ESC European Society of Cardiology
European Heart Journal - Case Reports
doi:10.1093/ehjcr/ytz105

CASE REPORT
Coronary heart disease

Transcatheter aortic valve implantation after aortic valve neocuspidization using autologous pericardium: a case report

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Received 28 July 2018; first decision 10 October 2018; accepted 18 June 2019

Background Aortic valve neocuspidization (AVNeo), a novel surgical procedure used in the treatment of aortic valve diseases, including aortic stenosis (AS), involves the replacement of three aortic valve cusps by glutaraldehyde-treated autologous pericardium. Although reoperation risk is low, no case report on the deterioration of the AVNeo has yet been published.

Case summary An 80-year-old woman who underwent AVNeo for severe degenerative tricuspid AS 6 years previously complained of shortness of breath. Echocardiographic assessment revealed the reconstructed aortic valve leaflet was elongated, thickened, and marginally calcified resulting in recurrent severe AS. Transcatheter aortic valve implantation using balloon-expandable transcatheter heart valve was successfully performed.

Discussion To our knowledge, this is the first case report regarding the structural deterioration of the AVNeo resulting in restenosis 6 years after the first surgery. Transcatheter aortic valve implantation is possibly a suitable approach for post-procedural recurrence after AVNeo to avoid redo open-heart surgery which would be of prohibitive risk especially in an elderly population.

Keywords Transcatheter aortic valve implantation • Aortic stenosis • Aortic valve neocuspidization • Case report

Learning points

- Aortic valve neocuspidization (AVNeo), a novel surgical procedure used in the treatment of aortic valve diseases, including aortic stenosis (AS), involves the replacement of three aortic valve cusps by glutaraldehyde-treated autologous pericardium.
- This is the first report on the structural degeneration of the AVNeo resulting in severe AS.
- Transcatheter aortic valve implantation is possibly a suitable approach for post-procedural recurrence after AVNeo to avoid redo open-heart surgery which would be of prohibitive risk especially in an elderly population.

Introduction

Aortic valve neocuspidization (AVNeo) is a novel surgical procedure that involves the replacement of all three aortic valve cusps by a glutaraldehyde-treated autologous pericardium. This procedure is used in the treatment of aortic valve diseases, such as aortic stenosis (AS), aortic regurgitation (AR), infective endocarditis, prosthetic valve endocarditis, and annuloaortic ectasia.[1,2] To date, retrospective observational studies have reported a few occurrences of a post-procedural reoperation of AVNeo,[2] although no detailed reports are available about their anatomical changes or aetiologies with images.

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Handling Editor: Nikolaos Bonarus
Peer-reviewers: Marco De Carlo, Savvas Loizos, Tomaz Podlesnikar, and Golnaz Houshmand
Compliance Editor: Anastasia Vamvakidou
Supplementary Material Editor: Ross Thomson

Here, we report the first case of the structural deterioration of the AVNeo and the choice of a transcatheter aortic valve implantation (TAVI) performed to treat recurrent AS after AVNeo.

Timeline

Time	Events
2011 December	The patient underwent aortic valve neocuspidization for severe degenerative tricuspid aortic stenosis (AS).
2012 March	At the 1-year follow-up after the surgery, echocardiography showed an effective orifice area (EOA) of 1.40 cm^2 and no regurgitation.
2017 May	The patient presented with shortness of breath and was diagnosed with recurrent severe AS.
2017 May	Transcatheter aortic valve implantation was successfully performed.
2018 June	The patient was doing well. Follow-up echocardiography revealed the EOA of 1.89 cm^2, with a mean pressure gradient of 8 mmHg, and trivial aortic regurgitation.

Case presentation

An 80-year-old woman with a history of hypertension and hyperlipidaemia on Carvedilol 5 mg/day and Atorvastatin 5 mg/day had undergone AVNeo using autologous pericardium for degenerative severe tricuspid AS 6 years previously.[1] At the 1-year follow-up after the surgery, transthoracic echocardiography (TTE) revealed an effective orifice area (EOA) of 1.40 cm^2 and no AR. She remained asymptomatic and had no further healthcare contact up to this presentation. At this time, she was admitted to our hospital complaining of shortness of breath of New York Heart Association 2 when walking up stairs. She had neither chest pain nor dizziness. Her blood pressure was 131/64 mmHg, with a heart rate of 58 b.p.m., and an oxygen saturation of 99% in room air. On physical examination, she had normal respiratory sounds, a normal cardiac examination with S1, S2, and a systolic ejection murmur, no jugular venous pressure elevation, and no leg oedema. A chest X-ray showed a normal cardiac size and no congestion nor pleural effusion. Electrocardiography revealed a normal sinus rhythm, left axis deviation, and left ventricular hypertrophy. Transthoracic echocardiography revealed that the reconstructed aortic valve was thick and elongated, and its motion was restricted. It resulted in severe AS with an aortic flow velocity of 5.39 m/s, a mean aortic valve pressure gradient (MPG) of 74 mmHg, and an EOA of 0.55 cm^2. Her left ventricular ejection fraction was 68%, and her left ventricular end-diastolic diameter was 41 mm. Aortic regurgitation was mild. Multidetector computed tomography revealed stenosis of the reconstructed aortic valve with elongated, thickened, and marginally calcified leaflets (*Figure 1*). Parameters of the aortic annulus were as follows: area, 335 mm^2; perimeter, 67.5 mm; and maximum and minimal diameters, 24.5 and 17.1 mm, respectively. The mean diameter of the sinus of Valsalva (SOV) was 23.4 mm, and the heights of the right and left coronary arteries were 12.9 and 10.4 mm, respectively. The length of the right and left reconstructed right coronary leaflets were 18.4 and 24.6 mm, respectively.

