Minimally invasive explantation of implantable left ventricular assist devices

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Interest in the management of dilated cardiomyopathy has recently been enhanced by the development of bridge to recovery techniques that use mechanical circulatory support.¹⁻⁵ A previously reported program of this type, combining mechanical with pharmacologic support involving induction of reverse remodeling followed by physiologic hypertrophy, has been developed at Harefield Hospital.⁶ After recovery, explantation of left ventricular assist devices has traditionally comprised median sternotomy and laparotomy^{7,8} with the associated extensive dissection of adhesions that can increase morbidity and mortality. To avoid these complications, we have developed and evaluated a new minimally invasive approach.

Method

The apex of the heart is exposed through an anterolateral minithoracotomy (Figure 1). Two other separate small incisions are made: an epigastric incision to expose the device and a limited anterior thoracotomy through the second intercostal space to expose the aortic anastomosis of the outflow cannula (Figure 2). Femorofemoral cardiopulmonary bypass is established, and the heart is fibrillated electrically to allow explantation of the device inflow cannula. After deairing, which is easily accomplished by rotation of the operating table to the right and partial constriction of the venous return cannula, the apex is repaired by direct suture (Figure 3). The heart is then defibrillated electrically with external or small internal paddles. Cardiopulmonary bypass is then discontinued, with strict monitoring of pulmonary arterial pressure by means of a thermodilution catheter (Swan-Ganz; Baxter Healthcare Corp, Edwards Division, Santa Ana, Calif). The outflow graft is divided as close as possible to the aortic anastomosis. The residual graft stump, which measures 2 to 3 mm in length, is oversewn (Figure 4), and the device is then explanted, along with the intrathoracic part of the Dacron polyester fabric graft, by traction applied from below (Figure 5).

Results

During the past 18 months we have used this technique to explant devices from 12 consecutive patients and have studied these cases

Figure 1. Diagram showing sites of minimally invasive incisions and arteriovenous cannulation in groin.

Figure 2. Diagram showing dissection of inflow cannula through minimally invasive anterior thoracotomy. Cannula is then extracted during short period of cardiopulmonary bypass.

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Figure 3. Drive line is divided close to device and is removed by traction from outside.

Figure 5. Finally, device is completely removed by traction on outflow graft from below.

Figure 4. Body of device is explanted after dissection around diaphragmatic passage of inflow cannula. Outflow cannula is exposed through anterior thoracotomy, then clamped and divided as close as possible to the ascending aorta. Stump is oversewn. An *inset* to Figure 4 is shown on the *right*.

on a prospective basis. All patients were supported by Thoratec HeartMate devices (11 HeartMate I and 1 HeartMate II; Thoratec Laboratories Corporation, Pleasanton, Calif, formerly Thermo Cardiosystems Inc). One patient died early of unrelated causes, and the 11 remaining patients all made a smooth recovery. Mean ($\pm$ SD) intensive treatment unit stay was 6.2 ± 3.3 days, with no cases of cerebral dysfunction, thromboembolism, or organ failure. Serious infection was not encountered. One patient had a superficial epigastric wound infection, which was treated conservatively.

Conclusion

We have evolved and used a simple, minimally invasive approach that appears to be safe, with a low complication rate. Because of increasing interest in bridge to recovery programs, we anticipate that this technique may become increasingly useful in reducing morbidity and mortality during the explantation of these devices.

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