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Case Report

Transcatheter aortic valve replacement for aortic insufficiency in a patient with aortic root Thrombus and left ventricular assist device: A risk worth taking?

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ABSTRACT

A 61-year-old man with end-stage ischemic cardiomyopathy post HeartMate 3 (Abbott laboratories, Chicago, Illinois, USA) left ventricular assist device (LVAD) implant was hospitalized after he had recurrent ventricular tachycardia requiring implantable cardioverter-defibrillator shocks. His transthoracic echocardiogram and computed tomography angiography of the chest showed presence of trace aortic insufficiency (AI) and aortic root thrombus (ART) of non-coronary cusp without obstruction of right or left coronary artery ostium despite therapeutic international normalized ratio. He presented again 3 months later with worsening heart failure signs and symptoms. Transesophageal echocardiogram showed progression to severe AI and persistent ART. Despite hemodynamically guided LVAD speed optimization, inotropic support, and diuresis, the patient continued to deteriorate with worsening renal function. The patient was not a transplant candidate due to frailty. After multi-disciplinary discussion he underwent successful 29-Sapien S3 (Edwards Lifesciences, Irvine, CA, USA) transcatheter aortic valve replacement utilizing distal protection filters in bilateral internal carotid arteries for stroke prevention. This case provides novel insight to physicians treating LVAD patients regarding management of severe AI in the setting of ART.

Learning objective: We report a rare approach employed for management of aortic insufficiency (AI) in a patient who also had an aortic root thrombus and left ventricular assist device (LVAD) that traditionally requires cardiac transplantation. Our patient had a favorable outcome with a minimally invasive transcatheter aortic valve replacement. With this case, we hope to generate awareness amongst physicians treating patients about management alternatives and approach of a commonly encountered, life-threatening complication of AI in patients with LVAD.

Introduction

Left ventricular assist devices (LVAD) increase survival in advanced heart failure patients and are emerging as treatment of choice for these patents either as a destination therapy, myocardial recovery, or bridge to transplantation. Up to 30 % of patient with continuous-flow LVADs (CF-LVAD) can develop moderate to severe aortic insufficiency (AI), that has been associated with an elevated risk of rehospitalization as well as death [1]. Transcatheter aortic valve replacement (TAVR) is being increasingly recognized as a management option with favorable reported outcomes [2].

Aortic root thrombus (ART) is another recognized complication after CF-LVAD implantation. Newer devices that provide continuous, non-pulsatile, axial flow throughout the cardiac cycle can change flow dynamics leading to constant pressure in the aortic valve cusps and ascending aorta causing stagnation of blood flow depending on the device outflow graft orientation [3]. This coupled with decreased preload and lack of left ventricular ejection that can lead to persistent closure of the immobile aortic valve can form a milieu for clot formation [3]. Insufficient anticoagulation can also play a role in clot formation. Prevention of ART may therefore be achieved by performing routine echocardiography and closely adjusting LVAD flows that permit intermittent aortic valve opening and left ventricular ejection.

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As ART is a relatively rare complication in this patient population, no guidelines exist to date to guide management. One study estimated its prevalence at 4.8 % with a median time of 22 days (interquartile range 3 to 56 days) after LVAD implantation and its association with stroke [28.6 %, 0.337 episodes per patient-year (EPPY)] and clinically significant myocardial infarction (28.6 %, 0.337 EPPY). Survival of patients with ART at 2 years was 44.3 % compared to 76.5 % in those who did not develop ART [3]. Options of managing ART include either medical management with anticoagulation, or surgical management with open thrombectomy. There are limited data on utilization of TAVR in patients with pre-existing ART. This report describes a successful case of TAVR for acute onset aortic regurgitation in a supremely complicated patient that had a pre-existing aortic root thrombus.