The heart team considered a TAVI appropriate for two reasons. First, redo heart valve surgery would be of higher risk. The patient's EuroSCORE II was 7.75%. Second, the aortic annulus size was small. Thus, TAVI seemed to be a better alternative to achieve larger EOA than that obtained by surgical aortic valve replacement (AVR). Informed consent was obtained from the patient.

Transfemoral TAVI from right femoral artery was performed under transoesophageal echocardiography guidance. The stenotic valve was crossed with the Judkins right catheter and straight wire. The risk of coronary occlusion was the key in this procedure because the aortic valve leaflets constructed with autologous pericardium were very long and much higher than each coronary height. Furthermore, the SOV diameter was small. We selected SAPIEN 3 (Edwards Lifesciences, Irvine, CA, USA) because the SOV diameter was smaller than that recommended by the manufacturer of EvolutR (Medtronic, Minneapolis, MN, USA) (>27 mm for 26 mm CoreValve series). We chose a larger size of SAPIEN 3 as 23 mm for the annulus area of 335 mm^2 (21% oversizing) due to the low calcified valve.[3] Considering the risk of tearing implanted leaflets, a balloon valvuloplasty was skipped and transcatheter heart valve (THV) was directly deployed with a coronary protection for both coronary arteries. Soft tip 6 French Hyperion (ASAHI INTECC CO., LTD., Aichi, Japan) coronary guide catheters were utilized for coronary protection; the Judkins right and left types for the right and left coronary arteries, respectively. Both catheters have side hall. A 0.014-inch coronary wire was advanced into each coronary artery, and THV was deployed under rapid pacing. We implanted the THV at a low position to cover the constructed leaflets which had migrated down into the left ventricular side as shown in the aortography (*Figure 2A*). With this management, the coronary obstruction did not occur. Transoesophageal echocardiography showed AR was trivial after THV deployment (*Figure 2E* and *F*). At the 1-year follow-up, the patient was well, and TTE revealed an EOA of 1.89 cm^2, MPG of 8 mmHg, and trivial paravalvular leak.

Discussion

To the best of our knowledge, this is the first case report on the structural deterioration of the AVNeo resulting in AS, which was managed with TAVI.

In AVNeo, all three aortic valve cusps are replaced by glutaraldehyde-treated autologous pericardium.[1,2] Its clinical benefits include the avoidance of oral anticoagulation and foreign material as well as its suitability for use in patients with infective endocarditis. Furthermore, because reconstructed valve leaflets are directly sutured to the aortic annulus, this technique produces larger EOA compared with an AVR using prosthetic valves with suture rings. Therefore, AVNeo is a good indication for small aortic annulus similar to that observed in this case.

To date, only a few reports have described the structural deterioration after AVNeo.[2] Ozaki *et al.*[2] have reported the mid-term outcomes of AVNeo, and the reoperation incidence was 4.2% in the

