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CASE REPORT
Other

Modified valve-in-valve bailout technique of transcatheter aortic valve replacement in severe aortic regurgitation for valve jumping up to ascending aorta: a case report

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Background Aortic regurgitation remains a challenge for transcatheter aortic valve replacement (TAVR), because of the high risk of post-procedural migration or paravalvular leakage resulting from the anatomical and pathophysiological features.

Case summary A 75-year-old male with symptomatic severe aortic regurgitation underwent transfemoral TAVR due to poor physical condition and a Society of Thoracic Surgeons score of 11.3%. However, complete dislodgement of the valve into the ascending aorta occurred during the operation. We performed a modified valve-in-valve technique by using an ablation catheter (instead of performing urgent surgery), and no post-interventional complications were found during hospitalization. The patient was discharged in a stable condition on postoperative Day 12. At the 6-month follow-up, echocardiography showed trivial paravalvular leakage. The left ventricular ejection fraction further improved from 30 to 48%.

Discussion The management of valve migration can be troublesome. In this case, we performed a modified valve-in-valve technique by using an ablation catheter without post-interventional complications. This is a novel strategy for the management of emergencies, which could avoid surgical thoracotomy. Our strategy may be an alternative option in some cases of valve jumping up to the ascending aorta.

Keywords Aortic regurgitation • Transfemoral TAVR • Migration • Ascending aorta • Valve-in-valve • Case report

ESC curriculum 4.1 Aortic regurgitation • 9.1 Aortic disease • 6.4 Acute heart failure • 4.10 Prosthetic valves

Learning points

- Valve displacement caused by lack of valve anchoring force is still one of the problems in severe aortic regurgitation treated with transcatheter aortic valve replacement.
- Modified valve-in-valve technique by using ablation catheter may be an alternative option in some cases of valve jumping up to the ascending aorta.

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Introduction

Outcomes for aortic regurgitation (AR) are poor once symptoms develop, with a 5-year survival of only 30%.[1] Although surgical aortic valve replacement (SAVR) is currently the preferred treatment according to current guidelines,[2] many patients are ineligible due to high surgical risk. Transcatheter aortic valve replacement (TAVR) is still used in an off-label manner for AR to reduce mortality and improve quality of life. Registration data demonstrate that the incidence of TAVR device dislodgement in AR treated with new-generation valve is as high as 9%,[3] which is still significantly higher than that in aortic stenosis treated with TAVR.[4] Herein, we report a case of a symptomatic severe AR patient who underwent TAVR due to high surgical risk. However, complete dislodgement of the valve into the ascending aorta occurred during the operation. We performed a modified valve-in-valve technique by using an ablation catheter.

Timeline

Admission	Admitted to hospital with acute heart failure symptoms. Transthoracic echocardiogram demonstrated severe aortic regurgitation with a left ventricular ejection fraction (LVEF) of 30%
Hospital Day 1	Worsening of dyspnoea, admission to coronary care unit (CCU), intermittent ventilation, *diuretic*, and inotropes
Days 2–10	Computed tomography show dilation of the aortic annulus and a lack of calcium. The heart team decided to perform transfemoral TAVR due to poor physical condition and a Society of Thoracic Surgeons score of 11.3%
Day 20	Deployment of a 32 mm retrievable VenusA-Plus valve under rapid pacing. However, complete dislodgement of the valve into the ascending aorta occurred during the operation. We performed a modified valve-in-valve technique by using an ablation catheter without post-interventional complications
Day 42	Discharged from hospital
Day 200	Improvement of cardiac function (LVEF 48%) at follow-up

Case presentation

A 75-year-old male was hospitalized for acute heart failure symptoms [New York Heart Association (NYHA) Class IV]. Two years ago, he was diagnosed with aortic regurgitation. Comorbidities were hyperlipidaemia, hypertension, renal insufficiency, and cerebral infarction. His cardiovascular medications included spironolactone 20 daily, furosemide 20 mg daily, and sacubitril/valsartan 100 mg daily. Heart rate was 71 beats/min, blood pressure was 116/49 mmHg, and respiratory rate was 16 breaths/min. Physical examination revealed a harsh holodiastolic murmur at aortic valve area, scattered rales in the lungs, and moderate peripheral oedema. The patient was quickly transferred to the coronary care unit and received urgent treatment: intermittent ventilation and intravenous bolus of cedi-lanid (0.2 mg) for 6 days and furosemide (20 mg) for 14 days.

