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.
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, 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-in-valve technique by using an ablation catheter.

Timeline

| Day   | Event                                                                                       |
|-------|--------------------------------------------------------------------------------------------|
| Admission Day 1 | Admitted to hospital with acute heart failure symptoms. Transthoracic echocardiogram demonstrated severe aortic regurgitation with a left ventricular ejection fraction (LVEF) of 30% |
| Days 2–10 | Worsening of dyspnoea, admission to coronary care unit (CCU), intermittent ventilation, diuretic, and inotropes |
| Day 20 | 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 42 | 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 200 | Discharged from hospital 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 cedilanid (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 aortocircumferential 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 (diameter 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.

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 mm³. (G and H) The left and right coronary artery ostial heights were 13.4 and 20.6 mm, respectively.
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. Compared with transfemoral access, transapical access is associated with a higher risk of complications, including adverse periprocedural events and death. 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. 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. 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). 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. 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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