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HeartMate 3 upgrade and aortic root replacement for severe aortic insufficiency and ventricular fibrillation

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A 31-year-old woman with left ventricular (LV) assist device (LVAD) support presented with refractory ventricular arrhythmias attributed to severe aortic insufficiency and inadequate left ventricular offloading. The patient had a history of 2 prior pump exchanges in the setting of chronic polymicrobial driveline infections and prior transcatheter aortic valve implantation (TAVI). She underwent aortic valve replacement for management of her ventricular arrythmias. Due to her complicated surgical history, right heart failure, and prolonged cardiopulmonary bypass time the surgical aortic valve replacement and HeartMate 3 upgrade was complicated, but surgery was successful with subsequent termination of her ventricular arrythmias.

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Aortic insufficiency (AI) is common in patients with left ventricular (LV) assist device (LVAD) support, occurring in 25–50% within 1 year of implantation.[1,2] Recognizing and intervening on severe AI is of particular importance in this population, as valvular incompetence may lead to increased LV filling pressures, lowering effective circulatory output.

A 31-year-old woman with a HeartMate II presented to the emergency department with chest discomfort after receiving several shocks from her implantable cardioverter-defibrillator (ICD). Her medical history was notable for non-ischemic cardiomyopathy secondary to polysubstance abuse and destination LVAD 12 years prior. She had undergone 2 pump exchanges in the setting of chronic polymicrobial driveline infection and post-operative course was complicated by wound dehiscence and mediastinum osteomyelitis with subtotal sternal resection. The patient also had a history of a CoreValve (Medtronic, Minneapolis, MN) transcatheter aortic valve implantation (TAVI) for AI 5 years prior. At presentation, blood pressure was 83/65 mm Hg and heart rate was 161 bpm. Electrocardiogram

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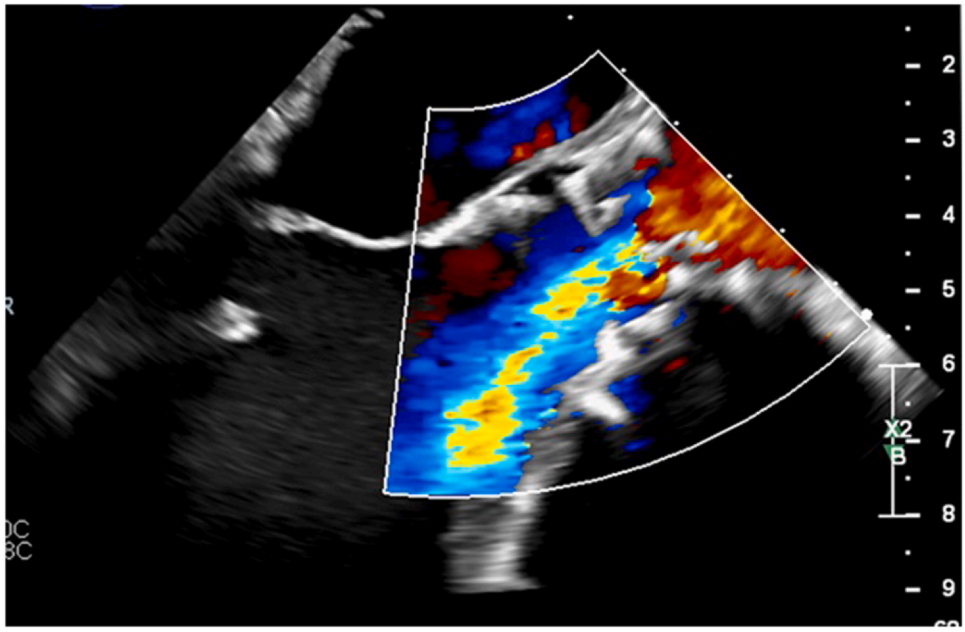

Figure 1 Transesophageal echocardiogram appreciating severe, continuous aortic insufficiency with a 34 mm Medtronic CoreValve Evolut transcatheter pericardial aortic valve prosthesis.

demonstrated ventricular fibrillation (VF) at a rate of 300 bpm. Device interrogation revealed 302 episodes of ventricular tachycardia (VT), morphing into VF with rates above 300 following recent shock, and unsuccessful termination by subsequent shocks. She was treated with an amiodarone bolus and continuous infusion, in addition to 2 unsuccessful defibrillation attempts, after which she was transferred to our quaternary care center given hemodynamic stability. Upon arrival, the patient received further medical management without ventricular arrythmia (VA) termination. Ultimately, she underwent a left sided stellate ganglion block and subsequent defibrillation restored sinus rhythm after 5 hours of sustained VAs.