Transthoracic echocardiography (TTE) demonstrated severe aortic regurgitation (*Figure 1A* and Supplementary material online, *Video S1*), severe mitral regurgitation, and a dilatational atrioventricular structure, with a left ventricular ejection fraction (LVEF) of 30%. The left ventricular diameter in diastole was 64 mm (*Table 1*). The colour Doppler regurgitation jet of the aortic valve showed a width of 78%; additionally, the Doppler vena contracta was 1.1 mm wide. The laboratory chemistry revealed NT pro-BNP of 10 663 pg/mL (normal $<$125 pg/mL). Computed tomography angiography (CTA, *Figure 2*) showed dilation of the aortic annulus (perimeter 83.8 mm, average diameter 26.8 mm) and lack of calcium. The left ventricular outflow tract (distal to the annulus, 4 mm) perimeter and average diameter were 92.5 and 29.2 mm, respectively. The sinotubular junction height and average diameter were 29.5 and 37.8 mm, respectively. Sinus of the Valsalva dimensions (35.4 mm×37.7 mm×40.9 mm) and coronary ostia (left 13.4 mm, right 20.6 mm) suggested the low risk of coronary obstruction.

The Society of Thoracic Surgeons (STS) score was 11.3%. Poor physical conditions resulted in the patient being ineligible for SAVR and transapical TAVR, and the heart team decided to perform transfemoral TAVR. Based on the CT measurements, a 32 mm retrievable VenusA-Plus valve (Venus Medtech, Hangzhou, China; *Figure 3*) was chosen. The procedure was performed under general anaesthesia via femoral access. A 20 Fr sheath was placed into the right femoral artery as the main access, and a 7 Fr sheath was placed into the left femoral artery as the auxiliary access. The pigtail catheter passed through the auxiliary access into the non-coronary cusp. After delivery through main access to the annular plane (*Figure 1B*), the valve was deployed under rapid pacing (180 beats/min) (*Figure 1C* and Supplementary material online, *Video S2*). However, the entire valve jumped up to the ascending aorta (*Figure 1D* and Supplementary material online, *Video S3*). The patient was ineligible for removal of the dislodgement of the valve via surgery. Therefore, a valve-in-valve (VIV) strategy was performed for entrapment of the dislocation valve. A steerable ablation catheter (APT Medical Inc., Shenzhen, China) was delivered to the ascending aorta and shaped into an L-shape. The head of the ablation catheter crossed the mesh of the valve. Subsequently, the dislocated valve was delicately pushed towards the sinus of Valsalva and fixed firmly with the help of the ablation catheter (*Figure 1E* and Supplementary material online, *Video S4*). The upper crown of the second 32 mm VenusA-Plus was anchored at the narrowest part of the first valve (*Figure 1F* and Supplementary material online, *Video S5*). Angiography (*Figure 1G* and Supplementary material online, *Video S6*) and TTE (*Figure 1H* and Supplementary material online, *Video S7*) at the end of the procedure showed a well-functioning prosthesis with trivial perivalvular leakage (PVL). No new conduction block was observed in the post-procedural electrocardiogram. The patient was discharged in a stable condition on postoperative Day 12. At the 6-month follow-up, cardiac function was improved to NYHA Class I, and echocardiography confirmed trivial paravalvular leakage without valve migration. The LVEF further improved from 30 to 48%, and mitral regurgitation was improved from severe to mild (*Table 1* and Supplementary material online, *Video S8*).

Discussion

The anatomical and pathophysiological features of AR including dilation of the aortic root, ascending aorta, and the lack of calcium may result in

