Case Reports

CentriMag Left Ventricular Assist System

Cannulation through a Right Minithoracotomy

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The CentriMag left ventricular assist system can be used for perioperative or postcardiotomy circulatory support of the failing heart. The device resides at the patient's bedside, and the cannulae are usually inserted through a midline sternotomy, with the inflow cannula in the left ventricle or right superior pulmonary vein and the outflow cannula in the aorta. In a patient whose chest has been closed and who has a delayed need for temporary mechanical support, a less invasive method of left ventricular assist device cannula insertion is preferred. In these cases, the CentriMag cannulae can be inserted through a right minithoracotomy with the inflow cannula in the right superior pulmonary vein and the outflow cannula in the aorta, with no heparinization. Herein, we describe this approach in a patient who experienced postcardiotomy cardiogenic shock after aortocoronary bypass surgery. This technique may facilitate ambulation and recovery in selected patients. ***(Tex Heart Inst J 2008;35(2):184-5)***

Despite many advances in the care of postcardiotomy heart failure, the mortality rate for this condition remains high. The therapeutic priority is inotropic and vasoactive drug infusion along with intra-aortic balloon pump (IABP) support,[1] but a higher level of circulatory support—such as that of a left ventricular assist device (LVAD)—may be necessary to improve outcomes in selected patients.

The Levitronix® CentriMag® left ventricular assist system (Levitronix LLC; Waltham, Mass) is a magnetically levitated centrifugal-flow pump that can be applied rapidly in the operating room. By providing flows of up to 10 L/min,[2,3] this pump can safely support a patient's circulation for 2 weeks or longer. Typically, the CentriMag pump resides at the bedside and is connected to cannulae that are inserted through the existing sternotomy incision. The disadvantage of this cannulation technique is that the sternum usually remains unwired; patients not only are more susceptible to infection but also must remain sedated postoperatively. Conversely, if the sternum has already been wired, it must be reopened for cannula insertion. If left ventricular function deteriorates postoperatively after chest closure, a less invasive means of cannula insertion may be preferable. We present the case of a patient in whom LVAD cannulation was achieved through a minithoracotomy, without the use of cardiopulmonary bypass (CPB), after the sternum was already closed.

Key words: *Centrifugation/instrumentation; equipment design; extracorporeal circulation/instrumentation; heart-assist devices; heart failure/therapy; heart valve prosthesis implantation; patient selection; treatment outcome*

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Case Report

In March 2007, a 59-year-old woman underwent coronary artery bypass surgery at another hospital. At the end of the operation, weaning from CPB necessitated full inotropic support and the insertion of an IABP. The patient's cardiac function continued to deteriorate. Despite increased inotropic therapy, she experienced end-organ dysfunction with poor oxygenation, acute renal failure, fluid overload, and cardiogenic shock. On postoperative day 5, she was transferred to our institution, where her condition initially improved after continuous venovenous hemodialysis and fluid removal. Nevertheless, on postoperative day 8, her condition again deteriorated, and she required even higher doses of inotropic and vasoactive drugs to maintain adequate blood pressure. To provide increased cardiac support, we decided to use a CentriMag system. Because the patient's sternum had been closed postoperatively, the pump cannulae were inserted through a right minithoracotomy.

On arrival in the operating room, the patient was hypotensive; her mean arterial pressure was 55 mmHg. Her fingers and toes were cyanotic, due to high doses of vasopressors. She was placed in the 45° left decubitus position. After we made a 6-cm right

submammary incision, we entered the chest through the 4th intercostal space and exposed the right superior pulmonary vein and the aorta. A 2.0 polypropylene purse-string suture was placed on the right superior pulmonary vein and on the lateral portion of the aorta.[1] The cannulae were brought out through the chest wall, in the 6th intercostal space, via separate skin incisions in the midclavicular line. The aorta and the right superior pulmonary vein were then cannulated and rapidly connected to the inflow and outflow ports of the previously primed CentriMag pump. The LVAD was started, and flow was gradually increased to 4 L/min. Immediately after LVAD actuation, transesophageal echocardiography showed an improvement in contractility and in left and right ventricular function. After a chest tube was inserted, the thoracotomy was closed in routine fashion, and the patient was transferred to the intensive care unit. Her hemodynamic levels normalized. However, the patient experienced infection and multi-organ failure and died during the 2nd week of support.

Discussion

An ideal mechanical system for treating postcardiotomy cardiogenic shock is not currently available. Each of the systems designed for short-term use has limitations regarding cannulation, thrombogenicity, infection, and patient mobility. The TandemHeart® LVAD (CardiacAssist, Inc.; Pittsburgh, Pa) may be inserted percutaneously for immediate cardiopulmonary support. This approach is not ideal, however, unless the patient is in the hybrid suite for both surgery and catheterization, where imaging is available to guide insertion. On the other hand, the IMPELLA® RECOVER® LP 5.0 percutaneous LVAD (ABIOMED, Inc.; Danvers, Mass) may be applied in the operating room, but its use is limited in patients who have aortic valve disease or a mechanical aortic valve prosthesis. The insertion of other pumps, such as the ABIOMED® AB5000™ (ABIOMED), necessitates reopening of the sternum and partial clamping of the aorta for the creation of the graft anastomosis. This may pose a problem in patients who have coronary bypass grafts anastomosed to the aorta. Because these grafts are occluded during the creation of the anastomosis, heparin must be administered. Moreover, to prevent hypoperfusion of the myocardium, this procedure must be done with the patient under CPB, which prolongs operative time and increases the risk of postoperative bleeding.

In contrast, the CentriMag LVAS is quite practical for postcardiotomy circulatory support. Because this system does not require the use of specific cannulae, various cannulation techniques may be used. When weaning of the patient from CPB fails, existing cannulae may be used by simply changing the connections. In our patient, the cannulae were inserted through a right minithoracotomy in order to avoid reopening the sternum. If necessary, the subclavian artery could have been used for outflow return. Because of the CentriMag's versatility of cannulation and the ample flow-rate range (up to 10 L/min), the system may be used in patients of widely varying body sizes. The magnetically levitated impeller eliminates friction and heat within the pump housing, minimizing blood trauma and thrombogenicity.[3,4] In turn, the reduced thrombogenicity minimizes the amount of anticoagulant therapy that is needed to prevent thrombosis.

Although the CentriMag is designed for short-term use (up to 14 days), we have found that it may be safely used for longer periods. The lack of friction within the pump's drive system eliminates component wear.[5] External cannulae in any pump system limit patient mobility and increase infection rates. Nevertheless, the new, less invasive technique described here, which avoids aortic clamping and the need for large doses of heparin, may facilitate pump insertion and, in selected patients, may hasten recovery and increase mobility.

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