The TAVR that Got Away: A Case Report

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INTRODUCTION

Transcatheter aortic valve replacement (TAVR) is being increasingly used for symptomatic severe aortic stenosis across all surgical risk populations. Although relatively well tolerated, TAVR carries inherent infrequent risks.[1] Complications include death, myocardial infarction, stroke, limb ischemia, bleeding, acute kidney injury, paravalvular regurgitation, valve malpositioning, embolization, coronary obstruction, and conduction abnormalities. Predicting, detecting, and managing possible complications in a timely fashion are essential in limiting adverse consequences and promoting better patient outcomes. Although left main coronary artery obstruction during TAVR infrequently occurs,[1] obstruction of the right coronary artery (RCA) is much less common because of a higher ostial takeoff. Herein we discuss the case of a patient with both RCA occlusion and valve migration during TAVR. There are no reports of this combination to our knowledge. We describe the importance of precise preprocedural imaging and the utility of multimodality imaging of these complications and their management.

CASE PRESENTATION

A 70-year-old woman with a medical history of renal transplantation in the setting of end-stage renal disease, prior venous thromboembolism on anticoagulation, hypertension, nonobstructive coronary artery disease, and severe aortic stenosis with a peak velocity of 4.2 m/sec, mean gradient of 46 mm Hg (Videos 1 and 2), and estimated Society of Thoracic Surgeons risk of 4.8% presented with New York Heart Association functional class II to III dyspnea on exertion. Preoperative computed tomography (CT) suggested adequate coronary heights with a coronary ostial height of 11.4 mm and sinus of Valsalva height of 20.5 mm on the left, a coronary ostial height of 13.2 mm and sinus of Valsalva height of 18.5 mm on the right, and an average aortic annular diameter of 22.3 mm, though not well visualized. The patient underwent TAVR with a Medtronic 26-mm Evolut PRO (Medtronic, Minneapolis, MN) bioprosthetic valve as specified by the annular dimensions obtained on CT. Valve deployment was successful (Figure 1A), with an improved peak velocity to 1.7 m/sec, mean gradient to 4.4 mm Hg, and trivial paravalvular regurgitation (Videos 3 and 4). The frame appeared well positioned and secure. Supravalvular root angiography immediately after valve deployment demonstrated patent coronary arteries and appropriate prosthesis location in reference to the aortic annulus.

After sheath removal and hemostasis, the patient became hypotensive with systolic blood pressure of 65 mm Hg and bradycardic at 45 beats/min. Electrocardiography showed inferior ST-segment elevation. Repeat transesophageal echocardiography (TEE) revealed new right ventricular (RV) dilation and severe dysfunction (Video 5), basal left ventricular inferior wall dyskinesis (Video 6), and no pericardial effusion (Figure 2). Aortography showed no RCA flow, prompting concern about native leaflet ostial obstruction (Figure 1B). The patient received extensive volume resuscitation, pressor support, and RV pacing. Multiple attempts were made to engage and wire the RCA ostium, which were largely unsuccessful (Video 7). Eventually, partial flow was restored (Video 8), which was associated with a drastic improvement in systolic blood pressure to >200 mm Hg, resolution of RV dysfunction, and improved left ventricular dysfunction (Video 9). Because of concern for potential RCA reocclusion in the future, the decision was made to proceed with wiring and possibly stenting the RCA through the prosthetic valve struts. With additional attempts to wire through the valve struts into the RCA ostium, the guiding catheter became trapped in the struts of the valve. Efforts to remove the trapped guiding catheter from the valve led to prosthetic valve dislodgement and migration into the ascending aorta (Figure 1C and Videos 10-12). Attempts were then made to withdraw the prosthetic valve back to the descending aorta using a lasso technique but were unsuccessful, as the expanded prosthesis could not be pulled beyond the aortic arch (Figure 3).

The team decided to defer further intervention at this point because of the prolonged hypotension and anesthesia and extensive contrast use. The plan was to enable the patient to recuperate to better tolerate surgical valve replacement and removal of the dislodged prosthesis in a few days. However, before this could be done, her clinical course was further complicated by profound hypoxia due to aspiration requiring endotracheal reintubation, cardiac tamponade due to RV perforation by the temporary pacer lead subsequently necessitating drainage, new-onset atrial fibrillation, and an acute ischemic stroke. The patient was eventually extubated and sent to an extended-care facility to recover for future surgical intervention. Unfortunately, she was readmitted for acute encephalopathy and septic shock and expired 2 months after TAVR (see Video 13).