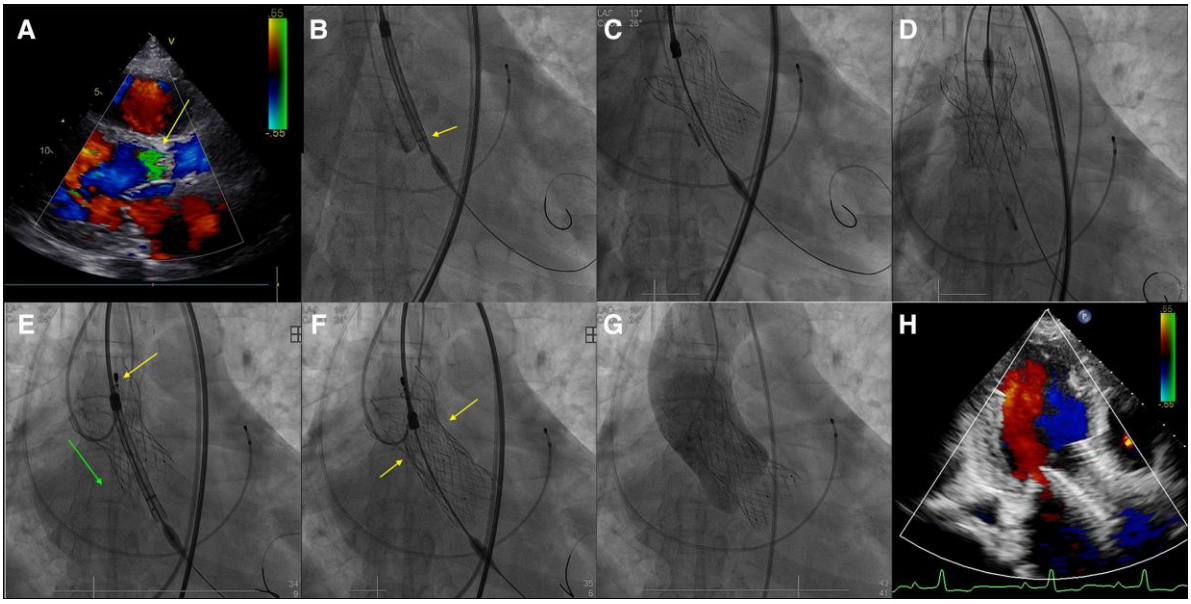


Figure 1 (*A*) Transthoracic echocardiography on admission showing severe aortic regurgitation in diastole; (*B*) the marker point of the valve was slightly higher than that of the non-coronary cusp plane; (*C*) position of the first valve after deployment; (*D*) the entire valve jumped up to the ascending aorta; (*E*) the passage of the ablation catheter through the mesh of the valve (yellow arrow) and pushing of the valve to the sinus of Valsalva (green arrow); (*F*) the corolla of the second valve was anchored at the narrowest part of the first valve; (*G*) angiography at the end of the procedure. (*H*) Result of the post-procedural transthoracic echocardiography.

Table 1 **Outcomes of echocardiography**

	LVEF (%)	LAD (mm)	LVDD (mm)	RAD (mm)	RVD (mm)	AR (PVL)	MR
Admission	30	63	64	58	34	severe	severe
7 days after operation	31	49	61	52	37	trivial	severe
6 months after operation	48	50	60	32	30	trivial	mild

LVEF, left ventricular ejection fraction; LAD, left atrial diameter; LVDD, left ventricular diastolic diameter; RAD, right atrial diameter; RVD, right ventricular diameter; AR, aortic regurgitation; PVL, perivalvular leakage; MR, mitral regurgitation.

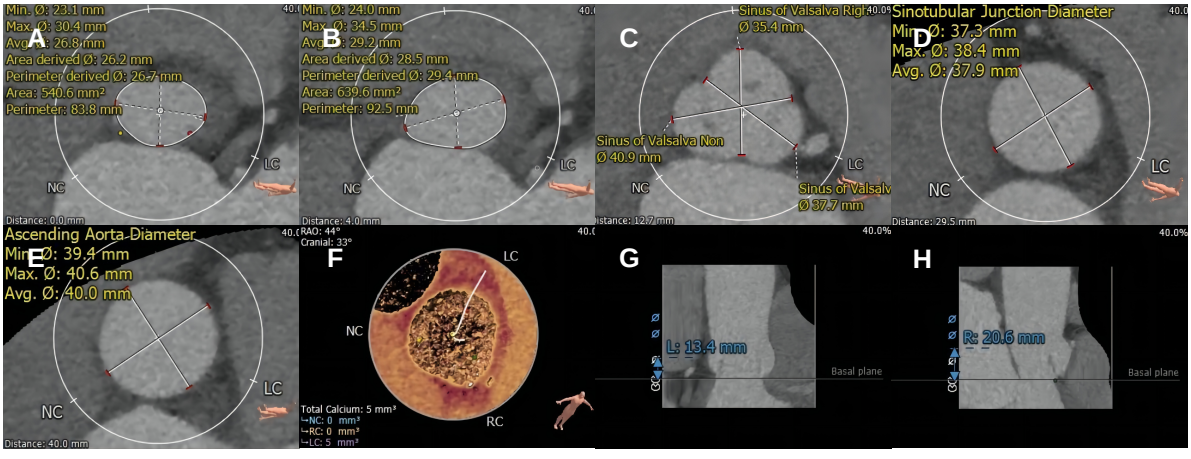
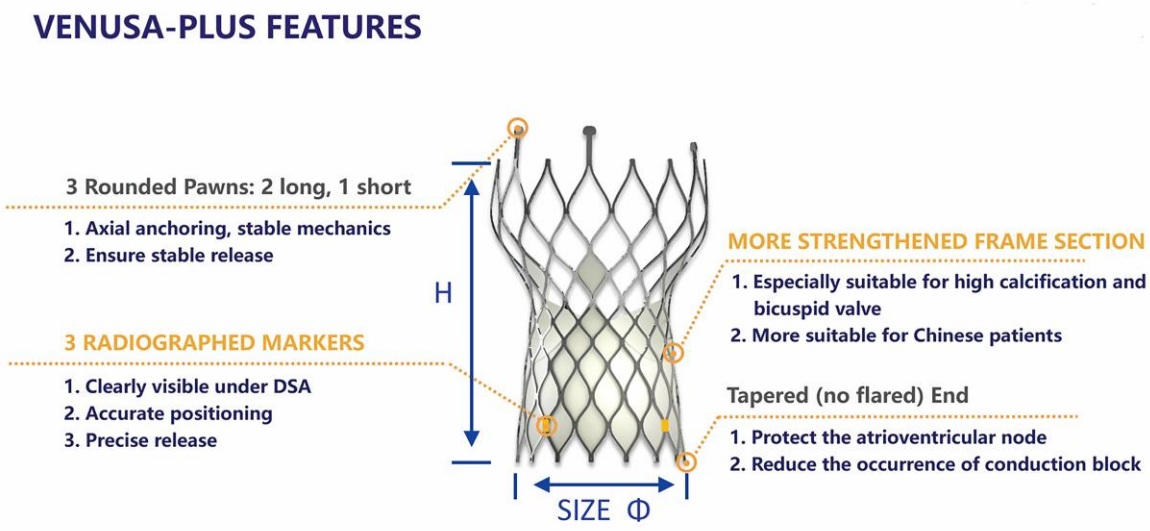


