The VAD Journal: *The journal of mechanical assisted circulation and heart failure*

Peer-Reviewed Case Report

Off-pump HeartMate II Exchange in a Patient with Severe Lower Extremity Peripheral Artery Disease: A Case Report

Mehmet Akay, Ismael Salas De Armas, Manish K. Patel, Rajko Radovancevic, Igor D. Gregoric*

Department of Advanced Cardiopulmonary Therapies and Transplantation, University of Texas Health Science Center at Houston, Houston, TX

*Corresponding author: *igor.d.gregoric@uth.tmc.edu*

Citation: Akay M, et al. Off-pump HeartMate II Exchange in a Patient with Severe Lower Extremity Peripheral Artery Disease: A Case Report. *The VAD Journal*. 2021; 7(1):e2021718. https://doi.org/10.11589/vad/e2021718

Editor-in-Chief: Maya Guglin, University of Indiana

Received: March 19, 2021

Accepted: June 5, 2021

Published Online: June 14, 2021

Funding: Not applicable

Competing interests: None

Keywords: LVAD exchange, subcostal incision, off-pump, case report

Abstract

Thrombosis of left ventricular assist device (LVAD) pumps is a serious complication that often requires exchange of the device. A 66-year-old man with severe peripheral vascular disease presented with pump thrombosis of the HeartMate II (HMII) LVAD 1.5 years after implantation. The HMII was exchanged to another HMII through a subcostal incision and without the use of cardiopulmonary bypass. For safety, the patient was prepared for cardiopulmonary bypass by exposing the right subclavian artery and insertion of a 5 FR cannula in the left common femoral vein. The pump was exchanged through a subcostal incision made over the LVAD pump pocket perpendicular to the costal margin. After deairing the pump and graft, LVAD support was resumed, postoperative course was uneventful, and the patient was discharged from the hospital four days later. Re-thrombosis, stroke, and right heart failure are frequent complications after LVAD exchange. Exchange through a subcostal incision with cardiopulmonary bypass backup appears to be safe.

Background

Pump thrombosis is a major complication of left ventricular assist device (LVAD) therapy that increases morbidity, cost of care, and often requires an exchange of the device.[1] Less invasive techniques for safe device exchange have been devised and are associated with low mortality rates.[2, 3] Device exchange without cardiopulmonary bypass through a subcostal incision minimizes bleeding with less postoperative complications and recovery time.[4-6] In cases of pump thrombosis where thrombolysis is not a suitable treatment option and a heart transplant is not available, exchange of the LVAD is necessary. We present a case where off-pump exchange through the subcostal approach was successfully performed in a patient with severe peripheral vascular disease.

Case Report

A sixty-six-year-old man with ischemic cardiomyopathy was implanted with a HMII LVAD (Abbott, Chicago, IL) for destination therapy. The patient was not a transplant candidate due to severe peripheral arterial disease, including bilateral iliac artery stenosis. Before LVAD implantation, the patient underwent a right femoropopliteal bypass. At 18 months after LVAD implantation, the patient was admitted to the hospital with elevated lactate dehydrogenase and sustained LVAD pump power elevation. Anticoagulation therapy with bivalirudin was initiated. A ramp speed study indicated minimal flow through the LVAD, and a pump exchange was planned. The HMII exchange was completed through a subcostal incision and without the use of cardiopulmonary bypass.

The LVAD pump speed was decreased from 10400 to 6800 rpms, and the patient remained hemodynamically stable. In case of hemodynamic decompensation during the procedure, cannulation for cardiopulmonary bypass was prepared. The right subclavian artery was exposed for an arterial inflow cannula placement. The left common femoral vein was cannulated with a 5 FR catheter using the Seldinger technique with Doppler ultrasonography guidance. A subcostal incision was made over the LVAD pump pocket perpendicular to the costal margin. The outflow and inflow connections were dissected free and exposed (Fig. 1).