Case report

A 61-year-old man with past medical history of New York Heart Association class IV, American College of Cardiology/American Heart Association stage D heart failure, combined ischemic and nonischemic cardiomyopathy, chronic atrial fibrillation, and dual chamber implantable cardioverter-defibrillator (ICD) in situ underwent Heartmate 3(Abbott laboratories, Chicago, Illinois, USA) LVAD implantation as INTERMACs category 3. The immediate post-operative course was uncomplicated, and he was discharged on post-operative day 9. Two weeks later, the patient was readmitted due to ventricular tachycardia (VT) requiring ICD shocks. During this visit he developed ventricular fibrillation (VF), cardiac arrest, and multiple rounds of chest compressions per advanced cardiac life support protocol, ICD shocks to achieve return of spontaneous circulation. Transthoracic echocardiogram (TTE) showed severe right ventricle (RV) dysfunction, trace AI, suspicion for ART, and closure of aortic valve throughout the cardiac cycle. Computed tomography angiography of the chest showed an aortic annulus area of 6.5 cm^2 and also ART of non-coronary cusp without obstruction of right or left coronary artery ostium (Fig. 1). International normalized ratio (INR) was within therapeutic goal 2–2.5. His course was complicated by retroperitoneal bleeding requiring coil embolization. He was discharged to rehabilitation on antiarrhythmic medications amiodarone and mexiletine and warfarin was started with a reduced goal of 1.8–2.2.

Three months (current admission) later, the patient developed worsening shortness of breath and cough. On examination there were bilateral crackles, jugular venous pressure ~ 15 cm, and lower extremity edema. TTE revealed progression of previously mild AI to severe AI and worsening RV dysfunction. Right heart catheterization: Right Atrium: 13 mmHg, Right Ventricle: 50/13 mmHg, Pulmonary Artery: 50/35 mmHg, and Pulmonary Capillary Wedge Pressure: 26 mmHg, PA sat: 41 %, CO/CI: 2.9 L/min, and 1.3 L/min/m^2.Transesophageal echocardiogram (TEE): severe AI, persistent ART above non-coronary cusp of aortic valve, without vegetation or aortic root abscess (Fig. 2A and B). The ART persisted despite anticoagulation. Despite hemodynamically guided LVAD speed optimization, inotropic support, and diuresis, the patient continued to deteriorate with worsening symptoms and renal function. After multidisciplinary team discussion the decision was made to pursue TAVR as he was not deemed a suitable candidate for heart transplantation due to frailty.

The procedure carried risk of potential embolization to brain and coronary arteries. The patient underwent successful 29-Sapien S3 (Edwards Lifesciences, Irvine, CA, USA) TAVR after placement of bilateral internal carotid artery distal protection with 7 mm Spider Rx filters(Medtronic, Minneapolis, MN, USA) as protection from thromboembolic events. Aortic pressure tracing obtained before the TAVR placement showed a systolic pressure of 83 mmHg and diastolic pressure of 66 mmHg with a mean of 73 mmHg (Fig. 2C). His aortic pressure tracing post TAVR placement showed a mean aortic pressure of 104 mmHg without much difference between his systolic and diastolic pressures (Fig. 2D). Fig. 3A and B shows significant contrast entering the LV on pre TAVR aortogram which resolved after placement of the TAVR.

He was discharged home after his speed was optimized and anticoagulation regimen adjusted (goal INR 2.5–3) and aspirin 325 mg po daily. At 4-month follow up, there had been no readmission for decompensated heart failure and TTE showed mild paravalvular AI, no transvalvular AI, and improvement in RV function (Fig. 3C and D). The most recent echocardiogram 9 months after TAVR showed similar stable findings with aortic valve opening intermittently.

Description of procedure

Access was obtained in the right and left common femoral artery with placement of a 5-french sheath, which was sized up to an 18 Fr and 14 Fr delivery sheath. Dual ProGlide pre-close technique was utilized bilaterally. A 5 Fr Diag bipolar balloon-tipped temporary pacemaker was advanced to the right ventricle. Subsequently, 7-mm spider distal protection filters were placed both in the left and right internal carotid arteries for distal protection against thrombotic embolization. A 4.0 × 12 mm balloon was also placed into the left main in anticipation for possible embolization. Access was obtained into the left ventricle using an AL1 catheter and guidewire, and using a Safari small wire, a number 29 Sapien S3 valve was deployed under fluoroscopic guidance with an additional 4 cc volume in the delivery balloon. The valve was well seated with aortic: ventricular ratio of 90 %:10 %. Coronary angiography post deployment did not reveal any evidence of thrombus in the left main, left anterior descending, left circumflex, or distal cut-offs. Spider device retrieval revealed moderate amount of atheromatous and thrombotic debris in the filter baskets. TEE revealed a well seated TAVR valve with no paravalvular regurgitation and no evidence of central valve regurgitation. Ascending aortography confirmed no aortic valve regurgitation, with no evidence of dissection, perforation, intramural hematoma, plaque disruption, or thrombus.