Blood cultures from admission grew *Granulicatella adiacens* and she was treated with vancomycin. A transthoracic echocardiogram was obtained to investigate the etiology of VAs, demonstrating an ejection fraction of 15%, severe right ventricular (RV) failure, and worsening/severe continuous AI without signs of endocarditis. Subsequent transesophageal echocardiogram and positron emission tomography computed tomography confirmed severity of AI and lack of endocarditis (Figure 1).

While recurrent bacteremia may have been a precipitating factor in her presentation, the refractory VAs were thought to be most likely secondary to inadequate LV offloading despite LVAD support, due to regurgitant flow from AI. Valve-in-valve TAVI was considered but declined due to low origin of the right coronary artery ostium and high potential for obstruction. Transplant candidacy was ruled out due to continuous polysubstance abuse. It was decided she would be better served with surgical aortic valve replacement and LVAD upgrade due to chronic polymicrobial driveline infection.

At our institution, pump exchanges are performed for thrombosis, infection, or malfunction. Exchange for infection is performed after failure of local treatment/antibiotics in cases not eligible for transplant. A subcostal surgical approach with HeartMate II exchange and a short period of cardiopulmonary bypass (CPB) may be utilized. Alternatively, a sternotomy may be required in the setting of additional surgical indication, such as in the present case. A left thoracotomy is sometimes preferred and part of the previous outflow graft is often left attached to the aorta if not thrombosed or infected. An end-to-end outflow graft anastomosis performed.

In this instance, the patient underwent femoral cannulation and third time redo sternotomy with successful dissection of the mediastinal structures and HeartMate II. She was initiated on CPB, followed by right atrium opening and cannulation of the coronary sinus. Aortic cross-clamping, retrograde del Nido cardioplegia, and distal aorta opening were completed. The previous CoreValve had eroded into multiple areas of the root/ascending aorta with partial obstruction of the LVAD outflow graft orifice (Figure 2) and was explanted. An additional lower aortotomy was made, ostial cardioplegia and resection of the native aortic valve. Multiple disrupted aortic wall areas were repaired, and the outflow graft orifice reconstructed with a bovine pericardium patch. The HeartMate 3 was then inserted, locked, and the driveline exteriorized. The aortic valve was then replaced with a 19 mm Carpentier-Edwards Perimount Magna Ease valve. The sutures were tied down with Corknot (LSI solutions, Victor, NY) device. However, the device failed twice. Pledgets dropped into the LV, requiring transient HeartMate 3 removal and pledget removal. After cross clamp release, severe bleeding from the aortic root occurred. Sutures placed on bypass and after repeat cross clamping did not stop the bleeding. Therefore, a root replacement with a 21 mm Konnect Resilia valve conduit (Edward Life Sciences, Irvine, CA) was pursued.

