter Aortic Valve Implantation in a Patient With Degenerated Aortic Homograft and Anomalous Right Coronary Artery Originating From Left Aortic Sinus

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INTRODUCTION

Aortic valve substitution by an aortic root homograft is an alternative to prosthesis implantation, particularly used in young populations. This technique prevents the need for chronic anticoagulation and its complications and demonstrates lower infection rates. However, these benefits are achieved at the expense of an association with progressive homograft degeneration, which may lead to reintervention in the future. Substitution of an aortic root homograft is a complex and high-risk surgical scenario, with poor success rates and high postsurgical complications and mortality. Despite scarce evidence, transcatheter aortic valve implantation (TAVI), with a valve-in-valve technique has been proposed as a safe alternative to complex redo surgery.

Nonetheless, cautious anatomic planning guided by advanced imaging techniques is required to assess the more appropriate landing zone. We present the case of a 63-year-old man with a degenerated aortic homograft and an anomalous right coronary artery (RCA) who successfully underwent TAVI.

CASE PRESENTATION

A 63-year-old man, with a medical history notable for complete aortic valve and root substitution with a 23-mm homograft prosthesis because of infectious endocarditis on a bicuspid aortic valve 20 years previously, was referred to the cardiology outpatient clinic to reestablish regular follow-up of the bioprosthesis. The patient remained asymptomatic. Routine transthoracic echocardiography revealed a nondilated left ventricle with a preserved left ventricular (LV) ejection fraction (65.3%), aortic bioprosthesis dysfunction with moderate to severe regurgitation, and increased mean and peak gradients of 26 and 49 mm Hg, respectively.

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VIDEO HIGHLIGHTS

Video 1: Two-dimensional transesophageal echocardiography, midesophageal position biplane short-axis (*left*) and long-axis (*right*) views with color flow Doppler at the aortic valve, demonstrating the degenerative aortic valve homograft prosthesis with severe eccentric aortic regurgitation.

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With regard to this last finding, transesophageal echocardiography was performed and showed thickened, restrictive aortic valve leaflets with prolapse of the left coronary cusp resulting in central, severe regurgitation flow (Video 1). Cardiovascular magnetic resonance imaging was performed to confirm the severity of regurgitation and make an accurate evaluation of LV ejection fraction and LV diameter. This demonstrated LV dilatation and LV ejection fraction deterioration compared with the previous cardiovascular magnetic resonance study, as well as mild dilation of the ascending aorta (43 mm). Given the evident homograft dysfunction and severe aortic regurgitation, with a high risk for rapid progression and LV function deterioration, cardiac computed tomography of the thoracic and abdominal aorta with gating of the cardiothoracic segment was performed (Figure 1) to plan imminent surgical intervention. Severe calcification of the whole extension of the homograft was seen, as well as an abnormal origin of the RCA from the left coronary sinus with an interarterial course. No significant obstructive coronary artery lesions were observed.

The case was discussed in our weekly heart team session, and the cardiovascular surgery team decided against surgical intervention because of its anatomic complexity, the extensive calcification of the homograft, and the predictable low successful rates of the intervention. Cautious anatomic planning guided by cardiac computed tomography (Figure 2) allowed the calculation of aortic annular perimeter and area, calcium quantification and its anatomic distribution, and risk for coronary artery complications. TAVI with a valve-in-valve technique, under general anesthesia and guided by fluoroscopy following our interventional team's daily practice, was performed. A 26-mm SAPIEN 3 Ultra bioprosthesis (Edwards Lifesciences) was implanted on the degenerated homograft without complications (Figure 3).

Follow-up transthoracic echocardiography was performed before discharge and show a normally functioning bioprosthetic valve in the homograft (valve-in-valve), with no residual regurgitation (Figure 4). Peak velocity, derived mean pressure difference, effective

Figure 1 Contrast-enhanced cardiac computed tomography, three-dimensional volume-rendered reconstruction of the thoracic aorta, demonstrating aortic root and ascending aortic dilation.

orifice area by the continuity equation, and Doppler velocity index showed normal values. At 6-month follow-up, the patient remained asymptomatic. The only incident after TAVI was the development of complete right bundle branch block and left anterior hemiblock, with no progression to advanced atrioventricular conduction disturbances after this period.

