

Delayed Valsalva obstruction after transcatheter self-expandable aortic valve implantation: a case report

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Background

Delayed coronary obstruction after transcatheter aortic valve implantation has been reported to occur more commonly after self-expandable aortic valve implantation than balloon-expandable valve.

Case summary

An 86-year-old woman treated by transcatheter self-expandable aortic valve implantation had acute coronary syndrome 3 months after the procedure. Emergent coronary angiography showed decreased blood flow in the left coronary artery. Balloon angioplasty between the valve frame and the left coronary cusp was performed, and her ischaemia resolved. Contrast-enhanced computed tomography showed a commissural post of the supra-annular valve overlying the left coronary cusp, and serial computed tomography showed the valve frame expanding over time. She received coronary bypass grafting using saphenous vein grafts for the left anterior descending and left circumflex arteries. Four months after surgery for the left anterior descending artery, the patient had recurrent chest pain, and computed tomography showed a graft occlusion in the left anterior descending artery. Shortly afterwards, she died of sudden cardiac arrest.

Discussion

In this report, we describe delayed Valsalva obstruction after transcatheter self-expandable aortic valve implantation, which can be detectable by serial computed tomography. The sealing of a coronary cusp by a commissural post of the valve may be one of the causes of delayed coronary ischaemia after transcatheter self-expandable aortic valve implantation.

Keywords

Transcatheter aortic valve implantation • Aortic stenosis • Self-expandable aortic valve • Coronary obstruction • Case report

Learning points

- Commissural posts of supra-annular valves for transcatheter aortic valve implantation might cause delayed coronary ischaemia by overlaying the coronary arteries.
- This is rare but a severe complication, which may be prevented with a careful and meticulous procedure planning and use of specific methodological techniques.
- Special attention should be paid in particular to patients with small sinuses of Valsalva and those with commissural posts of supra-annular valves overlying the coronary arteries.

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Introduction

Transcatheter aortic valve implantation is widely used in patients with severe aortic stenosis despite surgical risk, because good prognosis can be predicted even in elderly patients.^{1,2} Both the newer-generation self-expandable and balloon-expandable transcatheter aortic valves have been widely used on the basis of the patient and anatomical condition (Table 1).^{3–6} Acute coronary obstruction is an unsolved clinical problem after transcatheter aortic valve implantation, which is caused by the shift of bulky calcified nodules on the coronary leaflets, especially after balloon-expandable aortic valve implantation.⁷ A recent study showed that the incidence of delayed coronary obstruction was more common after self-expandable aortic valve implantation.⁸ The continuing expansion of the valve seems to be one of the mechanisms of coronary obstruction, but the details are largely unexplored. Here, we report a case of delayed coronary obstruction due to the sealing of a coronary cusp after self-expandable aortic valve implantation.

Timeline

Procedure day	Transcatheter self-expandable aortic valve implantation
Seven days	Discharge home without any symptoms
Three months	Acute coronary syndrome due to delayed Valsalva obstruction Emergent coronary artery bypass grafting for the left anterior descending artery with a saphenous vein graft
Five months	Recurrence of chest discomfort at rest and widespread-redistribution revealed by myocardial perfusion imaging Coronary artery bypass grafting for the left circumflex artery with a saphenous vein graft
Seven months	Graft occlusion in the left anterior descending artery revealed by computed tomography Death of sudden cardiac arrest