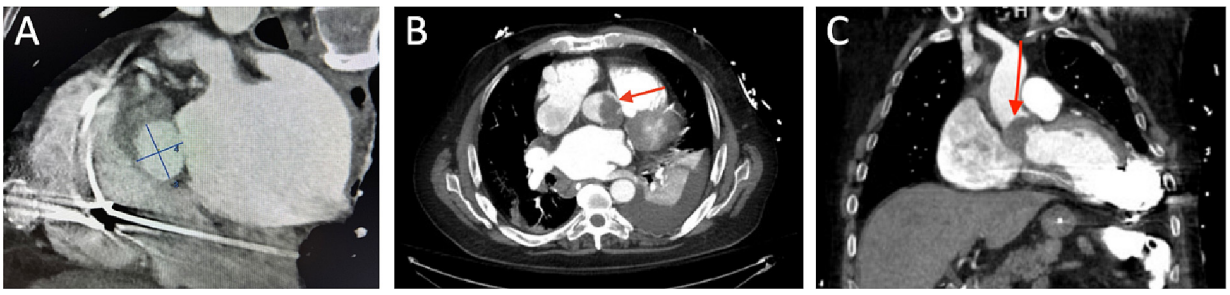

Fig. 1. (A) Computed tomography of chest showing aortic annulus area, major axis diameter (#3) of 3.1 cm and minor axis diameter (#4) of 2.7 cm. (B) Computed tomography angiography (CTA) of chest showing aortic root thrombus on trans-axial section. (C) CTA of chest showing aortic root thrombus on coronal section.