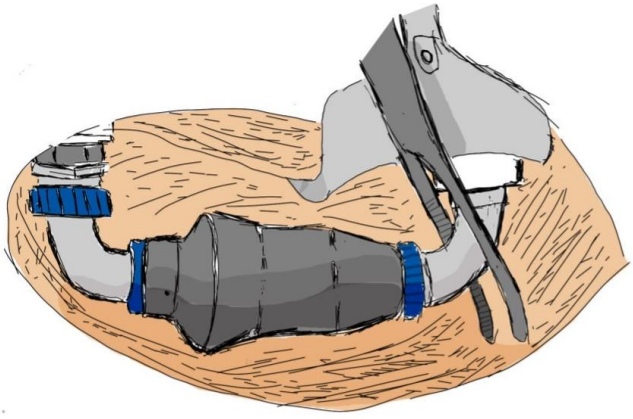

Figure 1. *A clamp is used to stabilize and maintain control of the inflow portion of the left ventricular assist device.*

The patient was fully anticoagulated with heparin, and inotropic support was provided as needed to maintain cardiac output. Usual hemodynamics monitoring with an arterial pressure line, pulse oximetry, and transesophageal echocardiography (TEE) were used. The HMII was stopped, and the driveline was transected near the pump, which allowed access to the pump and its connectors. The outflow graft was clamped, and the inflow and outflow attachments to the pump were disconnected (Fig 2). The replacement pump was immediately attached while back-bleeding through the pump de-aired the device. The percutaneous lead was tunneled to a new location on the left side of the abdomen.

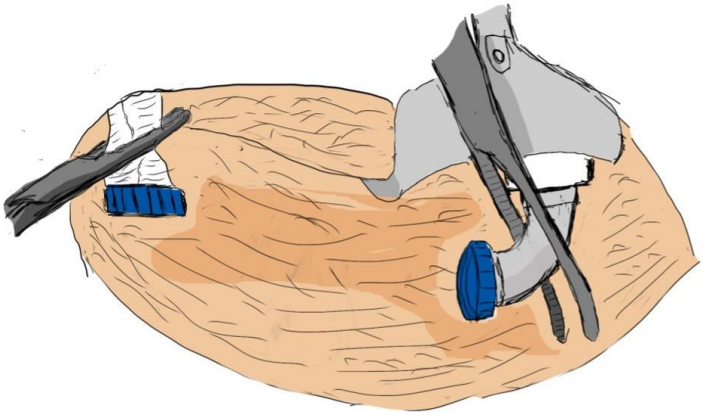

Figure 2. *The outflow graft is clamped, and the field is ready to connect the new pump.*

With the outflow graft clamped, a 16-gauge needle was inserted distal and proximal to the clamp to de-air the outflow graft, pump, and left ventricle. Only minimal air was evacuated. The pump was started at 6400 rpm, and de-airing continued through the 16-gauge needle with direct observation of the left ventricle andQ ascending aorta graft connection with TEE. The pump speed was increased to 8800 rpm, which provided sufficient cardiac output. The explanted pump had an organized thrombus on the rotor bearing (Fig. 3). The subcostal incision was closed in a regular fashion leaving 24 Fr Blake drain, which was removed 48 hours after surgery. Anticoagulation was started on the same day with heparin; the patient was then transitioned to warfarin. The patient recovered without complications and was discharged to home postoperative day 4.

Figure 3. *Thrombus formation on the HeartMate II rotor bearing.*

Discussion

LVAD pump thrombosis is a serious complication that has been reported to occur in as many as 12% of patients implanted with the HMII or the HeartWare Ventricular Assist Device (HVAD, Medtronic, Miami Lakes, FL).[1, 7] Although clinical management to prevent thrombosis has been effective, device thrombosis remains a concern for all implanted devices.[8] Pump thrombosis may result in cessation of circulatory support with abrupt heart failure symptoms, which necessitates prompt device exchange. Thromboembolism and stroke are also potential and severe complications. Heart failure and prior cardiac surgery establish a high risk for the exchange operation. Avoiding cardiopulmonary bypass and sternotomy appears to reduce the incidence of major complications associated with implantation or exchange.