Case presentation

The patient, an 86-year-old woman with hypertension and bilateral internal carotid artery stenosis, presented with a several-day history of dyspnoea on exertion. She had a harsh ejection murmur on cardiac auscultation and bilateral pitting oedema of her legs. Contrast-enhanced computed tomography (CT) revealed significant stenosis in the proximal left anterior descending artery, and transthoracic echocardiography showed severe aortic stenosis (Vmax 4.3 m/s and mean transvalvular gradient 43 mmHg without a high flow state). Pulmonary function tests were normal. Her status was vulnerable with clinical frailty scale of 4 and Society of Thoracic Surgeons (STS) score of 5.23%. After considering her advanced age, frailty, and intermediate surgical risk, the heart team decided to perform

transcatheter aortic valve implantation after percutaneous coronary intervention with a drug-eluting stent.⁹ Preprocedural contrast-enhanced CT findings were as follows: annulus diameter calculated from the area (360 mm²) and perimeter (67.3 mm), 21.4 mm for both; Valsalva diameter calculated from the area (667 mm²), 29.1 mm; sinotubular junction diameter calculated from the area (429 mm²), 23.4 mm; and bilateral femoral artery diameter, <5.5 mm. The coronary heights of the left and right coronary arteries were 15.7 and 15.1 mm, respectively. After successful percutaneous coronary intervention with a drug-eluting stent, the heart team decided to implant an Evolut R valve (Medtronic, Minneapolis, MN, USA) because of her femoral artery narrowing. The risk of coronary obstruction seemed to be relatively low with the adequate height of the coronary ostium and no bulky calcified nodules on the coronary leaflets, although the sinuses of Valsalva were slightly small. Admission medications included aspirin, prasugrel, candesartan, rosuvastatin, and vonopranzan. A 26-mm valve was implanted via the left femoral access using an EnVeo R InLine sheath (Medtronic). Post-procedural angiography showed that the left coronary artery ostium was patent and that the valve was placed at the optimal position (Figure 1A). Seven days later, the patient was discharged from hospital without any symptoms.

Three months later, the patient re-presented with chest pain at rest. An electrocardiogram showed global ST-segment depression in the inferior and precordial leads, and transthoracic echocardiography left ventricular dysfunction in the anterior to lateral wall. Emergent coronary angiography showed no stenosis in the right coronary artery, and the guiding catheter failed to reach the left coronary artery. A cusp shot of the neo-Valsalva showed TIMI-2 flow in the left coronary artery (Figure 1B). We initiated intra-aortic balloon pumping to treat cardiogenic shock, after which her haemodynamic state became stable, but her chest discomfort did not resolve completely. We performed balloon angioplasty between the valve frame and the left coronary cusp using a semi-compliant balloon (4.0 mm × 15 mm) (Figure 1C), after which her ST-segment depression improved, and her chest discomfort resolved (Figure 1D and Videos 1 and 2). Regardless, the instantaneous wave-free ratio dropped significantly from the left coronary artery ostium to the neo-Valsalva.

