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

Norio Tada1*, Naoyuki Tanaka1, Kazuo Abe2, and Masaki Hata3

1Department of Cardiology, Sendai Kousei Hospital, 4-15 Hirosemachi, Aoba Ward, Sendai, Miyagi 980-0873, Japan; 2Department of Cardiovascular Surgery, Yamagata Prefectural Central Hospital, 1800 Aoyagi, Yamagata city, Yamagata 990-2292, Japan; and 3Department of Cardiovascular Surgery, Sendai Kousei Hospital, 4-15 Hirosemachi, Aoba Ward, Sendai, Miyagi 980-0873, Japan

Received 28 July 2018; first decision 10 October 2018; accepted 18 June 2019; online publish-ahead-of-print 10 July 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 re-stenosis 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.
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 neocuspization 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 cm² 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 cm², 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 hyperlipidemia on Carvedilol 5 mg/day and Atorvastatin 5 mg/day had undergone AVNeo using autologous pericardium for degenerative severe tricuspid AS 6 years previously. At the 1-year follow-up after the surgery, transthoracic echocardiography (TTE) revealed an effective orifice area (EOA) of 1.40 cm² and no regurgitation. 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 cm². 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 mm²; 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 mm² (21% oversizing) due to the low calcified valve. 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 hole. 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 cm², 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. 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. Ozaki et al. have reported the mid-term outcomes of AVNeo, and the reoperation incidence was 4.2% in the...
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 neucuspidization. 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.

**References**

1. Ozaki S, Kawase I, Yamashita H, Uchida S, Nozawa Y, Takata H, Hagiwara S. A total of 404 cases of aortic valve reconstruction with glutaraldehyde-treated autologous pericardium. J Thorac Cardiovasc Surg 2014;147:301–306.
2. Ozaki S, Kawase I, Yamashita H, Uchida S, Takata H, Kiyohara N. Midterm outcomes after aortic valve neocuspization with glutaraldehyde-treated autologous pericardium. J Thorac Cardiovasc Surg 2018;155:2379–2387.
3. Blanke P, Pibarot P, Hahn R, Weissman N, Kodali S, Thourani V, Parvataneni R, Dvir D, Naoum C, Norgaard BL, Douglas P, Jaber W, Khaliwai OK, Jilaihawi H, Mack M, Smith C, Leon M, Webb J. Leipsic J. Computed tomography-based oversizing degrees and incidence of paravalvular regurgitation of a new generation transcatheter heart valve. JACC Cardiovasc Interv 2017;10:810–820.
4. Kodali S, Thourani VH, White J, Malaisrie SC, Lim S, Gressson KL, Williams M, Guerrero M, Eisenhauer AC, Kapadia S, Kereiakes DJ, Herrmann HC, Babaliaros V, Szteto WY, Hahn RT, Pibarot P, Weissman NJ, Leipsic J, Blanke P, Whisenant BK, Suri RM, Makkar RR, Ayele GM, Svensson LG, Webb JG, Mack MJ, Smith CR, Leon MB. Early clinical and echocardiographic outcomes after SAPIEN 3 transcatheter aortic valve replacement in inoperable, high-risk and intermediate-risk patients with aortic stenosis. Eur Heart J 2016;37:2252–2262.
5. Yoon S-H, Schmidt T, Bleiziffer S, Schofer N, Fiorina C, Munoz-Garcia AJ, Yzeiraj E, Amat-Santos IJ, Tchetchet D, Jung C, Fujita B, Mangieri A, Deutsch MA, Ubben T, Deuschl F, Kuvata S, De Biase C, Williams T, Dhole A, Kim W-K, Ferrari E, Barbanti M, Vollema EM, Miceli A, Giannini C, Atizzani GF, Kong WKF, Gutierrez-Ibanes E, Jimenez Diaz VA, Wijesundera HC, Kaneko H, Chakravarthy T, Makar M, Sievert H, Hengstenberg C, Prendergast BD, Vincent F, Abdel-Wahab M, Nobre-Franco L, Silaschi M, Tarantini G, Butter C, Ensminger SM, Hildick-Smith D, Petronio AS, Yin W-H, De Marco F, Testa L, Van Mieghem NM, Whisenant BK, Kuck K-H, Colombo A, Kar S, Moris C, Delgado V, Maisano F, Nettleship F, Mack MJ, Schofer J, Schaefer U, Bax JJ, Frerker C, Latsib A, Makkar RR. Transcatheter aortic valve replacement in pure native aortic valve regurgitation. J Am Coll Cardiol 2017;70:2752–2763.