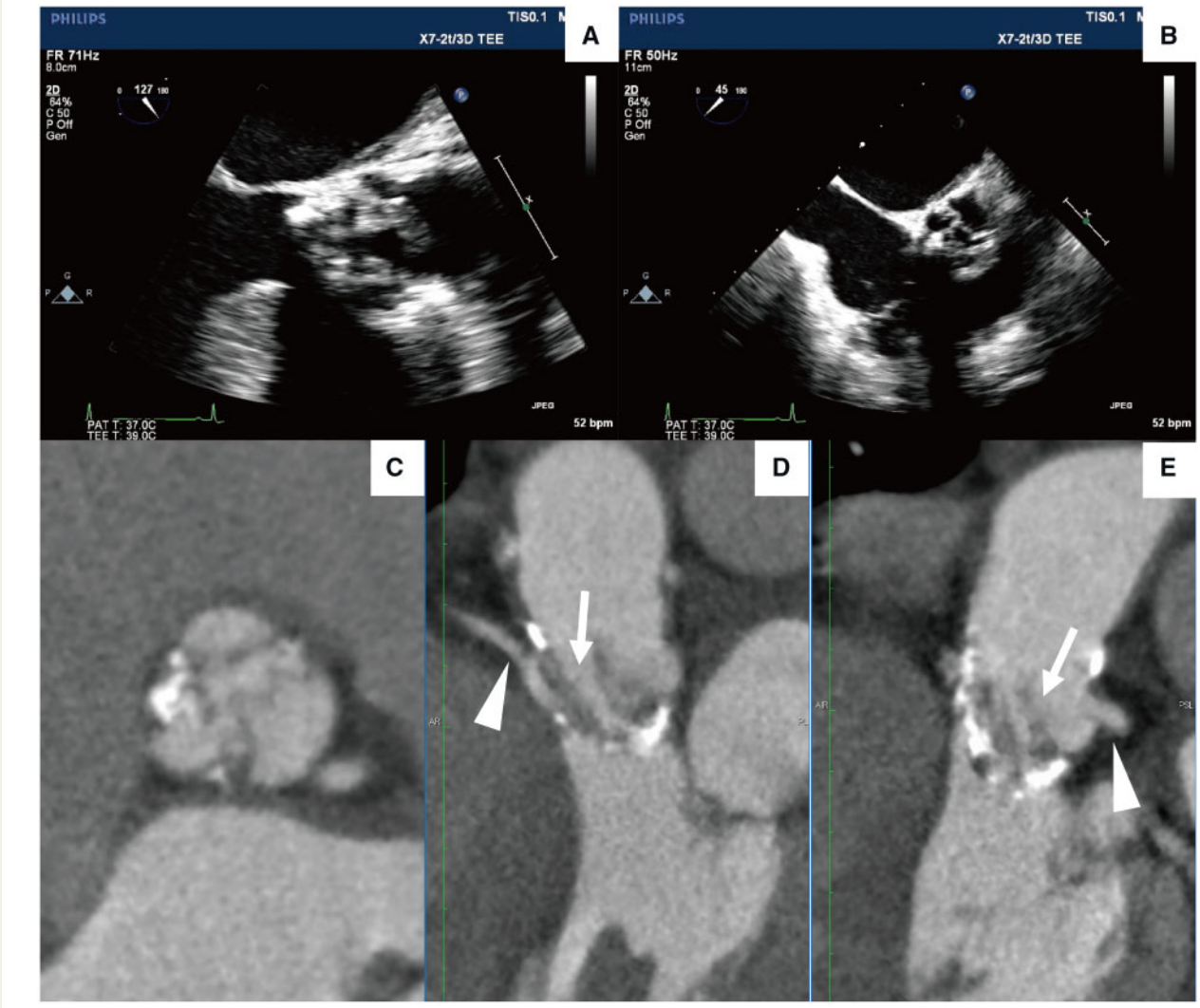

Figure 1 Images of pre-procedural examinations. Left ventricular outflow tract view (*A*) and short-axis view (*B*) of transoesophageal echo and short-axis image (*C*) and long-axis images (*D*, *E*) of multidetector computed tomography. All images were in systole. The reconstructed valve leaflets were elongated, thickened, and marginally calcified. Their mobility was decreased, resulting in severe stenosis. The reconstructed right valve leaflet (arrow) was adjacent to the right coronary artery (arrowhead) (*D*). The reconstructed left coronary leaflet (arrow) was sufficiently long to reach the left coronary artery (arrowhead) (*E*).

longest follow-up of 118 months. The reasons for reoperation included infective endocarditis ($N = 13$), cusp tear ($N = 1$), and break of thread ($N = 1$). In our case, at the 1-year follow-up after AVNeo, sufficient EOA and no AR were observed. Post this follow-up, the patient was not monitored; however, the reconstructed valve leaflets showed degenerative change this time. Although the causes of the degeneration are unknown, inflammation and metabolic factors can be identified as the possible causes.

The reported rate of recurrent moderate or greater AR after AVNeo is 7.3%.[2] The currently available TAVI devices offer a high performance to prevent paravalvular leakage[4] and reportedly improve the outcomes of pure AR.[5] In fact, the leaflets in our case were marginally calcified. Hence, TAVI may be also effective in the management of AR after AVNeo.

With regards to the TAVI procedure, several issues are still controversial. For example, the choice of THV, the need of coronary protection or bail out stent strategy, and the position of the THV deployment and its sizing.