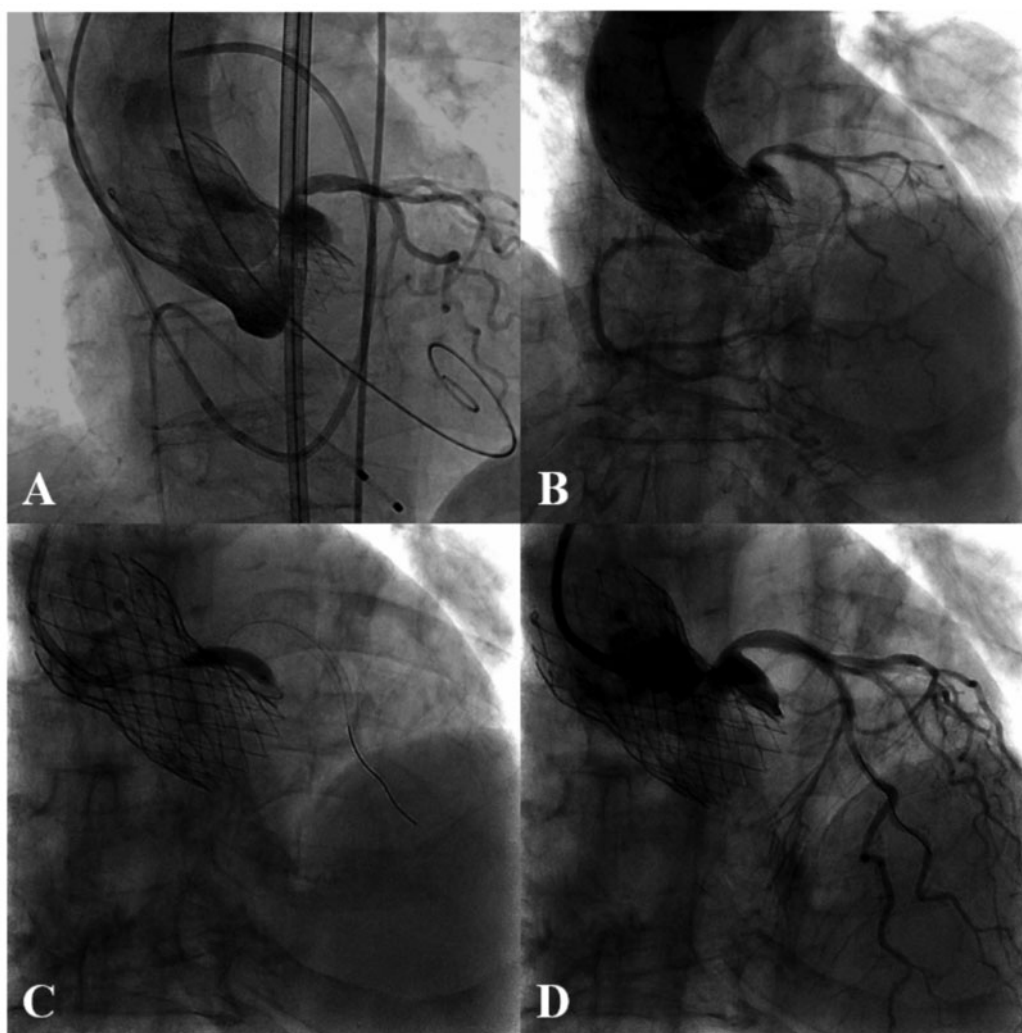
Contrast-enhanced CT showed a commissural post of the supra-annular valve overlying the left coronary cusp (Figure 2). We performed emergent off-pump coronary bypass grafting using a saphenous vein graft for the left anterior descending artery by median sternotomy because there were no stenotic lesions in the proximal left anterior descending and left circumflex arteries and the saphenous vein graft had a flow demand that was enough for the left coronary artery.

Two months after the surgery, however, she had recurrent chest pain at rest, and myocardial perfusion imaging revealed widespread redistribution at the antero-lateral site. We then performed off-pump coronary bypass grafting using a saphenous vein graft for the left circumflex artery by left anterior small thoracotomy. After the second surgery, she underwent physical therapy at a rehabilitation institution without any symptoms on exertion.

Four months after the first surgery, the patient had recurrent chest pain, and contrast-enhanced CT showed a graft occlusion in the left anterior descending artery. Shortly afterwards, she died of sudden cardiac arrest.

Table 1 Characteristics of newer-generation self-expandable and balloon-expandable transcatheter aortic valves

