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CASE REPORT
Other

Acute left main coronary occlusion after transcatheter aortic valve implantation: life-saving intervention using the snare technique—a case report

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Background Transcatheter aortic valve implantation (TAVI) has rapidly evolved and changed the field of structural cardiovascular intervention. Its advances lead to a marked reduction in the risk of complications and improved outcomes. However, TAVI is still associated with potential serious complications.

Case summary A 73-year-old man with severe aortic stenosis underwent TAVI using a 34-mm self-expanding aortic bioprosthesis. After valve deployment, the patient rapidly progressed to cardiac arrest. Acute left main occlusion, due to high valve implantation, was promptly recognized and advanced life support immediately initiated. Concomitantly, the valve was successfully retrieved toward the ascending aorta using the snare technique, resulting in immediate restoration of flow and successful cardiopulmonary resuscitation. Subsequently, a 29-mm balloon-expandable aortic bioprosthesis was uneventfully implanted. After TAVI, the patient had a remarkable clinical evolution and was discharged home at hospitalization day five without relevant electrocardiographic nor echocardiographic disturbances. At six-month follow-up, the patient remains asymptomatic and transthoracic echocardiography revealed a normofunctional aortic bioprosthesis with preserved left ventricular ejection fraction.

Discussion Acute coronary occlusion is a rare and life-threating complication of TAVI that may be prevented with accurate procedure planning. Pre-procedural computed tomography angiography is essential for a comprehensive patient evaluation, allowing appropriate valve selection, a key factor for successful management. Self-expandable valve retrieval with snare technique can be an appropriate strategy for the management of this complication. This case highlights the importance of performing these procedures in highly experienced centres and with fully equipped catheterization laboratories to allow timely interventions when facing unexpected events.

Keywords Transcatheter aortic valve implantation • Aortic stenosis • Acute coronary occlusion • Snare technique • Valve retrieval • Case report

ESC Curriculum 4.2 Aortic stenosis • 7.1 Haemodynamic instability

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Learning points

- To acknowledge the concept of coronary sequestration and understand the importance of prompt recognition and management of acute coronary occlusion, a rare and life-threatening complication of TAVI.
- To understand the importance of a careful evaluation of pre-procedural computed tomography angiography and appropriate valve selection.
- To recognize that emergent self-expandable valve retrieval with snare technique is a potential life-saving strategy for the management of acute coronary occlusion after TAVI.
- To acknowledge that cath labs and TAVI operators should be fully prepared to perform timely interventions when facing unexpected events.

Introduction

Transcatheter aortic valve implantation (TAVI) has rapidly evolved in the last decade to become the treatment of choice for most patients with severe aortic stenosis.[1] The widespread use of this treatment has prompted advances in transcatheter heart valve prostheses and TAVI-enabling devices leading to the simplification of the procedure, reduction of the risk of complications and improved short- and long-term outcomes.[2] Nevertheless, TAVI is still associated with potential serious complications, including annular or aortic rupture, coronary artery occlusion, myocardial infarction, stroke, or death.[3] Acute coronary occlusion after TAVI is a rare and life-threatening event with high morbidity and mortality rates.

Timeline

Time	Events
Six months before presentation	Progressively worsening exertion dyspnoea for daily activities and mild chest pain.
Initial presentation	Admitted for elective transcatheter aortic valve implantation (TAVI).
Procedure (day 0)	TAVI procedure using a 34-mm self-expanding CoreValve Evolut R, complicated by cardiac arrest due to acute left coronary sinus sequestration and occlusion of the main stem.
	Prompt initiation of advanced life support and valve retrieval with snare technique toward the ascending aorta, resulting in immediate restoration of flow and successful cardiopulmonary resuscitation
	Successful implantation of a 29-mm balloon-expandable Sapien 3 (Edwards) aortic bioprosthesis, as a second valve.
Cardiac Intensive Care Unit (day 0)	Extubated less than 6 h after the procedure, recovers uneventfully
Day 1	Transferred to the Cardiology ward. Post-procedural transthoracic echocardiography (TTE) showed no deterioration in left ventricular ejection fraction (LVEF) nor segmental abnormalities and a normofunctional aortic bioprosthesis.
Day 5	Discharged home
Six months follow-up	Remains asymptomatic and repeat TTE revealed a normofunctional aortic bioprosthesis with preserved LVEF. No heart failure hospitalizations nor major cardiovascular events.

Case presentation

A 73-year-old man presented with progressively worsening exertional dyspnoea and mild chest pain for the past six months. The patient denied syncope, orthopnea or paroxysmal nocturnal dyspnoea. His past medical history was notable for the presence of hypertension, dyslipidemia, type 2 diabetes, cerebrovascular disease, stage 3b chronic kidney disease, and Parkinson's disease. He was on regular valsartan 160 mg daily, amlodipine 5 mg daily, atorvastatin 40 mg daily, metformin 1000 mg daily, aspirin 100 mg daily, and levodopa/carbidopa 250 mg/25 mg three times a day.