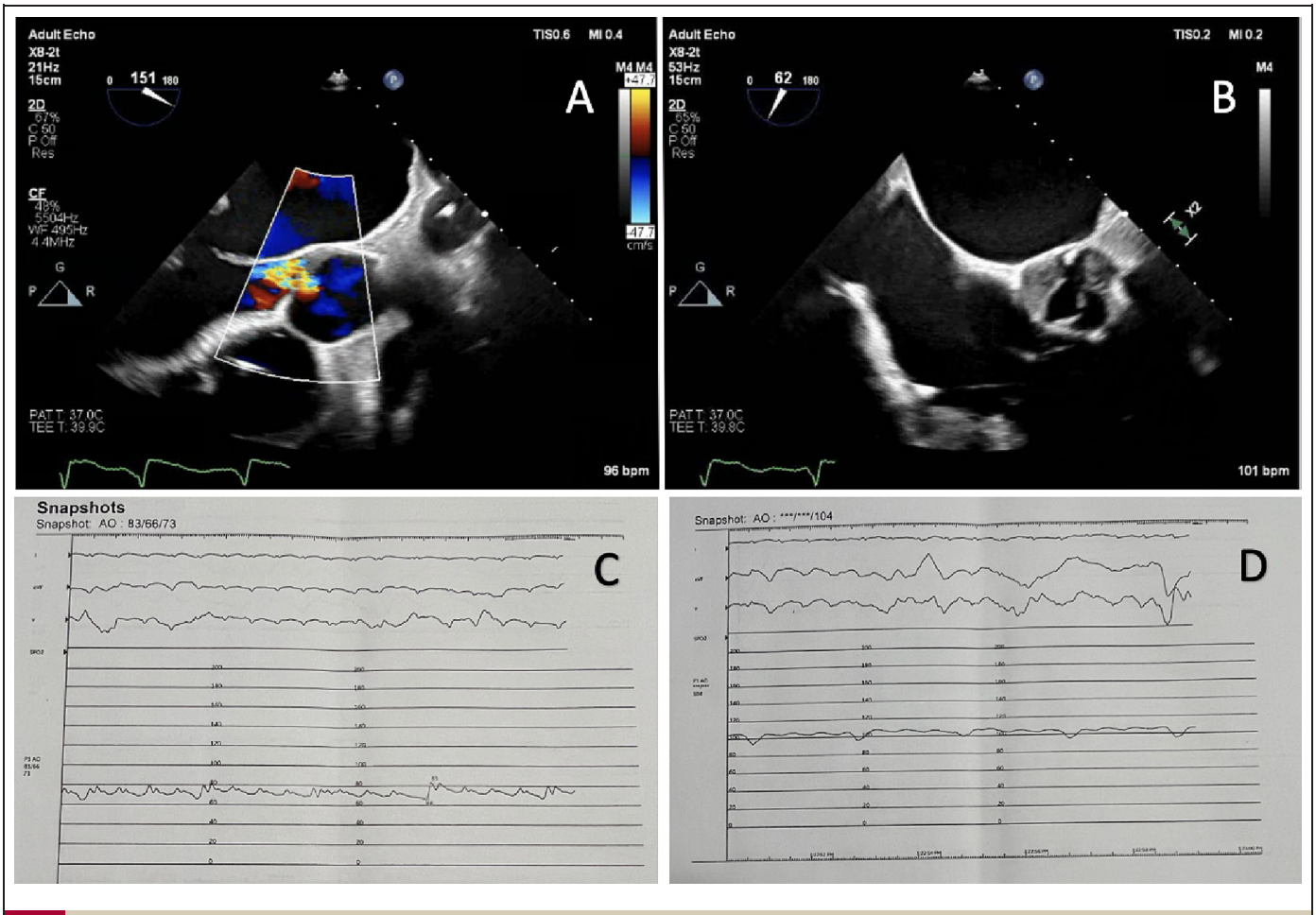

Fig. 2. Transesophageal echocardiogram showing (A) moderate to severe aortic regurgitation, (B) non coronary cusp aortic root thrombus. Aortic pressure tracing before (C) and after (D) transcatheter aortic valve replacement.

Discussion

To the best of our knowledge, this is the first case in which TAVR was performed on a patient with AI and ART. CF-LVAD improves survival, but it carries high complication rates. ART incidence is ~4.8 %, ventricular arrhythmias 16–42 %, RV failure 15–40 %, and AI ~30 % post CF-LVAD [4,5]. The state of aortic root stasis, degree of aortic valve opening, ventricular arrhythmia, down time, and increased sympathetic activity post LVAD can be a plausible explanation for the ART and AI noted in our patient. The most likely etiology of VT/VF in our patient was presence of structural heart disease from his prior ischemic cardiomyopathy.

Prevention of systemic embolization is of utmost importance in LVAD patients with ART. Once the ART is diagnosed, the LVAD speed must not be reduced as it can theoretically lead to aortic valve opening causing catastrophic thromboembolic events. Some authors suggest increasing the LVAD speed momentarily until ART resolves in an effort to close the aortic valve and prevent distal embolization [3,6]. Routine use of thrombectomy should be avoided, given associated surgical risk. The anticoagulation regimen should be intensified to aid thrombus resolution if the patient has no significant bleeding [3].

In our case we used a cerebral embolic protection device (Spider Rx) for prevention of stroke during TAVR. The embolic protection devices (EPD) were approved by the US Food and Drug Administration for commercial use in TAVR to help reduce the risk of stroke based on sparse data from the SENTINEL (Cerebral Protection in Transcatheter Aortic Valve Replacement) trial [7]. However, the data on use of EPD in LVAD patients are limited especially in LVAD patients with ART. EPD have been used in some cases requiring percutaneous intervention of LVAD outflow graft obstruction/stenosis. One recently published case described the role of EPD in a patient with prosthetic valve thrombosis undergoing thrombolysis [8]. These cases in addition to our case suggest that EPD may have a significant beneficial role in preventing thromboembolic events in high-risk patients such as ours.

Development of significant AI on LVAD support is a well-documented adverse event that portends a poor prognosis, especially in patients who undergo LVAD implantation as a destination therapy. Patients with significant AI after LVAD implantation have a higher mortality compared with those without (59.5 % vs 37.2 %, $p = 0.006$) [9]. TAVR is an alternative to open surgery in LVAD patients with AI and a case series of 3 patients reported this approach had uncomplicated long-term survival at 2 years [10].

This case provides novel insight to physicians treating LVAD patients regarding management of severe AI in the setting of ART. Larger studies are needed to evaluate the long-term efficacy of this approach.

Author contributions

Drs Anureet Malhotra and Tarun Dalia collected the data and drafted the manuscript. All authors reviewed the manuscript for critical and intellectual content.

Consent statement

A written informed consent was obtained from the patient.

