Implantation of the Jarvik 2000 Left Ventricular Assist Device Without the Use of Cardiopulmonary Bypass

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In this report, we describe successful implantation of a Jarvik 2000 left ventricular assist device (Jarvik Heart, Inc, New York, NY) without the use of cardiopulmonary bypass in a patient who was a member of the Jehovah's Witness faith. To accomplish this, we had to change our implantation technique. The modified technique, which minimizes the risk of bleeding and end-organ dysfunction, can also be used to decrease cardiopulmonary bypass time.

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Implantable, pulsatile left ventricular assist devices are now widely accepted as therapy for patients with severe heart failure, either as bridges to transplant or as destination therapy. In April 2000, the Jarvik 2000 left ventricular assist device (Jarvik Heart, Inc, New York, NY), a small, axial flow device, was first implanted at the Texas Heart Institute [1]. Since then, the Jarvik 2000 has proved particularly valuable as a true assist device for patients with heart failure. At the Texas Heart Institute, the Jarvik 2000 has been used as a bridge to transplant. In Europe the Jarvik 2000 has also been used as destination therapy. The device has many advantages, but it is particularly useful for small patients in whom other devices will not fit. This report is of its use in a terminally ill, heart-failure patient of small body surface area of 1.6 m^2, who was a devout member of the Jehovah's Witness faith.

Technique

Our patient, a 36-year-old woman with 3 children, had sustained heart failure for more than 4 years, a presumed postpartum cardiomyopathy. She was a member of the Jehovah's Witness faith. At the time of her admission she was in New York Heart Association functional class IV, despite maximal medical therapy. The only option for her was transplantation. We have performed 16 other heart transplant operations on Jehovah's Witnesses (with only 1 death) [2], so her religion did not preclude her consideration by our Medical Review Board. However, for transplants to be successful in this subset of patients, end-organ function must be preserved and bleeding must be minimized. She was approved, but while she was waiting for a suitable donor, her heart function deteriorated, requiring placement of an intraaortic balloon pump. As her creatinine level rose above 3 and her liver function became further compromised, it became apparent that she would not survive without some other form of cardiac assistance; and she was too small (body surface area, 1.6 m^2) for a conventional device like the HeartMate (Thoratec Corp, Pleasanton, CA). With the patient's consent, we decided to implant the Jarvik 2000 left ventricular assist device. In an effort to decrease the risk of bleeding, we decided to place the pump without the use of cardiopulmonary bypass (CPB), which we did by varying the implantation technique we had been using.

In a typical implantation, first a femoral-femoral bypass is instituted. With the patient in a head down position, the heart is then fibrillated and the core extracted from the left ventricle. The sewing ring is placed with circumferential sutures from the epicardium to the endocardium. However, since we developed this modified technique, we have routinely placed the sewing ring before beginning CPB (see as follows). The left thoracotomy approach allows access to the apex without manipulating the heart, which is very helpful for operating on these critically ill patients.

In the modified technique, the descending thoracic aorta was approached through a left thoracotomy and mobilized in the usual fashion, and a 16-mm graft was sewn to the aorta without heparinization (Fig 1A). The exit line was then tunneled from the right costochondral margin. After we determined a suitable length for the outflow graft attached to the Jarvik pump, the patient was given heparin (2 mg/kg), and that graft was sewn directly to the aortic graft. The apex of the patient's large left ventricle was exposed by incising the pericardium anterior to the phrenic nerve. The sewing ring was positioned with interrupted mattress sutures (2-0 Tycron [Tyco