DISCUSSION

This unusual case demonstrated two uncommon complications of TAVR: acute RCA occlusion with associated echocardiographic dysfunction and prosthetic valve migration in the setting of suboptimal preprocedural imaging. To our knowledge, no case reports describe both of these complications during a single procedure.

Valve migration occurs in approximately 0.2% of cases using self-expanding transcatheter aortic valve implants.[2] Risk factors for valve embolization include underestimation of the annular size leading to

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VIDEO HIGHLIGHTS

Video 1: TEE, midesophageal view at 43°, demonstrating a severely calcified and severely stenotic aortic valve.

Video 2: TEE, midesophageal view at 119°, focused view of the aortic valve. (*Left*) Two-dimensional view demonstrating severely calcified aortic valve leaflets with severely restricted motion. (*Right*) Color flow Doppler demonstrating highly turbulent flow across the severely stenotic aortic valve.

Video 3: TEE, midesophageal view at 134°, focused view of the aortic valve demonstrating successful transcatheter aortic valve deployment with a well-seated, normally functioning valve.

Video 4: TEE, midesophageal view at 134°, color flow Doppler, focused view of the aortic valve demonstrating decreased antegrade turbulence across transcatheter aortic valve prosthesis with trivial paravalvular regurgitation.

Video 5: TEE, midesophageal view at 0°, right atrial (RA) and RV focused view after transcatheter aortic valve deployment demonstrating marked RA and RV dilation and severe RV dysfunction.

Video 6: TEE, midesophageal view at 72°, left atrial and left ventricular (LV) focused view after transcatheter aortic valve deployment demonstrating basal LV inferior wall dyskinesis.

Video 7: X-ray fluoroscopy demonstrating a seated transcatheter aortic valve and attempted RCA ostial engagement using a guiding catheter through the prosthetic valve struts.

Video 8: X-ray fluoroscopy demonstrating a seated transcatheter aortic valve and some restoration of flow in the RCA after multiple failed attempts.

Video 9: TEE of the right ventricle and left ventricle. (*Left*) Midesophageal view at 0° demonstrating resolution of RV dilation and dysfunction. (*Right*) Midesophageal view at 90° demonstrating alleviation of left ventricular dysfunction.

Video 10: TEE, midesophageal view at 0°, of ascending aorta short axis, demonstrating dislodged transcatheter aortic valve in the ascending aorta.

Video 11: TEE, upper esophageal view at 0°, of aortic arch long axis (*left*) with three-dimensional correlate (*right*), demonstrating dislodged transcatheter aortic valve in the ascending aorta.

Video 12: X-ray fluoroscopy demonstrating dislodged transcatheter aortic valve in the ascending aorta.

Video 13: The video abstract case presentation demonstrates the sequence of clinical, echocardiographic, and fluoroscopic findings.

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an undersized prosthesis or incorrect positioning that is either too high or too low.[1] Aortic migration is typically managed by retrieving the valve high in the ascending aorta. This is done so as not to restrict a second valve's expansion or potentially compromise coronary arterial flow, which is a possible consequence of two valves placed in continuation.[1] In our case, valve migration was iatrogenic because of attempts to remove the trapped guiding catheter from the right coronary ostium. The operators deferred immediate surgical intervention because of the precedent RV shock, prolonged anesthesia, and substantial contrast use thus far. To date, no recommendations exist as to whether surgical intervention in the case of valve embolization can be safely deferred and for what duration this can be done without putting the patient at an extreme risk for further complications.

Coronary obstruction occurs with an incidence of approximately 0.3% to 0.4% during TAVR and is more common in the left main coronary artery, because of the naturally higher ostial takeoff of the RCA.[3,4] Mechanisms that have been implicated in cases of coronary obstruction during TAVR include ostial obstruction by native valve leaflets or, theoretically, by the transcatheter aortic valve implant frame. Risk factors for coronary obstruction include bulky calcification of the coronary leaflets, a <10- to 12-mm distance from the coronary ostia to the aortic annulus, and a small aortic root (<27–28 mm) with shallow sinuses of Valsalva,[1] the latter being present in our patient and also evident on long-axis TEE. Coronary obstruction should be suspected if the patient develops advanced heart blocks, lethal ventricular arrhythmias, or ST-segment elevation or, as in the case of our patient, rapidly progresses to a state of cardiogenic shock. Percutaneous coronary intervention with balloon angioplasty and possible stenting of the ostium are the mainstays of therapy; if these fail, coronary artery bypass grafting and removal of the malpositioned valve prosthesis are required. In our patient, it was suspected that RCA occlusion occurred because of native valve leaflet obstruction of the RCA ostium with progressive expansion on warming of the nitinol implant frame. On the basis of preoperative CT of annular dimensions and ostial heights, as well as the selected prosthetic valve size and type (self-expanding prosthesis portending a lower risk for coronary occlusion), RCA obstruction was not anticipated in our patient.