On physical examination, he was afebrile, with normal breathing rate. The pulse rate was 77 bpm, and blood pressure 125/60 mmHg. A rough grade III/VI ejection systolic murmur in the aortic area, and clear chest sounds were present on cardiopulmonary auscultation. The abdomen was non-tender to palpation and there was no peripheral oedema.

To study his symptoms and murmur, the patient underwent a transthoracic echocardiogram (TTE) that revealed a severe aortic stenosis (peak velocity = 4.21 m/s, mean transvalvular gradient = 45 mmHg, estimated aortic valve area = 0.8 cm2) with an LVEF of 59%, and no other valvular abnormality. A 12-lead electrocardiogram (ECG) demonstrated sinus rhythm without conduction abnormalities, and coronary angiography showed no obstructive coronary artery disease. Pre-procedural computed tomography angiography (CTA) revealed a mean aortic annulus diameter of 26.4 mm, an annulus area of 548 mm2 and perimeter of 85.2 mm, with a moderately calcified tricuspid aortic valve—*Figure 1*. Careful analysis of CTA reconstructions indicated adequate coronary ostia height and acceptable sinuses of Valsalva (SOV) and sinotubular junction (STJ) dimensions (*Figure 1D-1DF*). Both iliofemoral axes had acceptable diameters and no severe calcification, enabling transfemoral approach.

The patient was deemed at low risk for surgical aortic valve replacement, with a Society of Thoracic Surgeons score of 3.27% and an EuroSCORE II of 3.67%.[4,5] On Heart Team meeting, percutaneous approach was favoured, considering frailty (Katz Index 4), the presence of comorbidities not adequately reflected by the scores, suitability for transfemoral access, low risk for permanent pacemaker, and patient's preference.

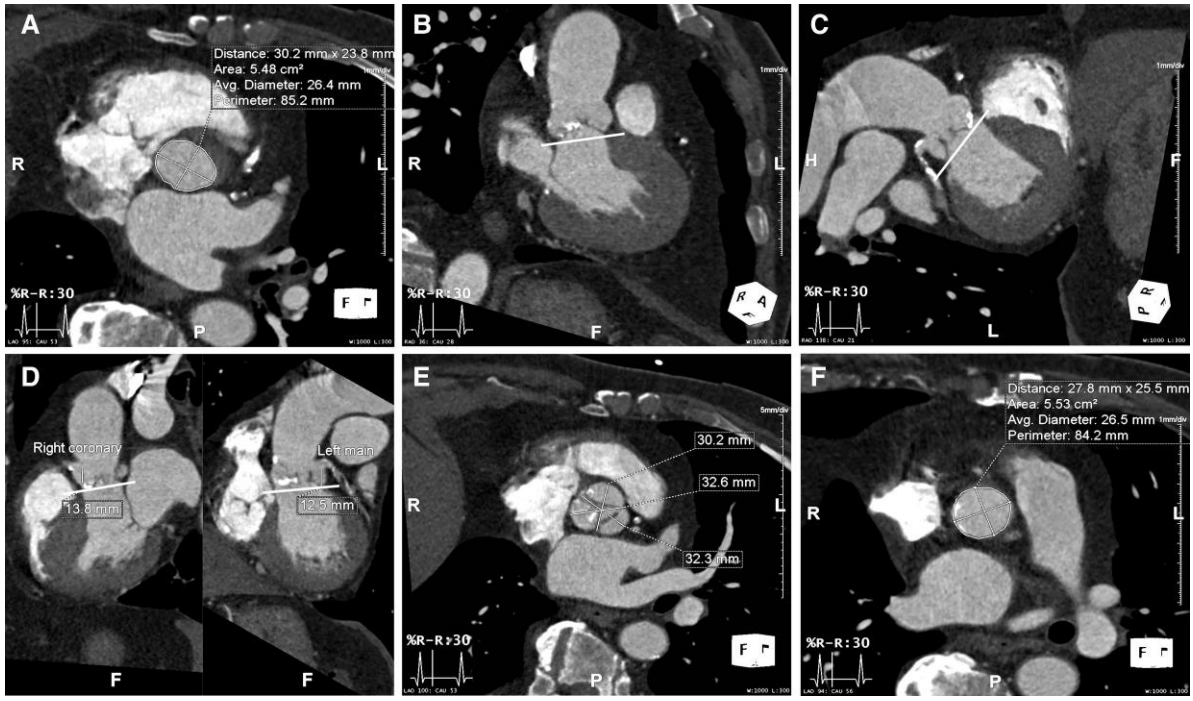

Figure 1 CTA-derived aortic valve reconstructions. (*A*) Mean annular diameter: 26.4 mm; annular area: 548 mm2 and annular perimeter: 85.2 mm. (*B and C*) Orthogonal multiplanar reconstructions of the annular plane (*D*) Left and right coronary artery ostium height. (*E*) Sinus of Valsalva dimensions. (*F*) Sinotubular junction measurements.