DISCUSSION

The aortic root homograft provides a lower incidence of infection and no need for chronic anticoagulation but is associated, on the other hand, with progressive degeneration, which may lead to reintervention within 10 to 20 years.[1] The surgical procedure for replacing the aortic valve in these patients, who have previously undergone aortic root replacement with cryopreserved homografts, is complex and associated with higher postsurgical complication rates and mortality.[2] TAVI is an alternative to redo aortic root surgery in this complex scenario. However, the reported cases of this technique are limited. Kislitsina *et al.*[3] compared the outcomes of 41 patients undergoing TAVI because of aortic valve degeneration, 33 with failed stented aortic bioprostheses and eight with failed homografts. The bioprosthesis group presented predominantly with prosthesis stenosis (94%, $P = .002$), whereas the homograft group showed mostly aortic regurgitation (88%, $P < .001$). They reported no 30-day mortality, stroke, or pacemaker implantation in both groups. These authors concluded that TAVI is a safe alternative to high-risk and complex surgical intervention in degenerated aortic homografts.

When performing this technique, a precise low position, 40% ventricular fixation in relation to the homograft annulus, is essential to prevent the development of paravalvular leaks and late prosthesis migration, thus minimizing the risk for reintervention.[3] Nonetheless, a lower landing zone has been significantly associated with higher rates of atrioventricular block and pacemaker implantation.[4]

A few cases have also been reported focused on added complexity of the procedure. Olsen *et al.*[5] reported the feasibility of this technique even when the femoral access is unavailable, performing a successful valve-in-valve implantation through the right subclavian artery. On the other hand, Shouls *et al.*[6] described a valve-in-valve TAVI procedure on a young 21-year-old patient with congenital aortic stenosis, highlighting the feasibility of this technique in young patients with congenital heart disease who have undergone numerous previous open surgical procedures.

With respect to the abnormal origin of the RCA from the left coronary sinus in our patient, there is only one case of TAVI reported in the literature. TAVI was performed in a 76-year-old man with low-flow, low-gradient aortic valve stenosis and anomalous RCA origin in the left coronary sinus. The authors described hemodynamic deterioration with clinical, electrocardiographic, and echocardiographic data of acute right ventricular infarction, requiring a single venous bypass graft surgery of the RCA. The postoperative weaning and evolution were adequate.[7] In our case, planning cardiac computed tomography was performed, and the aortic bioprosthesis was implanted in a low position to avoid occlusion of the left coronary ostium and minimize the risk for paravalvular leaks. In contrast, a higher risk for conduction disturbances was assumed.