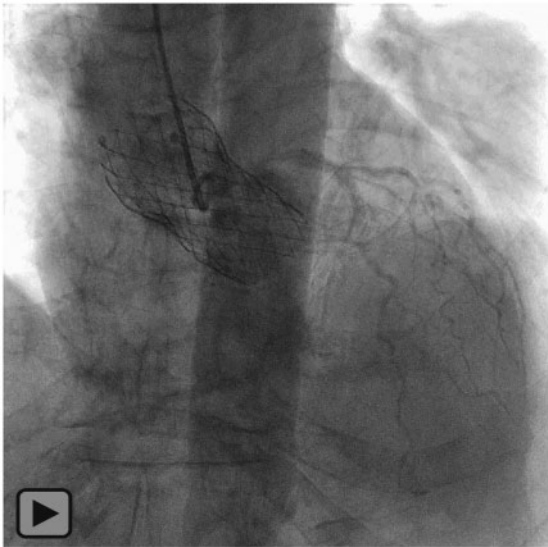
	Self-expandable valve	Balloon-expandable valve
Valve concept		
Newer-generation type	Evolut R (Medtronic)	Sapien 3 (Edwards)
Annular design	Supra-annular	Intra-annular
Recapture	Possible	Impossible
Minimum vascular access	5 mm	5.5 mm
Coronary access	Worse	Better
Device landing zone calcification	Advantage (presumably)	Disadvantage (presumably)
Clinical outcomes		
Pacemaker risk	Higher (presumably)	Lower (presumably)
Perivalvular leakage	More (presumably)	Less (presumably)
Coronary ischaemia	More at the chronic phase (presumably)	More at the acute phase (presumably)

**Figure 1** Angiograms after self-expandable aortic valve implantation with contrast dye (A). Angiograms before (B), during (C), and after (D) balloon angioplasty for acute coronary syndrome.

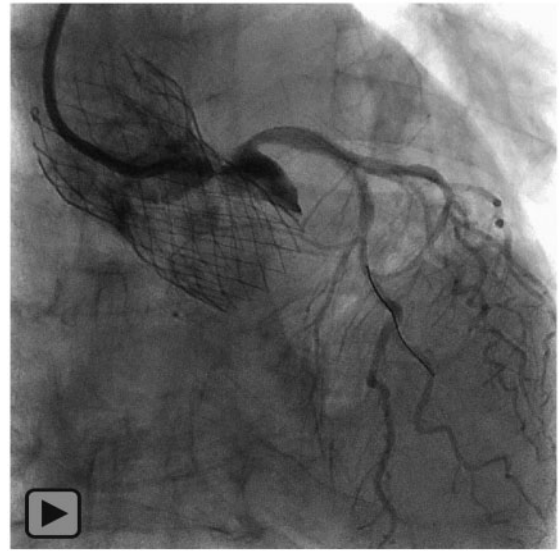
Discussion

Delayed coronary obstruction after transcatheter aortic valve implantation is a rare phenomenon. A multicentre registry showed that its incidence was 0.22% and that it occurred more commonly

after self-expandable aortic valve implantation than after balloon-expandable valve implantation.⁸ Evolut R is a supra-annular valve with a self-expanding nitinol frame, and the height of its commissural post is 26 mm (Figure 2). Ninomiya et al.¹⁰ reported a case of acute coronary syndrome caused by delayed coronary



Video 1 Angiograms before balloon angioplasty for acute coronary syndrome.



Video 2 Angiograms after balloon angioplasty for acute coronary syndrome.