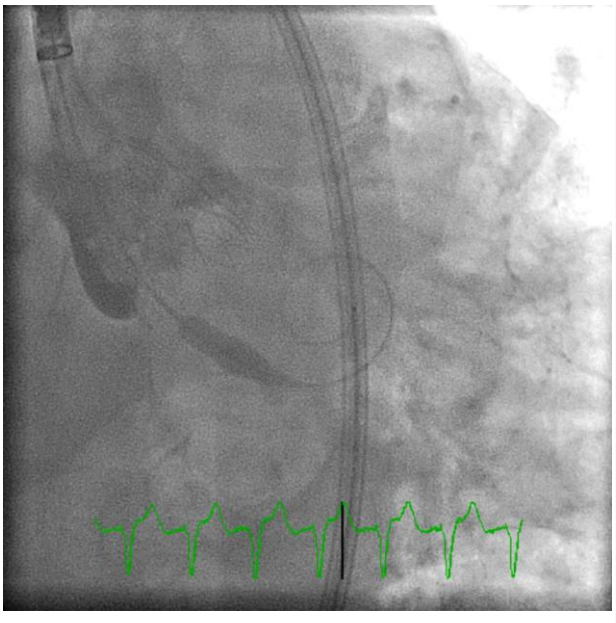

Figure 2 Aortography showing partial valve deployment immediately before release.

The procedure was performed under conscious sedation, and a 34-mm self-expandable CoreValve™ Evolut R™ (Medtronic) aortic bioprosthesis was selected for implantation. The right femoral artery was obtained using a 16F sheath for valve delivery (primary access), and the left radial artery was used for placement of a pigtail catheter, using a 6F sheath (secondary access). A Safari 2™ (Boston Scientific) extra small guidewire was advanced to the left ventricle, and the valve was slowly released under fluoroscopic guidance.

The implantation procedure was made difficult by haemodynamic instability every time the valve was flared on the aortic annulus. On third attempt, position check immediately before release, showed what seemed to be a good position, however careful prosthesis-cuspid alignment was not guaranteed (*Figure 2*). Immediately following valve implantation, the patient described chest pain and rapidly progressed with haemodynamic deterioration, culminating in cardiac arrest within less than a minute. Aortography revealed a very high valve implantation, without opacification of the left coronary sinus and occlusion of the main stem—coronary sequestration (Supplementary material online, *Video S1*). Advanced life support was promptly initiated, invasive ventilation was established, and a 20-mm Amplatz Goose Neck™ (Medtronic) snare was introduced through the secondary access to retrieve the valve (Supplementary material online, *Video S2*). It was rapidly and successfully removed toward the ascending aorta, resulting in immediate restoration of flow to the left main and a successful cardiopulmonary resuscitation (Supplementary material online, *Video S3*).

After achieving haemodynamic stability, detailed reanalysis of the aortic root was performed on CTA scan. The narrow STJ, SOV dimensions and the result obtained with the previous valve let the operators to decide to use a 29-mm balloon-expandable Sapien™ 3 (Edwards) aortic bioprosthesis, as a second valve. On this attempt, the valve was advanced through the CoreValve™ (Medtronic) placed in the ascending aorta, and uneventfully implanted with preserved flow to both coronary arteries (Supplementary material online, *Video S4*).

The patient was admitted to the Cardiac Intensive Care Unit with stable vital signs and without haemodynamic support. He was extubated less than 6 h later, and his clinical evolution was remarkable.

There were no neurologic disturbances, and despite a high-sensitive troponin-T peak of 1100 ng/L, post-procedural TTE showed no deterioration in LVEF nor segmental abnormalities, and a normofunctional aortic bioprosthesis (Supplementary material online, *Video S5*). Post-procedural ECG revealed no rhythm disturbances. He was discharged home at hospitalization day 5, on single antiplatelet therapy.

At the last clinical follow-up, six-month after discharge, the patient is in NYHA class I, and repeat TTE revealed a normofunctional aortic bioprosthesis with preserved LVEF. There were no heart failure hospitalizations nor major cardiovascular events.