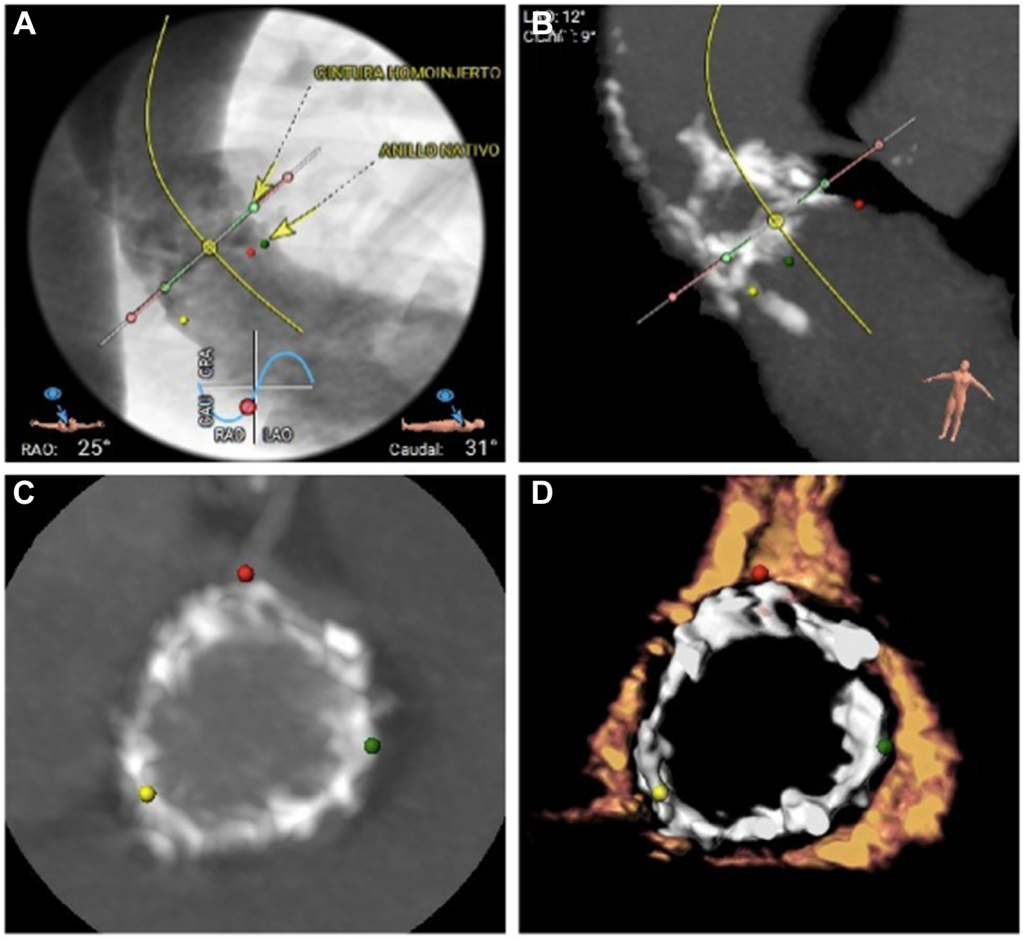

Figure 2 Multipanel display of cardiac computed tomographic images for TAVI planning. **(A)** Posteroanterior fluoroscopic simulation of the aortic annulus. The *upper arrow* marks the waist of the homograft and the *lower arrow* the native aortic annulus. **(B)** Posteroanterior fluoroscopy reconstruction with the window and level modified to highlight the calcification extension on the aortic root. Short-axis zoom **(C)** and volume-rendered three-dimensional display **(D)** of the aortic annulus emphasizing the calcium distribution at the waist of the homograft. The locations of the right coronary (*green dot*), left coronary (*red dot*), and noncoronary (*yellow dot*) portions of the ring are included for maximal anatomic understanding.

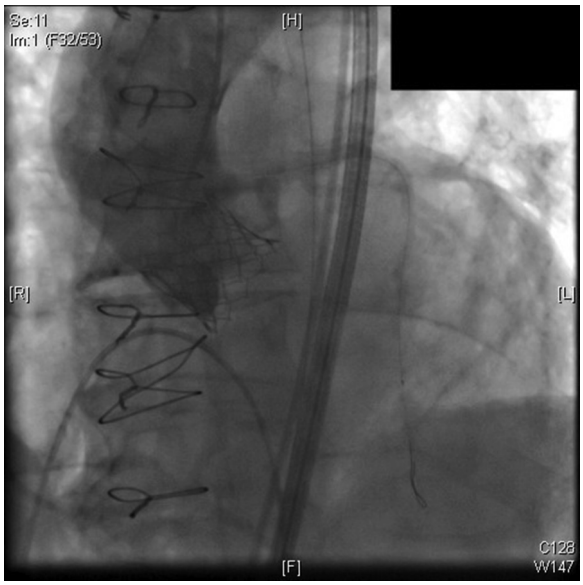

Figure 3 Posteroanterior aortogram obtained immediately after TAVI, showing absence of residual aortic regurgitation. Also seen are sternotomy wires, the TAVI prosthesis, the delivery sheath within the aorta, and a wire in the coronary artery.

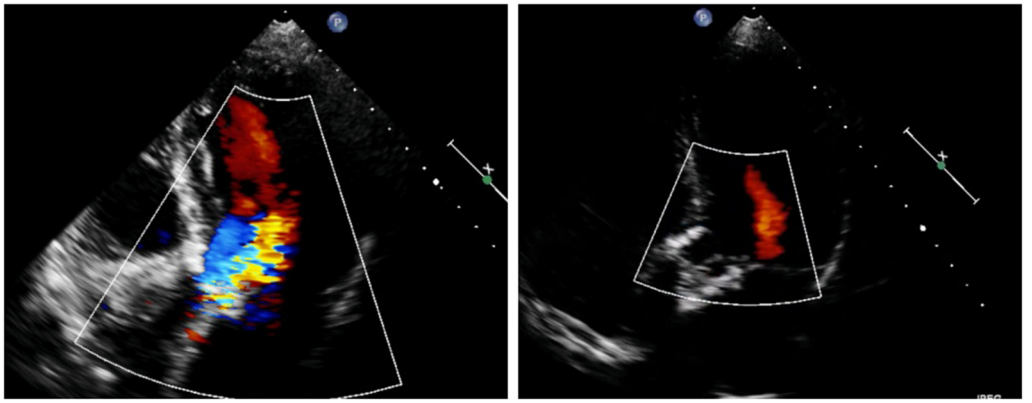

Figure 4 Two-dimensional transthoracic echocardiography with color flow Doppler, apical three-chamber view, diastolic phase, demonstrating severe eccentric aortic regurgitation at baseline (*left*) and after TAVI valve-in-valve procedure (*right*), with resolution of the regurgitant flow.

CONCLUSION

TAVI is proposed as a feasible and safe technique that allows the avoidance of redo surgery in a high-risk scenario. However, anatomic and technical planning guided by advanced imaging techniques is crucial to determine the best device landing position.

ETHICS STATEMENT

The authors declare that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

CONSENT STATEMENT

Complete written informed consent was obtained from the patient (or appropriate parent, guardian, or power of attorney) for the publication of this study and accompanying images.

FUNDING STATEMENT

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DISCLOSURE STATEMENT

The authors report no conflict of interest.

SUPPLEMENTARY DATA

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