AngioVac-assisted laser lead extraction in a patient with heterotopic heart transplant

Jonathan Na, MD, Stephanie C. Fuentes Rojas, MD, Min-Fang Chao, MD, MSc, Sai Sita Garapati, MD, Iriagbonse R. Asemota, MD, Amish S. Dave, MD, PhD

From the Houston Methodist Hospital, Houston, TX.

Introduction

Approved by the US Food and Drug Administration in 2014, the AngioVac system (AngioDynamics Inc, Latham, NY) has been used more commonly for aspiration of right-sided infective endocarditis (IE). The system requires veno-venous extracorporeal membrane oxygenation (ECMO) bypass that allows blood and debris to be suctioned from the tip of the cannula and returned to the body after filtration of the targeted material.[1] For patients with a cardiac implantable electronic device (CIED)-related IE, this system provides a nonsurgical option to debulk lead vegetations before lead removal for source control.[2] Unlike orthotopic heart transplantation, heterotopic heart transplantation involves connecting the donor heart to the native heart inside the right chest cavity.[3] For biventricular support, this surgery involves creating biatrial anastomoses between the donor and recipient's hearts with an anastomosis of the donor aorta into the native aorta and connection with a Dacron graft of the donor pulmonary artery to the native pulmonary artery.[4] As the donor heart functions essentially as a biological ventricular assist device, the CIEDs of the native heart are often purposely left intact postoperatively to help preserve the native heart. However, these devices can develop infections over time, as these patients require immunosuppression medications after transplantation. We present a case of AngioVac-assisted laser lead extraction of 2 CIEDs in the native heart of a patient after heterotopic heart transplantation.

KEY TEACHING POINTS

- We present a case of percutaneous vacuum-assisted removal of bacterial endocarditis involving the leads of cardiac implantable electronic devices in a patient with heterotopic heart transplantation.
- The AngioVac System (AngioDynamics Inc, Latham, NY) provides a safe and reliable option for removal of right-sided lesions with easy integration into workflow.
- This case highlights the potential for bacterial debulking for endocarditis in complex anatomy in patients for whom surgical removal may not be the optimal option.

Case report

A 67-year-old man with hypertension, hyperlipidemia, type 2 diabetes mellitus, chronic kidney disease stage IV, and history of heterotopic heart transplantation presented with fevers and chills.

He first developed heart failure approximately 20 years earlier due to lymphocytic myocarditis, which was complicated by fulminant biventricular cardiogenic shock refractory to mechanical support. As he was not an ideal candidate for a durable ventricular assist device due to right heart failure, he was referred for transplantation evaluation. Due to donor size mismatch and elevated pulmonary artery pressures, he underwent a heterotopic rather than orthotopic transplantation. Approximately 10 years later, his native heart had degenerated into persistent ventricular fibrillation (VF) refractory to implantable defibrillator-cardioverter (ICD) shocks and his device was turned off. Notably, he did well with his native heart in VF prior to this presentation without any episodes of rejection. In terms of device history, he had an abandoned biventricular ICD with a 17-year-old right ventricular dual coil defibrillator lead, a 16-year-old coronary sinus (CS) lead, and an abandoned right-sided hemodynamic monitoring device (Chronicle; Medtronic, Minneapolis, MN) with a 16-year-old right ventricular outflow tract lead, all in the native heart (Figure 1). These devices were not removed at the time of transplantation to preserve the functionality of his native heart for as long as possible postoperatively.

Over the past week before this presentation, he had been having worsening dyspnea on exertion, orthopnea, and weight gain over a week, with a decrease in his urine output.

KEYWORDS Cardiac implantable electronic device extraction; Infective endocarditis; Heterotopic heart transplantation; Percutaneous vacuum-assisted removal; Lead vegetation

(Heart Rhythm Case Reports 2025;11:138–141)

Address reprint requests and correspondence: Dr Jonathan Na, Houston Methodist Hospital, 6565 Fannin St, Houston, TX 77030. E-mail address: jna@houstonmethodist.org.