A key message demonstrated in this case is the crucial importance of multimodality imaging, in both the preoperative and intraoperative settings. Preoperatively, CT is often used to determine annular dimensions and coronary ostial and sinus of Valsalva heights and is excellent in quantifying the degree of valvular calcification. However, coronary height was not well visualized on our patient's computed tomographic images. Our patient had undergone prior renal transplantation; further CT would have necessitated an additional contrast load, putting the patient at risk for renal impairment. Therefore, it would have been prudent to consider an alternate imaging modality such as cardiac magnetic resonance imaging or three-dimensional TEE.

Currently, cardiac magnetic resonance imaging is reserved for patients with life-threatening iodinated contrast allergies and/or severely impaired renal function. However, studies have shown that the information gained from CT regarding annular dimensions and coronary ostial and sinus of Valsalva heights is reproducible with magnetic resonance imaging.[5] Preoperative recognition of a low coronary height

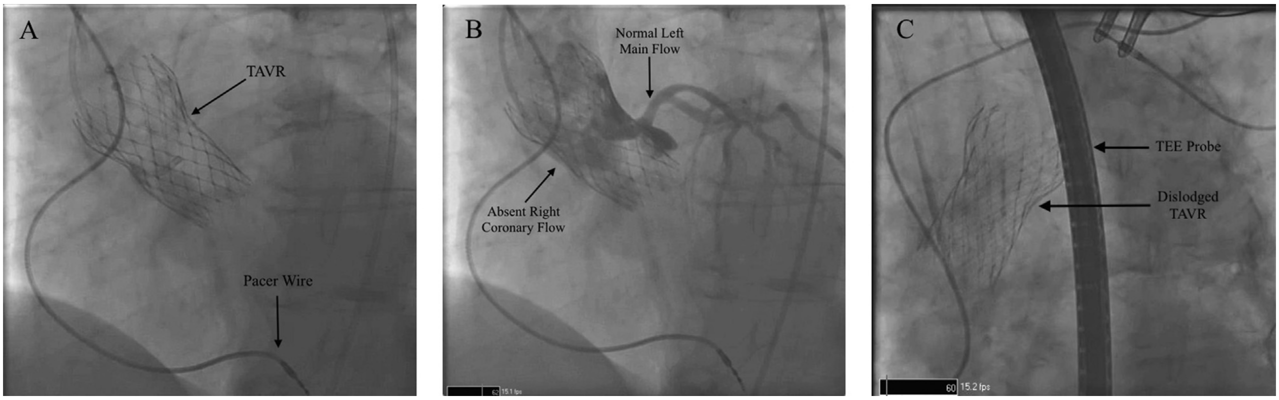

Figure 1 X-ray fluoroscopy after transcatheter aortic valve deployment. **(A)** X-ray fluoroscopy after transcatheter aortic valve deployment demonstrating a fully expanded, well-seated transcatheter prosthetic aortic valve and temporary pacer wire. **(B)** X-ray fluoroscopy and coronary angiography after transcatheter aortic valve deployment demonstrating normal flow through the left main coronary artery and complete absence of flow through the RCA. **(C)** X-ray fluoroscopy of transcatheter aortic valve following attempted RCA manipulation demonstrating complete dislodgement of the valve into the ascending aorta.

