

# An Approach to LVAD Explantation during Heart Transplantation

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## ABSTRACT

Reoperations during ventricular assist device (VAD) explantation and subsequent heart transplantation are difficult procedures because of dense adhesions, obliterated planes of dissection, and proximity of the right ventricle to the sternum. We present our approach for left VAD explantation to minimize potential complications that may occur during this procedure.

## INTRODUCTION

The ventricular assist device (VAD) has become an established therapy as a bridge to transplantation for patients with decompensated end-stage heart failure. In many instances devices are implanted in patients with a previous history of cardiomyopathy, making the actual device explantation and cardiac transplantation the third or possibly the fourth reentry into the chest. In addition, the persistently dilated right ventricle coupled with the high incidence of bleeding during the initial implantation can lead to significant adhesion of the heart to the retrosternal area [Hsu 2000]. In fact, left VAD explantation (LVAD), particularly in the setting of time constraints related to multiorgan procurement, is probably one of the most difficult and dangerous operations performed. Although others have described their technique, the increasing number of these procedures at many different centers continues to make this topic interesting [Oz 1994]. The technique described here is our approach for minimizing complications associated with chest reentry and LVAD explantation during heart transplantation.

## LVAD EXPLANTATION PROCEDURE

Our routine approach is to expose the femoral vein and artery, preferably on the right. This method has 2 advantages, (1) rapid initiation of cardiopulmonary bypass (CPB) as

needed and (2) increased length of ascending aorta available for cross clamping and anastomosis.

After a full dose of heparin is administered, the femoral artery and vein are cannulated with the venous cannula directed into the right atrium by transesophageal echocardiographic guidance. The incision is extended over the previous scar and the abdominal part is carried down all the way to the pump pocket. We typically place the LVAD in the peritoneal space, above or below the rectus fascia. This placement generally allows easier access to the pump pocket without the hazards associated with intraabdominal contents adhering to any part of the device. Entry into the pump pocket allows identification of the LVAD outflow graft, which can be followed superiorly and dissected off the distal sternum as far as visualization permits. Chest reentry is accomplished using an oscillating saw in the usual manner. If there is any concern regarding the proximity of the right ventricle to the retro sternum, temporary CPB is initiated to decompress the right ventricle (RV), and the LVAD is stopped to prevent air embolization. After complete sternal splitting the option exists to continue CPB or to wean the patient off bypass and resume LVAD support. In an uncomplicated case, we typically wean off bypass.

The left hemisternum is mobilized away from the heart by gradual dissection of the adhesions to the RV. This dissection is carried out by freeing up each portion of the RV by sequentially moving longitudinally along the sternum. It is important to avoid excessive traction for visualization because such traction can create a tear in the RV distant from the location of the dissection, where it is still adherent. Once the left side is mobilized, the right hemisternum is freed by following the LVAD outflow graft and using electrocautery to get it off the sternum. If visualization is difficult, the right pleural space is entered. Our approach during initial VAD implantation is to wrap a Dacron or Gore-Tex graft around the outflow graft [LePrince 2001]. This extra layer of protection makes mobilization of the outflow graft from the retrosternum easier.

Exposure of the right hemisternum facilitates placement of a retractor. The adhesions around the innominate vein are divided and the vein is dissected off the aorta as needed. Following the LVAD outflow graft to the anastomosis to the aorta may facilitate exposure of the aorta. Gentle traction on the outflow graft can also provide some exposure, but if the plane is difficult to define and the PA is densely adherent, further dissection in this area is relegated to later when CPB is initiated. Exposure of the

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right lateral aspect of the aorta allows for identification of the SVC and cannulation. If placement of a tourniquet around the superior vena cava (SVC) is difficult, a vascular clamp can be used to control the SVC inflow. Similarly, the inferior vena cava (IVC) cannula can be retracted below the diaphragm, and a vascular clamp can be used for control of the IVC.

The right atrium is generally densely adherent to the outflow graft, and dissection without CPB can be hazardous. To prevent air embolization, the sequence involves stopping the LVAD prior to initiation of CPB and immediately applying aortic cross clamping. The atrium is then gradually freed up from the graft. Once mobilized, the graft can be clamped proximally and distally and divided. If the planes of the RA cannot be easily defined, the SVC and IVC vascular clamps are applied, the RA is opened, and the boundaries are defined from within. Similarly, visualization and identification of the anatomy will be much easier if the aorta and pulmonary artery are freed up from within the heart. The left side of the heart can easily be dissected once the apex of the left ventricle is separated from the LVAD by cutting out the core. During this step attention to the course of the left phrenic nerve is important, because the nerve could be adherent just before branching out on the diaphragm. The remainder of the cardiectomy is performed as usual. If time permits, the LVAD is freed off the pocket, the drive line is separated with a rib

cutter, and the device is removed through the incision. The removal of the drive line is performed after completion of cardiac transplantation. The pump pocket is irrigated and drained externally.

Using the above techniques we have not encountered any life-threatening, uncontrollable situations in the last 40 LVAD explants/heart transplantations performed at our institution. In one case an inadvertent tear occurred on the aorta at the level of the outflow graft suture line. This tear was controlled by digital pressure until the distal segment was mobilized and aortic cross clamp applied. The luxury of dissecting the heart from inside also avoids iatrogenic injury during dissection and speeds up the process.

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