https://doi.org/10.1016/j.hrcr.2024.10.025

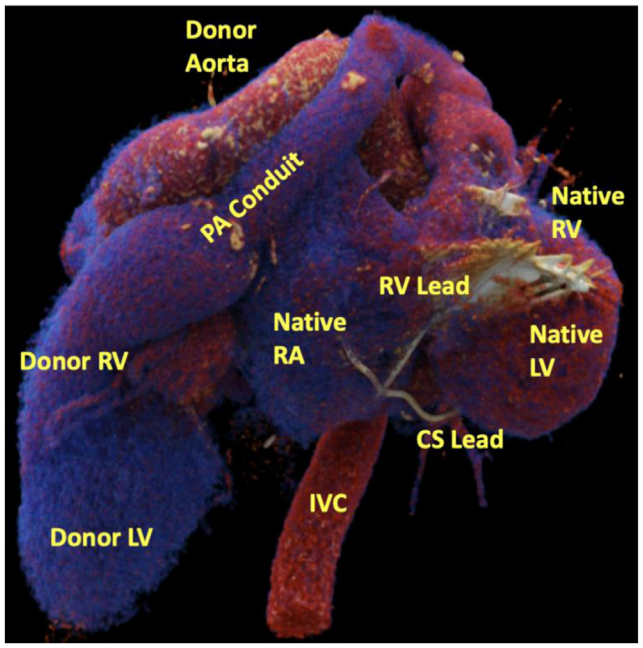

Figure 1 3-Dimensional reconstruction of computed tomography imaging of heterotopic heart transplantation with dual coil right ventricular (RV) and coronary sinus (CS) leads of implantable cardioverter-defibrillator and lead of Medtronic chronicle hemodynamic monitoring device. The Dacron pulmonary artery (PA) conduit connects the donor right ventricle to the native PA and the donor aorta is anastomosed to the native aorta. The biatrial anastomoses are not directly shown in this view. IVC = inferior vena cava; LV = left ventricle.

Furthermore, he had been having issues with recurrent bilateral lower extremity wounds related to his diabetes. After admission, he required temporary dialysis for volume removal, but was found to have blood cultures positive for Group C streptococcus bacteremia in 3 of 4 bottles. Transthoracic echocardiography did not show evidence of any vegetations in the donor heart, but could not evaluate the native heart. Subsequent transesophageal echocardiogram demonstrated a $>4 \times 2.6$ cm vegetation in the right atrium of the native heart attached to the right ventricular lead, but not involving the tricuspid valve (Figure 2A).

To avoid redo sternotomy, he was brought to the hybrid operating room for vacuum-assisted vegetation removal and whole system extraction. A 26Fr introducer sheath was placed in the right femoral vein and the 18Fr reinfusion cannula was placed in the left femoral vein to initiate veno-venous ECMO bypass with the AngioVac system. This catheter was guided to the right atrium under fluoroscopy (Figure 3A) and the vegetation was removed piecemeal. The final piece had to be suctioned into a funnel-tipped catheter that was pulled into the 26Fr sheath. After removal of the catheter, this piece occluded the sheath and a Fogerty catheter was passed through the mass inside the sheath. The balloon was inflated and pulled back to remove the entirety of the mass (Figure 3B and 3C). Intraoperative transesophageal echocardiogram showed resolution of the mass (Figure 2B) and the bypass circuit was stopped with removal of the venous cannulas. Hemostasis was obtained with a figure-of-8 suture and manual compression.

The right and left deltopectoral incision sites were opened, and each lead was removed from the respective devices. After disconnecting each lead, the generators were removed, each lead was prepared with locking stylets in typical fashion, and a Bulldog lead extender (Cook Medical, Bloomington, IN) was used for the ICD lead conductors. Initially, we used a 12Fr GlideLight laser sheath (Spectranetrics Corp, Colorado Springs, CO) for the CS lead, but this had to be switched for a 14Fr laser sheath. The CS lead was lasered up to the CS ostium with successful removal. Then we used a 16Fr and a 14Fr laser sheath to remove the ICD and Medtronic Chronicle leads, respectively. The 14Fr laser sheath was used to remove the hemodynamic sensor of the Medtronic Chronicle lead and the lead was pulled into the