Conclusions

Although AVNeo is a novel procedure for preserving the autologous tissue, reoperation is sometimes required. Since reoperative open-

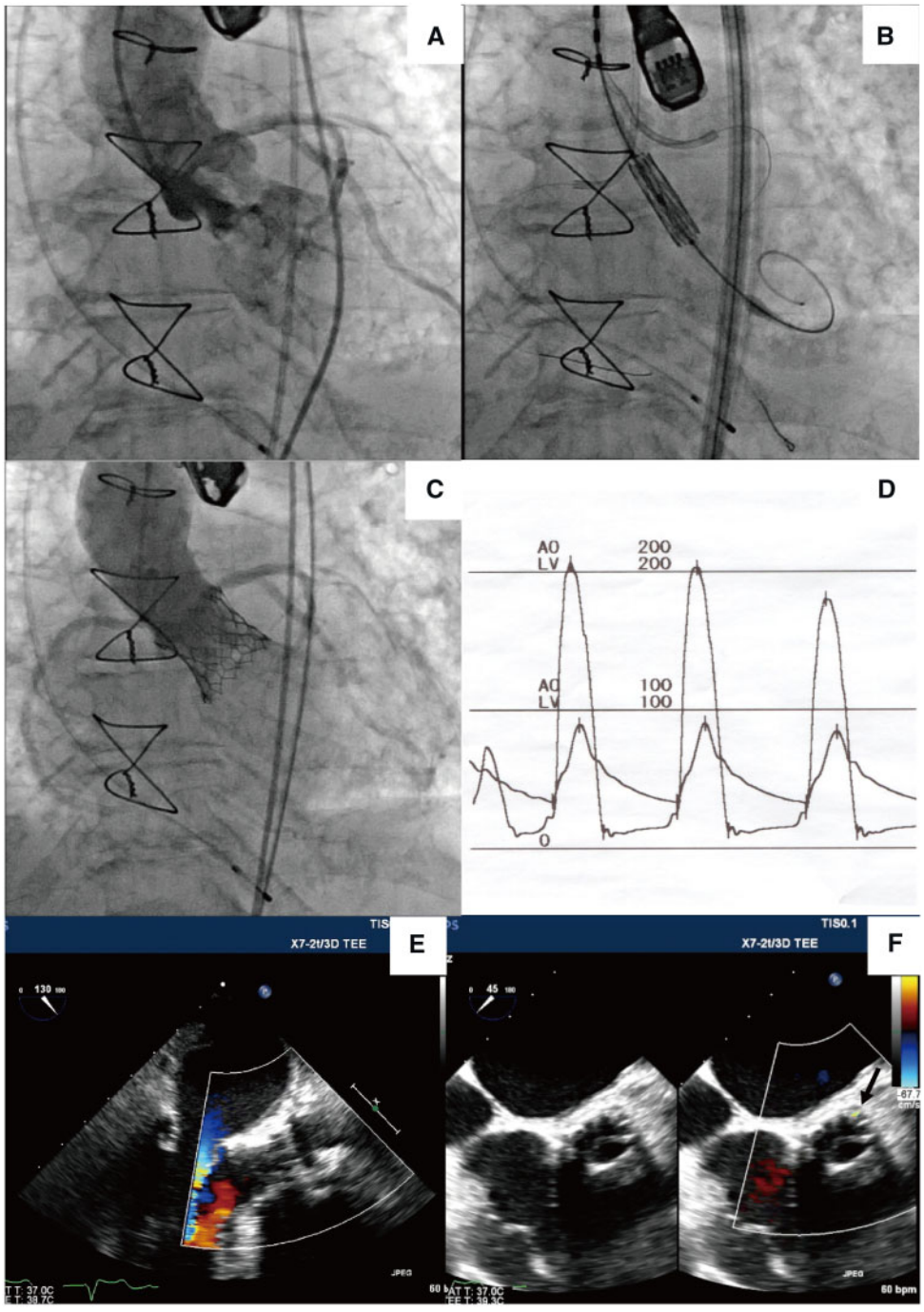

Figure 2 Transcatheter aortic valve implantation for severe stenosis after aortic valve neocuspidization. Pre-procedural aortography showed that opening of the aortic valve constructed with autologous pericardium was restricted and it had migrated down into the left ventricular outlet (*A*). Transcatheter heart valve SAPIEN 3 (23 mm) was deployed with the protection of both coronary arteries (*B*). Final aortography revealed trivial aortic regurgitation and patent coronary arteries (*C*). Pre-procedural simultaneous aortic and left ventricular pressures indicated severe aortic stenosis (*D*). After transcatheter heart valve deployment, paravalvular leakage was trivial in the long-axis (*E*) and short-axis (arrow, *F*).

heart surgery has a high surgical risk, the less invasive TAVI method may be suitable for treating recurrence of AS after AVNeo.

Lead author biography

Norio Tada is an interventional cardiologist and a specialist in cardiac intervention for structural heart disease including transcatheter aortic valve implantation (TAVI). He works at Sendai Kousei Hospital and his team performs over 200 TAVI cases a year.

Supplementary material

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

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: N.T. is a clinical proctor for Edwards Lifesciences and Medtronic. All the other authors have no conflict of interest to disclose.

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