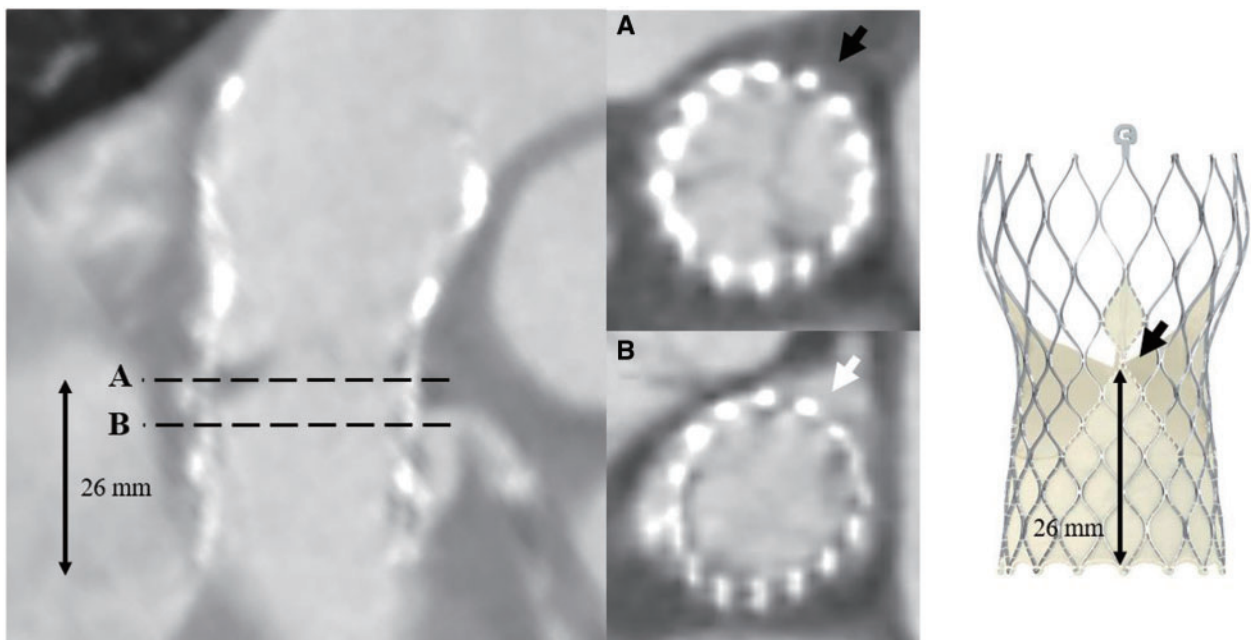


Figure 2 Contrast-enhanced computed tomography showing the distance between the waist of the Evolut R valve (A) and the level of the left coronary cusp (B). The arrows indicate a commissural post of the valve at each level.