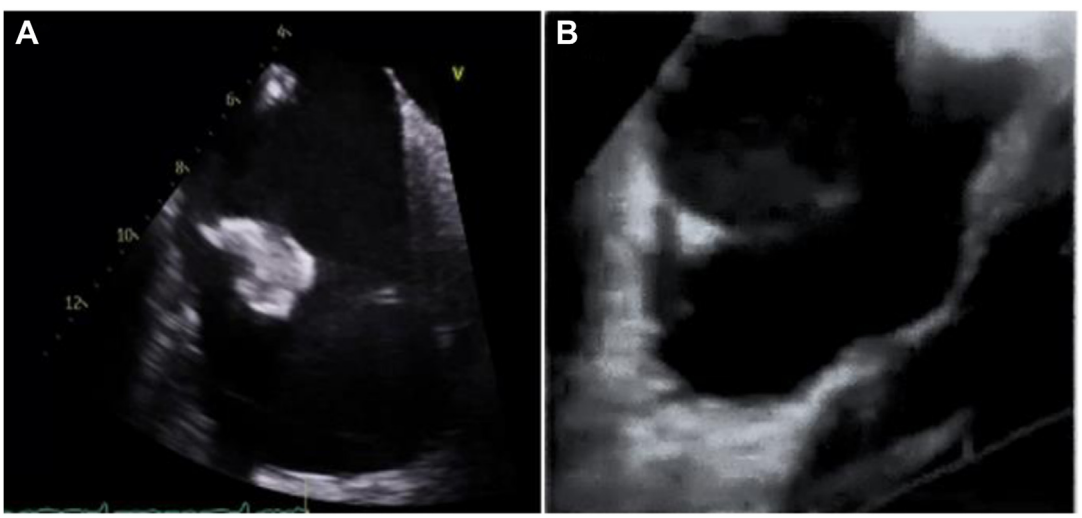

Figure 2 **A:** Right ventricular inflow view of transesophageal echocardiogram demonstrating right atrial vegetation on lead prior to extraction. **B:** Right ventricular inflow view of transesophageal echocardiogram with resolution of vegetation after AngioVac (AngioDynamics Inc, Latham, NY) extraction.

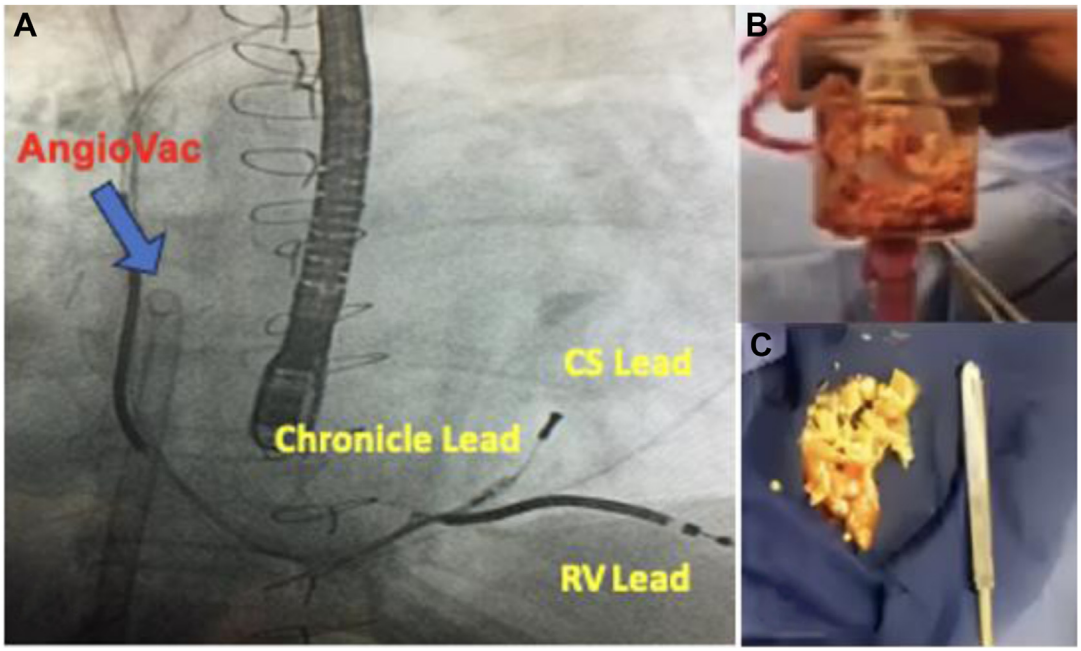

Figure 3 **A:** Fluoroscopy of AngioVac system (AngioDynamics Inc, Latham, NY) in the right atrium prior to extraction. **B:** Vegetation in AngioVac filter. **C:** Vegetation view postoperatively taken out of the filter.

sheath with traction. Transesophageal echocardiogram after lead removal demonstrated no pericardial effusion and he remained hemodynamically stable.

Postoperatively, he had a tunneled dialysis catheter and peripherally inserted central catheter placed to complete a 6-week course of intravenous ceftriaxone, which was completed without complications. He eventually recovered his renal function with the removal of his dialysis catheter and has remained free of recurrence of his bacteremia for the past 4 years.

Discussion

As source control remains one of the cornerstones of infection treatment, the most current guidelines for CIED-related IE recommended surgery for the removal of large vegetations before extraction of the device.[5] However, patients may have many proclivities for surgery, such as previous sternotomies, advanced renal disease, multisystem disease, and frailty.[6] Thus, a dilemma often arises with CIED-related IE with large vegetations, as complete system extraction may not be possible without initial removal of the bacterial burden. The development of devices for percutaneous aspiration of right-sided IE has been reported to have procedural success rate and a clinical success rates of 89% and 79%, respectively.[7] Although fewer cases of CIED-related IE prior to lead extraction have been reported, the existing data are favorable, with a high success rate and low complication rates.[8]

