Case Reports

Minimally Invasive LVAD Deactivation

in a 65-Year-Old Man with Recurrent Pump Thrombosis and Left Ventricular Recovery

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Pump thrombosis is a dire sequela after left ventricular assist device (LVAD) implantation. Treatment comprises antiplatelet agents, anticoagulants, thrombolytic agents, and pump exchange. Although pump exchange is the definitive therapy, it is also the most invasive, often exposing patients to the risks of repeat sternotomy and cardiopulmonary bypass. In some cases, patients experience left ventricular recovery after LVAD implantation. The optimal strategy surrounding the management of LVADs in patients who have experienced ventricular recovery is unknown; techniques range from total system explantation to partial pump resection. Here, we describe a novel means of LVAD deactivation in a 65-year-old man with recurrent pump thrombosis, via percutaneous outflow graft closure in the cardiac catheterization laboratory. We also review the existing literature on surgical and percutaneous LVAD deactivation techniques. ***(Tex Heart Inst J 2017;44(1):70-2)***

Key words: *Device removal/instrumentation/methods; heart failure/rehabilitation; heart-assist devices/adverse effects; recovery of function/physiology; thrombosis/etiology; treatment outcome; ventricular function/physiology*

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Left ventricular assist devices (LVADs) have become an important tool in the armamentarium of treatment for advanced, medication-refractory heart failure. They are used as both destination and bridge-to-transplantation therapy and have been shown to improve longevity and quality of life in selected patients.[1-3] Pump thrombosis is a feared sequela of LVAD therapy, which can occur despite adequate anticoagulation.[4] Pump exchange, the de facto treatment for pump thrombosis, might necessitate repeat sternotomy and a short run of cardiopulmonary bypass—a daunting proposition in patients with already-compromised cardiac function. Some patients experience improvement in native left ventricular (LV) function after a period of LVAD support. The optimal management of these patients is not clear.

The HeartMate II™ LVAD (Thoratec Corporation, now part of St. Jude Medical, Inc.; Pleasanton, Calif) is the most frequently implanted LVAD in the United States. Here, we describe a novel means of HeartMate II deactivation in a patient with recurrent pump thrombosis. We also review the literature on surgical and percutaneous LVAD deactivation techniques.

Case Report

We report the case of a 65-year-old man with chronic systolic heart failure due to nonischemic dilated cardiomyopathy who underwent initial implantation of a HeartMate II LVAD in May 2012, and, 5 months later, experienced pump thrombosis that necessitated total system exchange. Despite adequate anticoagulation, he had 2 additional episodes of pump thrombosis in the years following, which were treated medically.

In April 2015, he presented with dark urine and a serum lactate dehydrogenase level greater than 1,600 U/L—without signs or symptoms of infection or heart failure. Recurrent LVAD thrombosis, however, was a possibility. A transthoracic echocardiogram (TTE) showed normal LV cavity size and improved LV function, with an LV ejection fraction (LVEF) of 0.35 to 0.40, an LV internal diastolic diameter (LVIDd) of 4.4 cm, and an aortic valve that opened with each cardiac cycle—findings that were all consistent with an LV that had experienced some level of reconditioning.

The patient underwent right-sided heart catheterization with simultaneous LVAD speed reduction. Starting at 8,600 rpm and decreasing the patient's pump speed to 6,000 rpm in a stepwise fashion, we found that he maintained low resting intracardiac pressures, normal aortic valve opening, and normal LVIDd throughout all speed changes. At the end of the study, his pump speed at 6,000 rpm, the patient walked

briskly with stable vital signs and no symptoms. We obtained informed consent, turned off the patient's LVAD, then transected and internalized the LVAD driveline. Follow-up TTE 2 days later showed a LV cavity of normal size and an LVEF of 0.35 to 0.40; however, it also showed a Doppler signal near the LV apex, which suggested retrograde flow through the LVAD (Fig. 1).

The patient underwent percutaneous closure of the LVAD outflow graft with a 20-mm AMPLATZER™ Vascular Plug (St. Jude Medical), after which the outflow graft showed only a trace of residual flow (Fig. 2). He did well postprocedurally. At discharge, he was taking warfarin orally and was undergoing medical therapy for chronic systolic heart failure. Serial lactate dehydrogenase measurements, obtained for 3 months after LVAD deactivation, were normal. The patient ultimately underwent orthotopic heart transplantation in September 2015.