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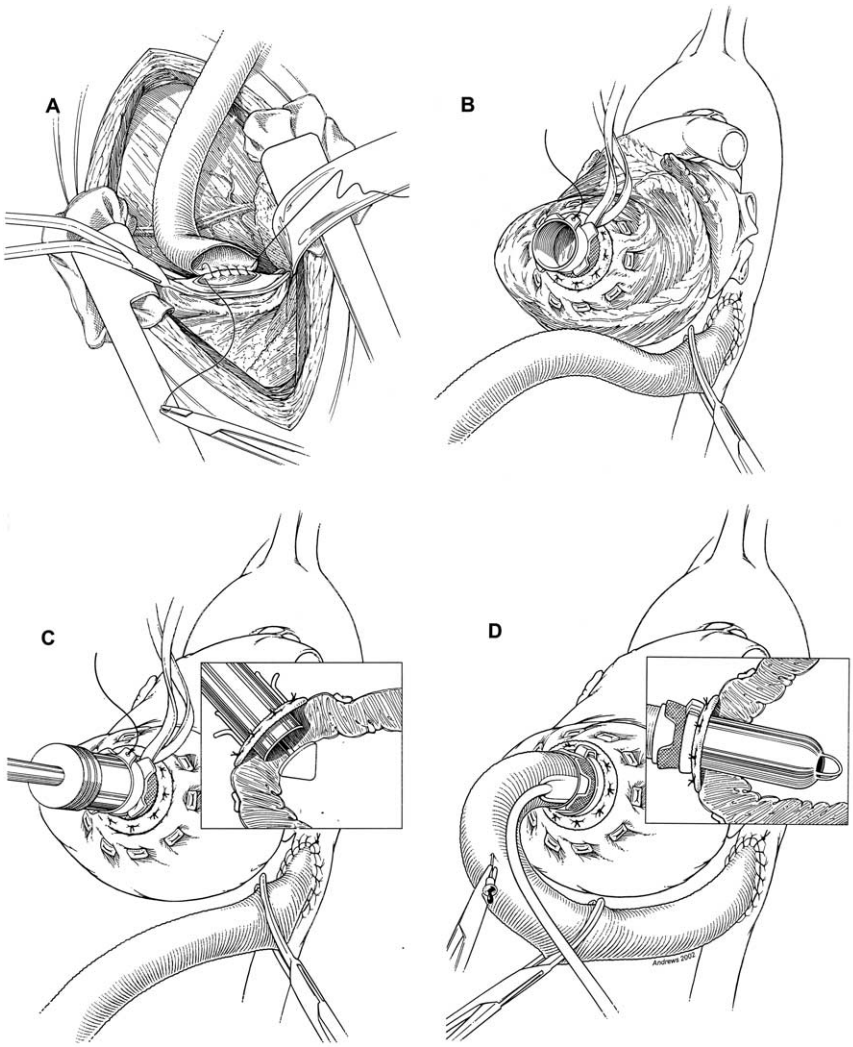

Fig 1. (A) Graft (16 mm) sewn to the descending thoracic aorta. (B) Sewing ring, sewn in place with interrupted mattress sutures. (C) Apex of the left ventricle cored with coring knife. (D) Jarvik pump placed inside the left ventricle and secured. Air from the native heart is removed after ejection resumes through a 19-gauge needle inserted into the graft.

Healthcare, Mansfield, MA]) (Fig 1B). After the sewing ring was secured and the graft clamped, the patient was placed in the extreme Trendelenburg position and the heart was fibrillated. The apex of the ventricle was then cored with a coring knife (Fig 1C); the Jarvik pump was promptly placed in the ventricle and secured with an umbilical tape tie (Fig 1D). Then the heart was defibrillated with one countershock. A total fibrillation time of 90 seconds was required to implant the pump. A cell saver was used to avoid blood loss.

The patient's heart began ejecting, and air within the heart was removed through the graft (Fig 1D). The Jarvik 2000 was then slowly turned on, resulting in a capture of 4 L/min of flow. This flow, coupled with the patient's native cardiac function, produced a pulsatile flow with a normal cardiac index. When normal cardiac index was achieved, heparin was reversed. All bleeding was well controlled. No pharmacologic support was required. By using this technique, total blood loss was kept to less than 50 mL. The patient was not anticoagulated in the immediate postoperative period. Minimal anticoagulation (dipyridamole and aspirin) was started 1 week postoperatively.

This critically ill patient survived and, over the next month, her hemoglobin levels gradually improved to 10 g/dL. She was able to eat and ambulate 1 month after the implant.

Comment

The simplicity of the Jarvik 2000 left ventricular assist device makes it amenable to expeditious implantation in critically ill patients who require left ventricular assistance. The Jarvik 2000 is a true assist device as it augments native heart function and works less effectively when it is required to capture the entire left ventricular output. Patients requiring support with the Jarvik 2000 should have some native heart function. This usually improves with the partial ventricular support of the

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Jarvik 2000. In fact, most patients successfully supported have regained a normal Starling's response while being supported by the Jarvik 2000 device.

By modifying our technique, we were able to successfully implant the pump without the use of CPB. In a subsequent patient who was not a Jehovah's Witness, we implanted the pump and weaned the patient from CPB in 7 minutes, also using this technique. Minimizing bypass time decreases the risk of bleeding and end-organ dysfunction, both of which are complications of prolonged CPB, especially in severely ill patients. Based on these 2 patients, we believe that the Jarvik 2000 can be implanted in typical patients within 10 minutes of CPB time.

References

1. Frazier OH, Myers TJ, Jarvik RK. Research and development of an implantable, axial-flow left ventricular assist device: the Jarvik 2000 heart. Ann Thorac Surg 2001;71:S125–32.
2. Burnett CM, Duncan JM, Vega JD, Lonquist JL, Sweeney MS, Frazier OH. Heart transplantation in Jehovah's Witnesses: an initial experience and follow-up. Arch Surg 1990;125:1430–3.