At this time, there are 3 available large-bore devices for percutaneous mechanical aspiration: the AngioVac, AlphaVac (AngioDynamics Inc), and the FlowTriever (Inari Medical Inc, Irvine, CA). As we described, the AngioVac system provides continuous and adjustable aspiration force with filtration through a veno-venous ECMO circuit. The AlphaVac system does not require ECMO and creates a high negative aspirating force with a controlled plunge of 10 or 30 mL, but this device does not have a method for blood return. The FlowTriever connects a negatively charged 60-mL aspiration syringe to an aspiration catheter that empties into a reservoir that can be reinfused to the patient.[9] The AlphaVac system was not yet developed at the time of our patient's procedure, and the Flowtriever was not available at our institution, which made the AngioVac the best option for retrieval, as other available devices, such as Penumbra (Penumbra Inc, Alameda, CA) were not felt to be large enough for this case.

In this case, our patient had undergone a previous sternotomy with his heterotopic heart transplantation. At this point in his transplant history, his native heart had degenerated into refractory VF, making his donor heart even more of an important hemodynamic asset to protect. Although medical management with intravenous antibiotics could be an option for patients with CIED-related IE only, the anatomic complexity of the heterotopic heart transplantation created an urgency for extraction. The vegetation was felt to be proximal to the right atrial anastomosis between the donor and native hearts, raising concern for potential embolization to the healthy, functional heart. Fortunately, the inferior vena cava is not typically manipulated during transplantation and did not create any barriers to percutaneous mechanical aspiration.

In regard to how this infection may have developed, the source of the infection was felt to be bacteremia from his

chronic lower extremity diabetic ulcers in addition to his immunosuppressed state after transplantation. The devices were not removed at the time of transplantation to preserve the native heart function postoperatively and to reduce the ischemic time during surgery. Although the likelihood of infection could have been reduced if the devices were extracted after his native heart degenerated into VF, there are minimal data to support prophylactic device extraction to prevent endocarditis. It is not known whether the patient had an antibiotic envelope at the time of implantation of his devices, as it was done outside of our hospital system. However, given that there was no concern for pocket infection at presentation, it remains difficult to assess whether an antibiotic envelope would have changed the development of this vegetation.

The AngioVac system presented a reliable option without need for redo sternotomy to obtain source control prior to complete system removal. With both fluoroscopic and echocardiographic guidance, complete resolution of the vegetation was achieved without complication, and extraction was expedited by aspiration. To this day, the patient has continued to follow-up without major issues or recurrence of his infection.

Conclusion

To our knowledge, this remains the only case of vacuum-assisted aspiration of CIED-related IE in a patient with a heterotopic heart transplant. We incorporated the AngioVac system into the workflow of device extraction without complication. Even for complex anatomy such as this case, percutaneous aspiration with systems, such as the AngioVac, provides a safe and reliable option for vegetation removal before lead extraction in patients for whom surgical removal would be high risk.

Funding Sources: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Disclosures: The authors have no conflicts of interest to disclose.

References

1. Basman C, Rashid U, Parmar YJ, Kliger C, Kronzon I. The role of percutaneous vacuum-assisted thrombectomy for intracardiac and intravascular pathology. J Card Surg 2018;33:666–672.
2. Mhanna M, Beran A, Al-Abdouh A, et al. AngioVac for vegetation debulking in right-sided infective endocarditis: a systematic review and meta-analysis. Curr Probl Cardiol 2022;47:101353.
3. Kadner A, Chen RH, Adams DH. Heterotopic heart transplantation: experimental development and clinical experience. Eur J Cardiothorac Surg 2000;17:474–481.
4. Flécher E, Fouquet O, Ruggieri VG, Chabanne C, Lelong B, Leguerrier A. Heterotopic heart transplantation: where do we stand? Eur J Cardiothorac Surg 2013;44:201–206.
5. Correction to: 2023 ESC Guidelines for the management of endocarditis: Developed by the task force on the management of endocarditis of the European Society of Cardiology (ESC) Endorsed by the European Association for Cardio-Thoracic Surgery (EACTS) and the European Association of Nuclear Medicine (EANM). Eur Heart J 2024;45:56.
6. Prendergast BD, Tornos P. Surgery for infective endocarditis: who and when? Circulation 2010;121:1141–1152.
7. Mhanna M, Beran A, Al-Abdouh A, et al. AngioVac for vegetation debulking in right-sided infective endocarditis: a systematic review and meta-analysis. Curr Probl Cardiol 2022;47:101353.
8. Rusia A, Shi AJ, Doshi RN. Vacuum-assisted vegetation removal with percutaneous lead extraction: a systematic review of the literature. J Interv Card Electrophysiol 2019;55:129–135.
9. Rozenbaum Z, Gnall E. Percutaneous cardiac chambers and pulmonary artery aspiration. Curr Cardiol Rep 2023;25:681–691.