Discussion

Pump thrombosis is a serious possible sequela of LVAD implantation, and its incidence may be increasing.[5] Treatment comprises anticoagulation, antiplatelet agents, thrombolysis, and, in many cases, pump exchange.[6] In the present case, however, the patient exhibited evidence of LV recovery at the time of his recurrent LVAD thrombosis; therefore, we chose to deactivate it. Data regarding LVAD deactivation in patients with LV recovery are few, but LVAD explantation for ventricular recovery is certainly feasible.[7] In our own single-center experience, which, to date, comprises 240 LVAD implantations, this is the 4th case of LV recovery after LVAD implantation, and the 3rd in which the LVAD housing was left in situ. At other centers, explantation techniques vary, with many patients undergoing total pump removal and oversewing of the inflow and outflow grafts.[8,9] Less invasive means of LVAD removal have recently been described, involving subxiphoid incision, surgical ligation of the outflow graft, and superficial excision of the driveline, leaving the inert pump in place.[10]

Less common, however, is the method that we describe, which involves LVAD deactivation without surgical manipulation of the LVAD pump or its inflow and outflow components. The inflow cannula, outflow graft, and pump are all left in situ and only the driveline is transected and internalized; an AMPLATZER Vascular Plug is percutaneously deployed in the outflow graft to prevent excessive LV loading due to retrograde aortic flow. Other authors have deployed an AMPLATZER

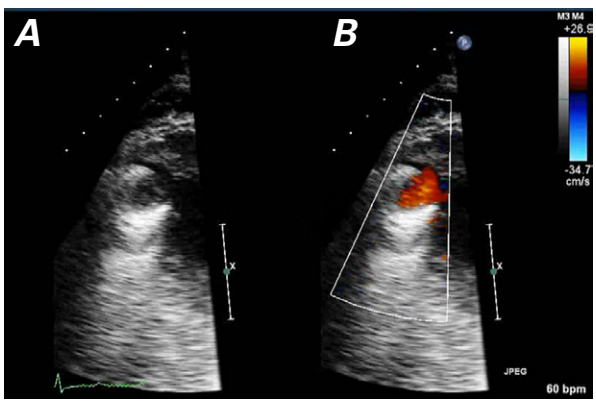

Fig. 1 *Transthoracic echocardiograms in **A**) 2-dimensional view and **B**) color-flow Doppler mode, obtained after left ventricular assist device deactivation, show a Doppler signal at the inflow cannula, suggesting retrograde aortic flow through the assist device.*

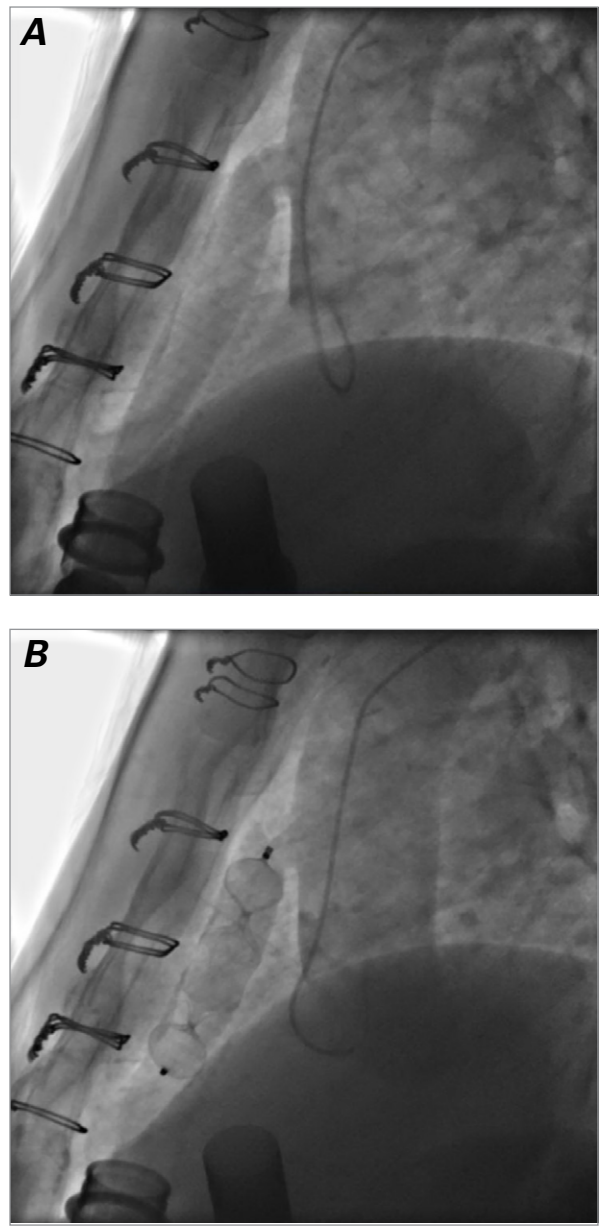

Fig. 2 *Fluoroscopic images show **A**) retrograde flow through the outflow graft that **B**) diminished after deployment of a 20-mm AMPLATZER Vascular Plug.*