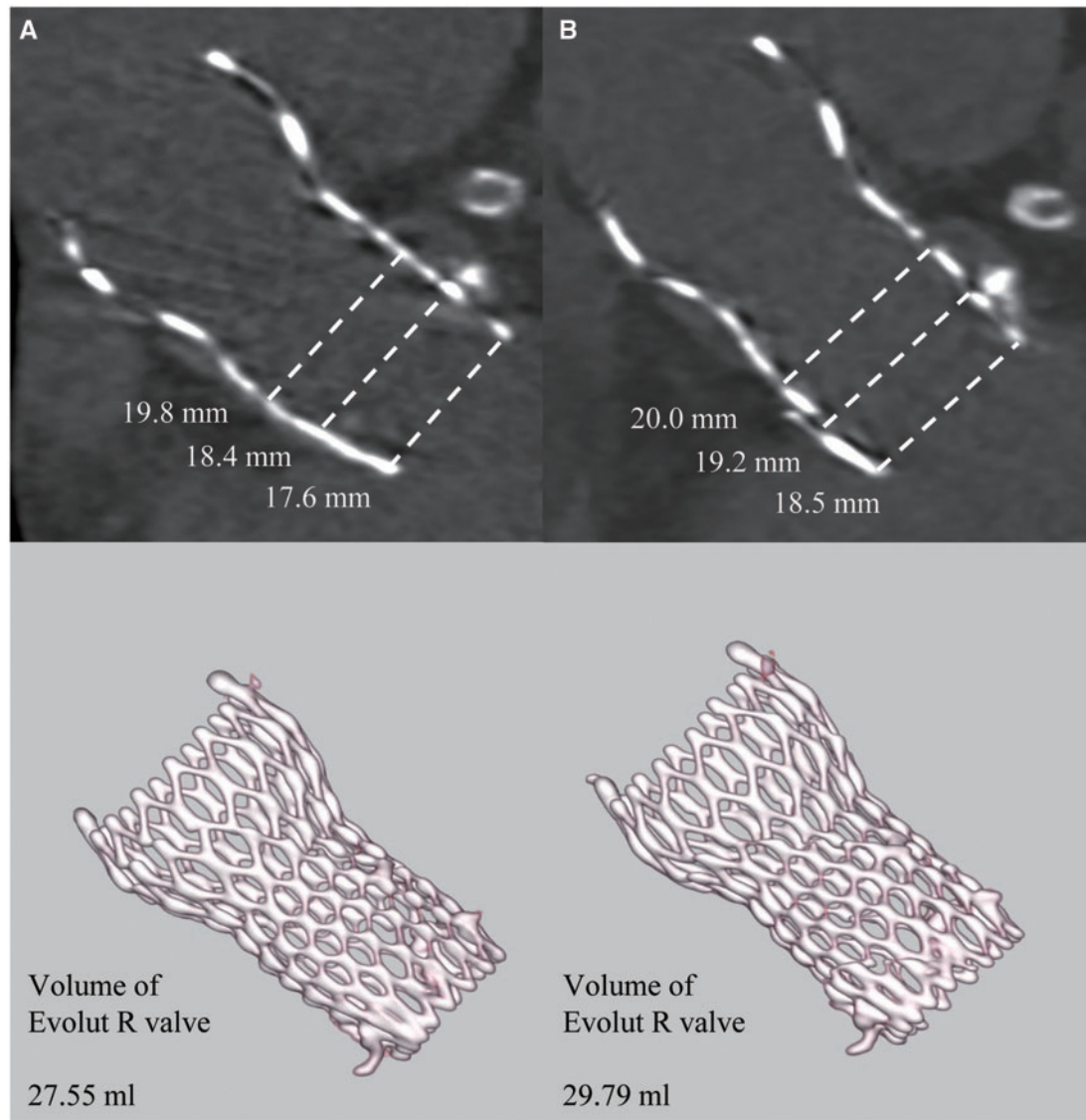


Figure 3 Temporal changes in the size of the Evolut R valve. Post-procedural computed tomography and volume rendering at 5 days (A) and at 3 months (B).

ischaemia after transcatheter self-expandable aortic valve implantation and revealed that a higher position of the self-expandable valve might induce coronary obstruction, especially in patients with small sinuses of Valsalva. In the present case, the commissural post accidentally overlaid the left coronary artery ostium, and the left coronary cusp was gradually blocked by the supra-annular valve. This mechanism is inherent to small sinuses of Valsalva, even when the valve is placed appropriately. In addition to progressive thrombus formation and endothelialization, valve dilatation over time might be also causal (Figure 3).

Valve implantation using hat marker orientation has been proposed to prevent this complication (Supplementary material online, Figures S3 and S4).¹¹ In this method, a C-paddle attached on one of the commissural posts is placed at 90° clockwise from the hat

marker. When the hat marker is oriented to the right direction with a projection in which both the right and left coronary ostia were visible, the commissural post coaxially aligned with the C-paddle is placed centrally between the left and right coronary ostia. Accordingly, the risk of coronary artery overlap by all the commissural posts can be minimized. However, this method is not always effective because the tortuous aorta may bend the delivery sheath tridimensionally and ideal positioning of the projection device is sometimes difficult.¹² The patient of the present case received transcatheter aortic valve implantation to avoid cardiac surgery and consequently developed delayed Valsalva obstruction. Meticulous follow-up is needed when self-expandable valves are implanted in patients with small sinuses of Valsalva and those with commissural posts of supra-annular valves overlying the coronary arteries.

Conclusion

Delayed Valsalva obstruction after transcatheter self-expandable aortic valve implantation can be detectable by serial computed tomography. The sealing of a coronary cusp by a commissural post of the valve may be one of the causes of delayed coronary ischaemia after transcatheter self-expandable aortic valve implantation.

Lead author biography



Masanobu Ohya, MD, PhD, is an interventional cardiologist at Kurashiki Central Hospital. He earned his PhD degree in cardiovascular internal medicine from Kyoto University Graduate School of Medicine in 2017. Multiple publications in peer review journals. His clinical and academic interests include percutaneous coronary intervention, transcatheter aortic valve implantation, and cardiac imaging.

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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