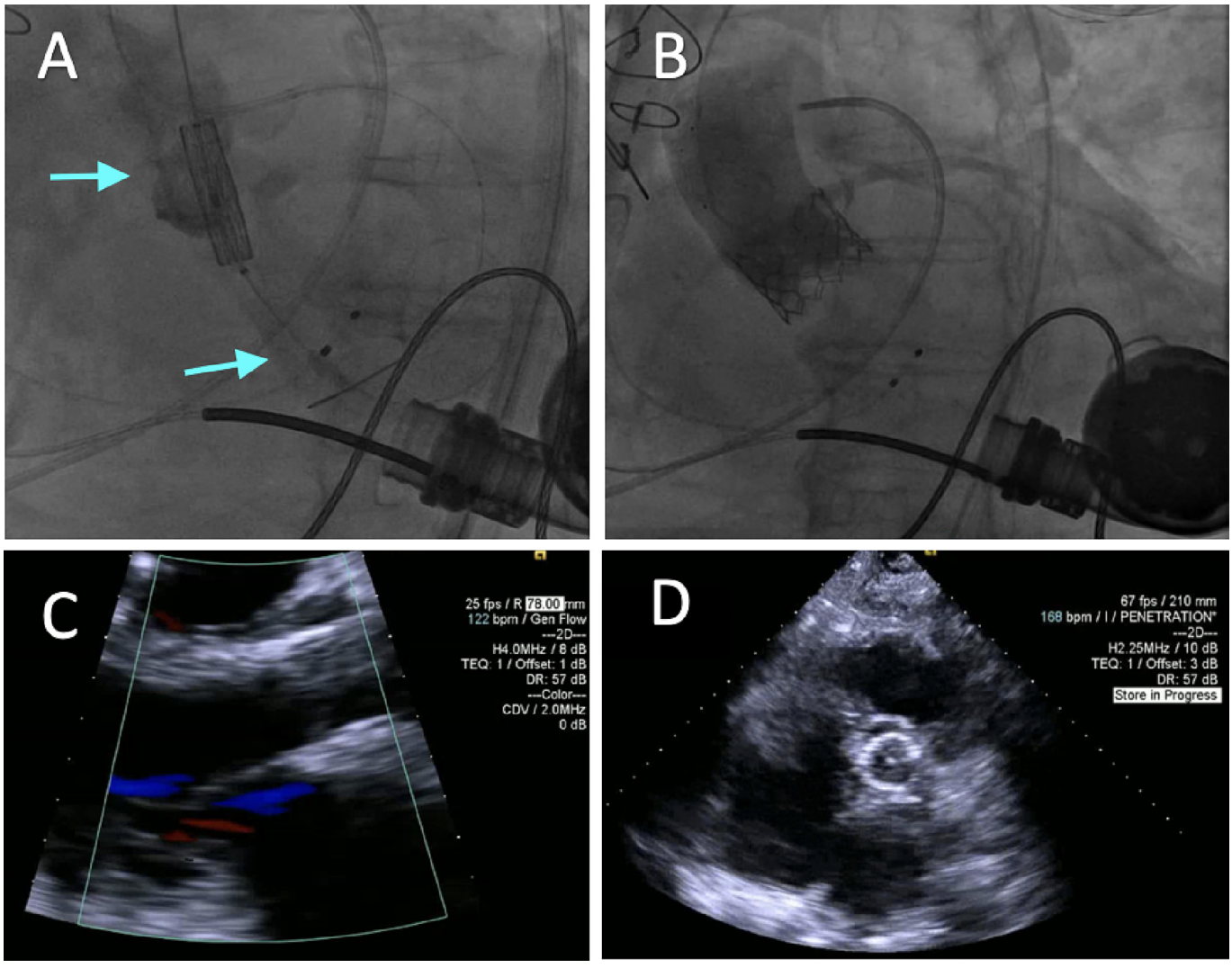

Fig. 3. Pre transcatheter aortic valve replacement (TAVR) aortogram (A) showing significant contrast entering left ventricle (LV) (as shown by arrows). Post TAVR aortogram (B) showing no contrast entering LV indicating resolution of aortic regurgitation. Post TAVR transthoracic echocardiogram. (C) Parasternal long-axis view showing no aortic regurgitation. (D) Parasternal short-axis view showing well seated TAVR.

Conflict of interest statement

The authors have no conflicts of interest to disclose. No funding was obtained for this case report.

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