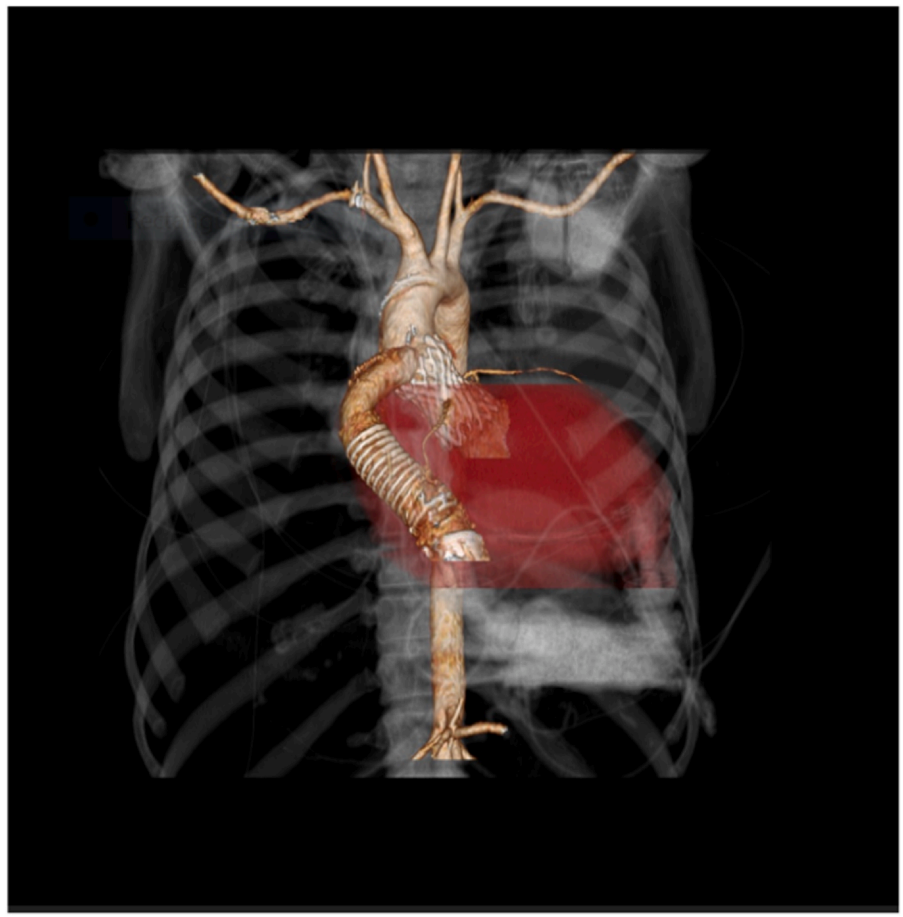

Figure 2 Pre-operative three dimensional image demonstrating TAVR covering outflow graft orifice.

Hemostasis was reinforced by suturing the remaining aortic wall to the prosthesis cuff and applying extra pledgeted sutures from the adjacent left atrium to the cuff. The root was small, and the ostium partially destroyed, making coronary reimplantation difficult but ultimately satisfactory. After 400 minutes of total cross-clamp time and 539 minutes of CPB, the operation was finalized and bleeding subsided.

This case was surgically challenging. Severe RV dysfunction and extremely long clamp time made myocardial protection critical. Open retrograde positioning as proximal as possible is paramount in preservation of RV function. Our institution has good experience with cold blood cardioplegia del Nido cardioplegia every 30 minutes in prolonged complex operations. Another challenge is the raw surface produced at the apex when replacing the HeartMate II for the HeartMate 3 ring. Air entry can cause stroke and pump flow failure after coming off bypass. For prevention, we routinely oversew the apex with a large 3–0 MH polypropylene needle from the very edge of the LVAD ring to the felts of the ring anchoring sutures. In cases of catastrophic root bleeding, we believe the only way forward is full root replacement, despite significant extension of operation length. Lastly, redo sternotomy is inherently challenging, and we prefer backup femoral access in case of outflow graft injury. Our policy is to cover all outflow grafts with a 22 mm ringed polytetrafluoroethylene graft and CorMmatrix (CorMatrix, Roswell, GA) between pericardial edges to minimize re-entry risk. The patient did well postoperatively and required no mechanical RV support. One episode of VA was managed medically postoperatively, and the patient was discharged after 26 days.

In the present case, AI contributed to difficulty in LV offloading and resultant sustained VAs. VAs are common in LVAD patients and while typically well tolerated due to maintenance of circulatory flow, circulatory collapse may ensue.[3,4] Pump exchange added complexity and surgical risk but was well tolerated and useful in solving the chronic device-related infection. When more conservative management does not suffice for VA control, aortic valvular insufficiency surgery may be considered.

Conflict of interest statement

None of the authors have any conflict of interests to disclose.

Patient consent

No identifiable features were included in his case study.

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