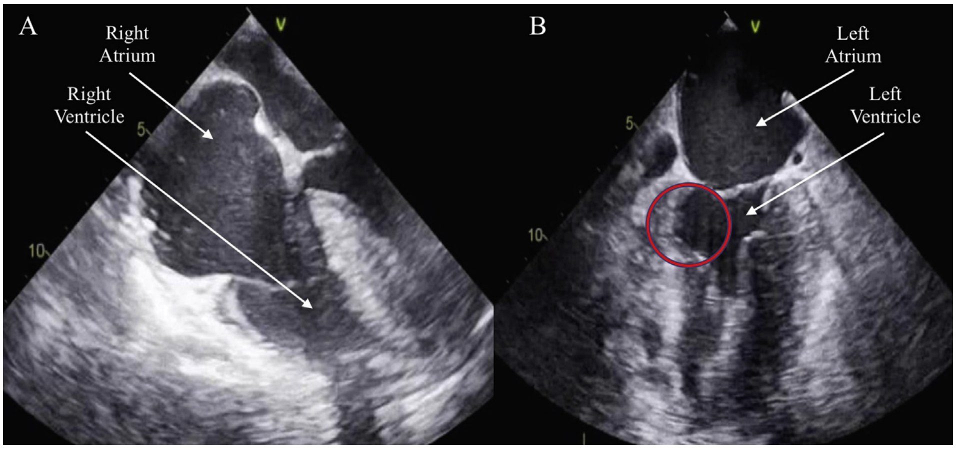

Figure 2 TEE of right and left ventricles after transcatheter aortic valve deployment. **(A)** Right atrial and RV focused, midesophageal view demonstrating dilated right atrium and right ventricle. **(B)** Left ventricular–focused, midesophageal view demonstrating segmental dilation and dyskinesis of the basal inferior wall (*red circle*).

and increased risk for coronary obstruction may have prompted consideration of RCA protection with a guidewire and/or ostial stenting before TAVR.

Our case demonstrates some of the advantages of TEE for TAVR guidance, even though many centers now depend on surface imaging. First, three-dimensional TEE can provide key information on sizing with regard to aortic annular and sinus of Valsalva dimensions, cusp length, and coronary heights.[6] Transesophageal echocardiographic measurements should be considered when there is concern about the accuracy of findings on CT. Second, TEE can be invaluable intraoperatively in allowing real-time expedited assessment of the etiology of the patient's hemodynamic compromise and the effectiveness of resuscitation efforts and aiding in guiding the attempted management of valve embolization thereafter; transthoracic echocardiography may be challenging during endotracheal intubation and cardiopulmonary resuscitation.

CONCLUSION

This case highlights the fundamental importance of precise preprocedural imaging in reducing the risk for TAVR complications. In the setting of a subpar study or conflicting information, multimodality imaging should be used to obtain definitive data to guide selection and implantation of the most appropriate prosthesis and assess the risk for coronary obstruction. Moreover, though three-dimensional TEE is being less frequently used in these procedures, it can be critical in allowing early detection and subsequent timely management of complications if they do arise.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2020.05.012.

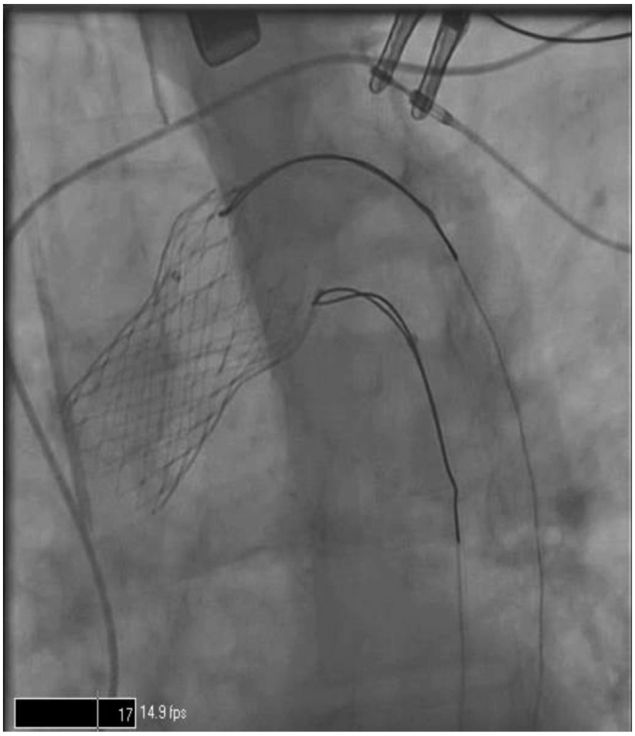

Figure 3 X-ray fluoroscopy demonstrating attempted snare of the transcatheter aortic valve using the lasso technique.

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