The subcostal approach for LVAD pump exchange was first described by Gregoric et al.[6] and has become a preferred approach by many surgeons for this operation. Pump exchange through a subcostal incision and without cardiopulmonary bypass results in minimal bleeding complications, shorter operative time and ICU length of stay, and with lower mortality when compared to a sternotomy approach.[5, 9, 10]

There are anatomic and hemodynamic factors to be considered before an off-pump LVAD exchange can be safely performed. Regarding the anatomic factors, we universally obtain a chest computed tomography to delineate the position of the body of the pump. Of even more importance is the location of the inflow and outflow screw in relation to the subcostal margin. The inflow and outflow screw should be located at least 2-3 cms to the costal margin.

With respect to hemodynamic factors, we evaluate the relevant parameters in the operating room. If the patient has a good contractility index and the amount of inotropic support is minimal, we assess the ventricles using TEE as well as the patient's central venous pressure, pulmonary artery pressures, and mean arterial pressure. If the patient tolerates a low LVAD speed in the setting of a few micrograms/minute of epinephrine and a low dose of vasopressin with minimal variations on the hemodynamics mentioned above, the patient should be able to tolerate the pump exchange with no cardiopulmonary bypass support.

Conclusion

Because pump exchange is a high-risk operation, standby cardiopulmonary bypass should always be employed. The authors emphasize the critical importance of preparing the subclavian artery for arterial cannulation instead of the femoral artery in patients with severe peripheral arterial disease. It is important to stabilize the inflow cannula during the detachment of the pump, digital control of inflow cannula opening, and reattachment of the pump to the inflow cannula. We found these points essential to enable a safe, off-pump exchange procedure.

LVAD pump exchange is necessary for the majority of patients who develop pump thrombosis, and re-thrombosis and stroke have been observed in as many as 30% of patients following the exchange.[3] Right heart failure following pump exchange is also a frequent complication after a device exchange that requires careful monitoring and treatment.[11] LVAD pump exchange can be safely performed via

subcostal incision without cardiopulmonary bypass, but post-exchange complications are a real concern.

References

1. Stewart GC, Givertz MM, Mehra MR. Pump thrombosis redux. J Heart Lung Transplant. 2015;34(12):1511-4.

2. Gregoric ID. Exchange techniques for implantable ventricular assist devices. ASAIO journal. 2008;54(1):14-9.

3. Hanke JS, Dogan G, Wert L, et al. Left ventricular assist device exchange for the treatment of HeartMate II pump thrombosis. J Thorac Dis. 2018;10(Suppl 15):S1728-S36.

4. Imamura T, Narang N, Rodgers D, et al. Outcomes following left ventricular assist device exchange. J Card Surg. 2020;35(3):591-97.

5. Kitahara H, Raikhelkar J, Kim G, et al. A subcostal approach is favorable compared to sternotomy for left ventricular assist device exchange. J Artif Organs. 2019;22:181-87.

6. Gregoric ID, Bruckner BA, Jacob L, et al. Clinical experience with sternotomy versus subcostal approach for exchange of the HeartMate XVE to the HeartMate II ventricular assist device. Ann Thorac Surg. 2008;85(5):1646-9.

7. Lopilato AC, Doligalski CT, Caldeira C. Incidence and risk factor analysis for gastrointestinal bleeding and pump thrombosis in left ventricular assist device recipients. Artif Organs. 2015;39(11):939-44.

8. Maltais S, Kilic A, Nathan S, et al. PREVENtion of HeartMate II pump thrombosis through clinical management: The PREVENT multi-center study. J Heart Lung Transplant. 2017;36(1):1-12.

9. Ota T, Yerebakan H, Akashi H, et al. Continuous-flow left ventricular assist device exchange: clinical outcomes. J Heart Lung Transplant. 2014;33(1):65-70.

10. Soleimani B, Stephenson ER, Price LC, El-Banayosy A, Pae WE. Clinical experience with sternotomy versus subcostal approach for exchange of HeartMate II left ventricular assist device. Ann Thorac Surg. 2015;100(5):1577-80.

11. Austin MA, Maynes EJ, Gadda MN, et al. Continuous-flow LVAD exchange to a different pump model: Systematic review and meta-analysis of the outcomes. Artif Organs. 2020;doi: 10.1111/aor.13893. Online ahead of print.