Heartmate II outflow graft ligation and driveline excision without pump removal for left ventricular recovery

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We report interruption of left ventricular assist device (VAD) support by way of outflow graft ligation and driveline excision while leaving the pump in situ. In this case, the indication for mechanical assist device separation was myocardial recovery, which occurred following 9 months of support. This case report demonstrates the feasibility of separating a patient from a VAD without the need for a major reoperative intervention.

A small proportion of patients who undergo ventricular assist device (VAD) therapy for the management of end-stage heart failure will regain myocardial function (i.e., recovery) (1–3). Less than a handful of surgical techniques have been described to separate the patient from the left VAD once recovery has occurred. This report describes a method of mechanical circulatory support (MCS) cessation for myocardial recovery by interruption of the outflow graft of the left VAD and excision of the driveline while leaving the pump and nearly all of its components in situ.

CASE REPORT

A 34-year-old man with nonischemic cardiomyopathy presented after having undergone the placement of a VAD 9 months earlier as a bridge to transplantation. Evidence of hemolysis prompted a workup that demonstrated a partially obstructing thrombus in the outflow graft on computed tomography (CT) scan. The patient was placed on intravenous anticoagulation therapy. An echocardiogram and right-sided heart catheterization were performed, revealing evidence of myocardial recovery.

The patient was taken to the operating room with the goal of separating him from MCS. After a subxiphoid incision and partial lower sternotomy, the outflow graft of the VAD was exposed. The patient was observed for 15 minutes with the VAD turned off to confirm his ability to be weaned from MCS. The outflow graft was ligated using interrupted horizontal mattress stitches placed in the distal portion of the graft. The driveline was transected. A 2-cm portion was excised and the segment exiting the abdomen removed. The wound was closed and the lower sternum reapproximated.

The patient's postoperative course was complicated by embolic occlusion of his femoral artery necessitating embolectomy

and, later, fasciotomy. The remainder of his hospital course was uncomplicated, and the patient was discharged to a rehabilitation facility 2 months after the index procedure. The length of stay was, in large part, prolonged due to the patient's lack of insurance and difficulty with placement. The follow up for this patient included weekly visits after discharge for 4 weeks and monthly visits thereafter. A radiograph at follow-up showed the retained VAD (*Figure*).

COMMENTS

There are few surgical alternatives to separate the patient from the VAD. The classic procedure involves a redo sternotomy with the complete explantation of the device and its components. The flaw of this approach resides in the mediastinal re-entry, with its inherent risks of bleeding and cardiac injury.

With the benefit of more recent, smaller-sized devices, VAD explants can be carried out by simply removing the pump

Figure. Postoperative upper abdominal x-ray. In this image the retained ventricular assist device can be seen with its transected driveline (arrow).

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through a subcostal incision, occluding the ventriculotomy with a plug (i.e., Cohn plug), and oversewing the outflow graft (4). This technique allows for safe removal of the VAD while avoiding the need for a major reoperative procedure and the risks associated with mediastinal dissection. Patients treated with this technique recuperate quickly and can routinely be discharged from the hospital within days.

An even less invasive procedure to separate the patient from support is needed. Thus, the reported method opens the door to a number of percutaneous approaches that could potentially be successfully applied. This case report begins to bridge the gap in knowledge of what happens when a VAD is left in situ. Ligation of the outflow graft and plugging of the ventricle interrupts blood flow through the pump, allowing the native heart to eject through the aortic valve without regurgitation. Theoretically, this goal could also be accomplished with the use of percutaneous devices such as endovascular occluders (i.e., Amplatzer device). We project that this procedure could be performed on an outpatient basis as part of the second visit (for removal of the driveline) for patients who have been deemed candidates for recovery. Alternatively, it could all be done as a single procedure in a hybrid operating room setting.

There are two theoretical concerns with this approach. First, there is the inherent risk of embolization from the VAD as it thromboses after interruption of blood flow. While our case had a thromboembolic event, it was probably associated with either embolization prior to incision or, more likely, the manipulation of thrombus present within the graft at the time of ligation. The likelihood of embolization happening after ligation in a patient without graft thrombosis is potentially minimal, as the pressure from the ventricle and aorta immobilizes the thrombus within the retained pump/components. As an example, VAD components being left at the time of heart transplant and VAD explant have been previously reported without a high risk of thromboembolization (4, 5). The intraoperative anticoagulation strategy for this patient involved administration of 5000 units of heparin prior to ligation of the graft. Another technique that may limit embolic events is ligation of the inflow graft instead of the outflow graft to discontinue MCS. Also, the application of

an Amplatz occluder device may reduce the risk of embolization while achieving interruption of flow through the VAD.

The second theoretical concern is the risk of VAD-associated infections. While infection may occur, its incidence is likely similar to that with other implantable surgical prostheses (i.e., vascular graft for dialysis or permanent pacemakers). Assessment of the true risk of this potential complication would require further investigation and evaluation of these patients over a longer course of time.

The long-term prognosis for patients who have demonstrated myocardial recovery after requiring MCS for advanced heart failure is unclear at this time. A recent publication reported a survival rate for the bridge to recovery cohort of 89.9% and 73.9% at 1 and 7 years, respectively. In the same retrospective analysis, 10% of the explanted patients subsequently required transplantation for recurrent heart failure (6). The durability of remission of heart failure will hopefully become clearer as more protocols and techniques are developed to address myocardial recovery in patients on VAD therapy.

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