Discussion

Acute coronary obstruction after TAVI is a rare and life-threatening complication. It is estimated to occur in less than 1% of cases and has a reported mortality rate of approximately 40%. The left coronary artery is most commonly affected (88%).[6,7] The main predictive factors of coronary occlusion include female gender, low coronary ostia height (<12 mm), narrow aortic root (<30 mm at the SOV), patients with previous surgical bioprosthesis and those receiving balloon-expandable valves.[6] These factors increase the likelihood of displacement of calcified native aortic cusps over the coronary ostium, shown to be the primary mechanism of coronary obstruction after TAVI. Other possible mechanisms involve: (1) ostium obstruction by the bioprosthesis itself due to malposition; (2) low coronary ostia height and obstruction of flow even with a well-placed prosthesis; (3) dislodgment of calcium debris; (4) leaflet avulsion and migration into the coronary ostium; (5) aortic dissection; or (6) haematoma extending near or into coronary ostia.[8]

Pre-procedural CTA is paramount for a comprehensive patient evaluation,[9] and these complications may be reasonably anticipated based on the derived anatomic details, enabling the use of some preventive strategies, such as a pre-implant balloon valvuloplasty with simultaneous associated aortography to ensure coronary patency, coronary protection with preventive coronary wiring or an undeployed balloon or stent, or the preference for repositionable valves, when intervening in patients with high-risk characteristics.[10,11] Additionally, the pre-procedural CTA, also allows appropriate valve selection, a key factor for successful treatment, that should be carefully reviewed.

Interestingly, this patient did not present any recognized risk factor for coronary obstruction. He is male, without previous valvular surgery and received a self-expandable valve. Pre-procedural CTA measurements, including, the distance from aortic annulus to coronary ostia seemed adequate (~13 mm and ~14 mm to left and right coronary ostia, respectively—*Figure 1D*), whereas SOV dimensions and annulus perimeter were within the range for a 34-mm CoreValve™ (Medtronic), according to the manufacturer sizing chart. However, STJ dimensions were relatively narrow for the valve size, and this should not have been neglected in our analysis (*Figure 1F*). Other potential source of error may have been an overestimation of the CT measurements, since the valve seemed to overfit the aortic root in the aortography (Supplementary material online, *Video S1*). Nevertheless, beyond inappropriate valve selection, technical characteristics, such as a high valve implantation, may also account for this complication. Indeed, the choice of a 34-mm CoreValve™ (Medtronic), due to its size and supra-annular leaflets functioning, associated with an extremely high implantation and relatively narrow STJ may have prevented passage of flow to the left coronary sinus (coronary sequestration), leading to left main occlusion. This complication may have been precluded by balloon sizing pre-implantation (both for size choice and for haemodynamic stabilization during deployment) or the use of a balloon-expandable valve, as positioning is less challenging than with self-expandable valves.

The spectrum of clinical presentation following coronary obstruction after TAVI may vary according to the severity of stenosis. Complete obstruction usually presents with severe persistent hypotension, ST-segment elevation, ventricular arrhythmias, and/or cardiac arrest. Conversely, partial obstruction may lead to more insidious presentation or delayed haemodynamic compromise.[6] The preferred treatment option is emergent percutaneous coronary intervention in most cases (>75%); however, some patients may need urgent coronary artery bypass surgery or mechanical haemodynamic support.[6,7,12] In extreme circumstances, snaring and removing the valve toward the ascending aorta may be a life-saving option to re-establish coronary flow, in the setting of self-expandable valve deployment.[10]

In fact, the management of this case required immediate intervention and the use of the snare technique was deemed necessary for coronary flow restoration. This technique, despite being recognized to manage several complications after TAVI,[10] is mainly used to valve repositioning after low implantation, in cases of severe paravalvular regurgitation, or to facilitate valve implantation in challenging anatomies.[13,14] Its use for valve retrieval after coronary occlusion is seldomly reported in medical literature, and to best of our knowledge, this is one the first case reports describing it to resolve a life-threatening coronary occlusion after TAVI.

This case highlights the importance of careful evaluation of the pre-procedural CTA and appropriate valve sizing, as well as the prompt recognition and management of this rare and life-threatening complication. It also demonstrates that valve retrieval with snare technique is a potential life-saving strategy, and reinforces the impact of performing these procedures in highly experienced centres and with fully equipped catheterization laboratories, to allow timely interventions when facing unexpected events.

Conclusion

We report a case of acute left main coronary occlusion after TAVI due to inappropriate valve sizing and high valve implantation, promptly recognized, and managed with valve retrieval using the snare technique, during cardiac arrest. This approach resulted in immediate restoration of coronary blood flow and successful cardiopulmonary resuscitation.

Lead author biography

Dr Pedro M. Lopes graduated in 2016 at Nova Medical School, Lisbon, Portugal. He is currently a Cardiology resident at Hospital Santa Cruz, Lisbon, Portugal. His main areas of interest include multimodality cardiovascular imaging and structural heart interventions.

Supplementary material

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

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.

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