closure device into the inflow cannula of a CircuLite® LVAD (HeartWare International Inc.; Framingham, Mass) via open subclavicular incision in the operating room.[11] Similarly, another group has described percutaneous withdrawal of HeartWare LVAD support, during which vascular plugs were deployed at both ends of the outflow graft.[12] To our knowledge, ours is only the 2nd report of a minimally invasive approach to HeartMate II LVAD deactivation involving percutaneous closure of the outflow graft in the cardiac catheterization laboratory.[13] The present case illustrates the safety and feasibility of this approach in selected patients, and perhaps this approach presents an attractive alternative to the hazards of the operating room. We believe that such an alternative should be considered in candidates who are at high risk for operative intervention.

References

1. Farrar DJ, Holman WR, McBride LR, Kormos RL, Icenogle TB, Hendry PJ, et al. Long-term follow-up of Thoratec ventricular assist device bridge-to-recovery patients successfully removed from support after recovery of ventricular function. J Heart Lung Transplant 2002;21(5):516-21.
2. Miller LW, Pagani FD, Russell SD, John R, Boyle AJ, Aaronson KD, et al. Use of a continuous-flow device in patients awaiting heart transplantation. N Engl J Med 2007;357(9):885-96.
3. Slaughter MS, Rogers JG, Milano CA, Russell SD, Conte JV, Feldman D, et al. Advanced heart failure treated with continuous-flow left ventricular assist device. N Engl J Med 2009;361(23):2241-51.
4. Uriel N, Han J, Morrison KA, Nahumi N, Yuzefpolskaya M, Garan AR, et al. Device thrombosis in HeartMate II continuous-flow left ventricular assist devices: a multifactorial phenomenon. J Heart Lung Transplant 2014;33(1):51-9.
5. Starling RC, Moazami N, Silvestry SC, Ewald G, Rogers JG, Milano CA, et al. Unexpected abrupt increase in left ventricular assist device thrombosis. N Engl J Med 2014;370(1):33-40.
6. Hohner E, Crow J, Moranville MP. Medication management for left ventricular assist device thrombosis. Am J Health Syst Pharm 2015;72(13):1104-13.
7. Birks EJ, Tansley PD, Hardy J, George RS, Bowles CT, Burke M, et al. Left ventricular assist device and drug therapy for the reversal of heart failure. N Engl J Med 2006;355(18):1873-84.
8. Cohn WE, Gregoric ID, Radovancevic B, Frazier OH. A felt plug simplifies left ventricular assist device removal after successful bridge to recovery. J Heart Lung Transplant 2007;26(11):1209-11.
9. Gonzalez-Stawinski GV, Mountis MM, Cohn WE, Frazier OH. Inflow graft interruption as a simple method for left ventricular assist device removal after successful bridge to recovery. J Card Surg 2012;27(3):397-9.
10. Frazier OH, Baldwin AC, Demirozu ZT, Segura AM, Hernandez R, Taegtmeyer H, et al. Ventricular reconditioning and pump explantation in patients supported by continuous-flow left ventricular assist devices. J Heart Lung Transplant 2015;34(6):766-72.
11. Sainte S, Gewillig M, Droogne W, Van Cleemput J, Vanhaecke J, Meyns B, Rega F. Explantation of a CircuLite left ventricular assist device without removal of the inflow cannula: how to do it? Interact Cardiovasc Thorac Surg 2014;18(3):393-5.
12. Pettit SJ, Shapiro LM, Lewis C, Parameshwar JK, Tsui SS. Percutaneous withdrawal of HeartWare HVAD left ventricular assist device support. J Heart Lung Transplant 2015;34(7):990-2.
13. Zeigler SM, Sheikh AY, Lee PH, Desai J, Banerjee D, Oyer P, et al. A novel, catheter-based approach to left ventricular assist device deactivation after myocardial recovery. Ann Thorac Surg 2014;98(2):710-3.