Figure 2 (*A*) the perimeter and average diameter of the annulus were 83.8 and 26.8 mm, respectively. (*B*) The perimeter and average diameter of the left ventricular outflow tract were 92.5 and 29.2 mm, respectively. (*C*) The diameter of the sinus of Valsalva was 40.9 mm (non), 35.4 mm (right), and 37.7 mm (left). (*D*) The average diameter of the sinotubular junction was 37.9 mm. (*E*) The average diameter of the ascending aorta was 40.0 mm. (*F*) The total calcium was 5 mm^3. (*G* and *H*) The left and right coronary artery ostial heights were 13.4 and 20.6 mm, respectively.



size Φ	23mm	26mm	29mm	32mm
Aortic Annulus Diameter	17-20mm	20-23mm	23-26mm	26-29mm
Height H	46mm	50mm	50mm	50mm

Figure 3 The VenusA-Plus valve. VenusA-Plus valve is made of a self-expanding nitinol frame and tri-leaflet porcine pericardial valve.

a high risk of post-procedural migration, which limit the application of TAVR in AR. For patients with AR and ineligible for SAVR, the guideline mentions that TAVR may be considered in experienced centres.[2] Compared with transfemoral access, transapical access is associated with a higher risk of complications, including adverse periprocedural events and death.[5,6]

VenusA-Plus valve in this case is the approved domestic self-expanding transcatheter heart valve (THV) by the China Medical Products Administration with a similar design to the CoreValve but a stronger radial force designed for aortic stenosis. It is the second-generation THV, while thoroughly optimizing the delivery system and adding retrievable and repositionable features. Most of the current valves were originally designed for aortic stenosis, and new-generation off-label valves that are used in AR have demonstrated feasibility.[7] Combined with STS score of 11.3% and poor physical condition, transfemoral TAVR might be an option for the patient to reduce mortality and improve quality of life, and VenusA-Plus valve was chosen.

Adequate oversizing of the valve is a key factor for a successful procedure. Large degrees of oversizing (>15–20%) were proposed for lack of calcium and the more expansile aortic regurgitation.[8] In this case, the oversizing was 19.2% in relation to the annulus perimeter, but there was little anchoring force in the plane of the ascending aorta and left ventricular outflow tract. The valve was almost solely anchored by the single annular plane, which led to valve migration.

Severe AR resulting in secondary MR is common. Whether correction of the volume overload by aortic valve replacement is sufficient to manage severe secondary MR has not yet been established. Mitral valve repair or replacement in patients with combined severe AR and secondary MR has a Class IIa recommendation (level of evidence B).[9] At the 6-month follow-up, the MR of the patient was improved from severe to mild. Thus, for the MR in this case, conservative treatment may be a well strategy.

Surgical bailout is a usual option and more reported in pure AR patients undergoing TAVR.[10] Most pure AR patients undergoing TAVR are high-risk surgical risk, and surgical bailout will lead to adverse events including death. In this case, the head of the ablation catheter has the steerable characteristics, which can help capture the migrated valve and push it back to annulus more easily. This is a novel bailout strategy for the management of emergencies, which could avoid surgical thoracotomy. However, attention should be used to avoid aortic wall trauma and coronary obstruction. If possible, our strategy may be an alternative option in some cases of valve jumping up to the ascending aorta.

Lead author biography

Dr Jing Chen is the director of Division V of Cardiovascular Medicine Department in Renmin Hospital of Wuhan University. She has particular expertise in the interventional therapy of the coronary artery and valvular heart diseases. She is also a Fellow of the American College of Cardiology and an associate professor.

Supplementary material

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

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

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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