Bridge to Transplantation With a Thoratec Left Ventricular Assist Device in a 17-kg Child

Jack G. Copeland, MD, Francisco A. Arabia, MD, and Richard G. Smith, MSEE
Section of Cardiovascular and Thoracic Surgery and Artificial Heart Program, University Medical Center, University of Arizona, Tucson, Arizona

A Thoratec left ventricular assist device (LVAD) was used to support a 7-year-old 17-kg boy with viral cardiomyopathy for 23 days before heart transplantation. The boy is still living more than 1 year posttransplant, and functional except for some spastic paresis of the left hand, a residual from a stroke during device support. He is the smallest person to be supported with this device. We discuss techniques for using the Thoratec in children. (Ann Thorac Surg 2001;71:1003–4) © 2001 by The Society of Thoracic Surgeons

The Thoratec pump is a pneumatic pulsatile extracorporeal circulatory support device that may be used for univentricular or biventricular support. Inflow cannulas carrying blood from the heart to the device may be placed in the atrium or ventricle and outflow cannulas connect the device to a great vessel [1]. Normally, these devices are used in adults in a biventricular or left ventricular mode, pumping up to 5 to 6 L/min. Each ventricle has a volume of approximately 70 mL, that, under the usual fill-to-empty logic used by the drive console, ejects an effective stroke volume of 65 mL with each beat.

Our patient, an undersized 7-year-old, was noted to be fatigued and depressed 3 weeks before admission. He was transferred to us from a referring hospital taking dobutamine, dopamine, and lidocaine. By transthoracic echocardiography, he was found to have a huge heart with a left ventricle that barely contracted, measuring 71 mm in end diastole. He was cachectic and had hepatomegaly, but appeared to be an adequate transplant candidate and continued to deteriorate rapidly (Fig 1A). A Thoratec LVAD (Thoratec Laboratories Corporation, Pleasanton, CA) was inserted on the seventh hospital day using an apical inflow cannula in his huge left ventricle (Fig 1B). According to the company, this is the smallest person to be supported with a Thoratec pump. The outflow cannula distal end, a 14-mm woven Dacron graft, was felt too large for anastomosis to the patient’s ascending aorta. We placed an interposition 12-mm tube graft between the standard Thoratec graft and the ascending aorta.

Immediately after beginning Thoratec support in the normal fill-to-empty mode, we observed severe hypertension with systolic pressures in the 170 to 180 mm Hg range, with outputs in the 4.5 to 5 L/min range (5.9 to 6.6 L/min/M2). Nitroprusside administration dropped the pressures only slightly. We, therefore, modified the usual console settings to drop the device output by increasing the % systole to 60 (systole occupied 60% of the cardiac cycle) and switching to a fixed rate mode set at 60 beats per minute. Under these conditions, the device did not fully fill during diastole, but it continued to fully eject. Because there was not full filling, the console could not provide a cardiac output readout. We were, thus, left with...
clinical findings (pulses and estimated perfusion), clinical measurements (blood pressure, central venous pressure), and echocardiographic findings (failure of native aortic valve opening) to establish adequacy of cardiac output. We were able to drop the blood pressure to systolics of 90 to 120 without nitroprusside and maintain adequate perfusion. The patient was able to ambulate after the stroke and was beginning to walk short distances just before his transplant 23 days postimplant. Despite his small stature and the presence of an extracorporeal pump, no major mechanical problems were encountered in his ambulation, positioning in bed, or normal daily functions. His donor was a 35-year-old women with a normal size heart that fit easily. The portion of the native heart removed at transplantation weighed 235 gm (normal for the entire heart for his age is 106 gm). No return of native left ventricular function of this huge ventricle was noted before transplantation.

A small right hemisphere (middle cerebral artery) embolic stroke characterized by transient leg and arm weakness occurred on the fourteenth postimplant day. The patient regained function of his leg within 24 hours, but his arm and hand were paretic at transplantation. As anticipated from the absence of any CT scan evidence of cerebral hemorrhage, we observed no worsening of the patient’s neurologic condition from the transplant procedure. He has, over the last 10 months, regained arm function, but continues to have hand spasticity. He is otherwise completely normal. At the time of his embolic stroke, his International Normalized ratio (INR) was not therapeutic and we were changing medication from heparin to warfarin plus aspirin, dipyridamole, and pentoxifylline. We did not change our usual monitoring or anticoagulation in this patient. The philosophy was to maintain normocoagulability with four-drug anticoagulation.

Psychologically, the patient was depressed following both operations. After discharge, he returned to his preoperative “normal” self.

Comment

There is no pulsatile circulatory support device designed for children and approved for use in the USA. The Berlin Heart has models that are, by virtue of lower stroke volume, suitable for children and that have been used in children in Europe. The only FDA-approved pulsatile device that might be used in children for bridge to transplantation is the Thoratec pump. As we discovered, the stroke volume of the Thoratec under normal operating conditions is too much for a child of 17 kg. But the device may be adjusted to accommodate a child of this size and, thus, save his life. The price of such adjustments may be an increased risk of thromboembolism because of reduction in flow velocities and blood stasis in some areas of the device.

Bridge to transplantation is a method of rescuing the sickest of the advanced heart failure population who continue to deteriorate on maximal medical therapy. We believe children should benefit from bridging technology and that the Thoratec pump may serve as an interim solution for some.

Reference


Aerosolized Iloprost for Severe Pulmonary Hypertension as a Bridge to Heart Transplantation

Thorsten Wittwer, MD, Klaus Pethig, MD, Martin Strüber, MD, Marius Hoener, MD, Wolfgang Harringer, MD, Axel Haverich, MD, Ulrich Franke, MD, and Thorsten Wahlers, MD

Departments of Thoracic and Cardiovascular Surgery and Pulmonary Medicine, Medical School Hannover, Hannover, Germany

Preexisting pulmonary hypertension in pediatric patients is associated with poor outcome after cardiac transplantation because of donor right ventricular dysfunction. To avoid a combined heart-lung transplantation in a 17-year-old patient, we used an intensified pretreatment with intravenous prostacyclin and dobutamine combined with an inhalative therapy with the aerosolized prostacyclin-analog Iloprost. With this regimen, the patient was hemodynamically stabilized for the waiting period of 21 days after which an uneventful cardiac transplantation was performed.


Cardiac transplantation has become a standard therapy in end-stage heart disease, increasingly used in patients with heart failure from congenital defects [1]. Preexisting pulmonary hypertension (PHT) is frequent in this patients and remains a major risk factor for donor right ventricular dysfunction [2]. Therefore, pediatric patients with secondary PHT are usually considered for heart-lung transplantation [3], however, with impaired long-term results as compared to isolated heart transplantation [4]. We report on our experience with heart transplantation in a pediatric patient with severe PHT resulting from progressive failure of the systemic ventricle, 16 years following a Mustard correction for transposition of the great arteries (d-TGA). The patient was intensively pretreated with intravenous prostacyclin and

Address reprint requests to Dr Wittwer, Department of Cardiothoracic and Vascular Surgery, Friedrich-Schiller University, 07740 Jena, Germany; e-mail: th.wittwer-md@t-online.de.

Accepted for publication March 21, 2000.