

First Paediatric Left Ventricular Assist Device Implantation as Bridge-to-Recovery in Singapore

Dear Editor,

Severe acute heart failure in young and elderly patients regardless of the aetiology is a challenging condition for the involved therapeutic team. Left ventricular assist devices (LVADs) have proven their capacity to work as valuable tools to support impaired heart function and prevent the progression of multi-organ failure.¹ Mainly used as a bridge-to-transplantation, we would like to report the first introduction of such a device in Singapore which served successfully as a bridge-to-recovery.

A 14-year-old female patient was admitted to a regional hospital with a flu-like febrile episode of 3 days and sudden collapse. Cardiopulmonary resuscitation (CPR) was commenced twice and the girl was transferred for further last resort treatments to our university clinic. The consulted paediatric cardiologist performed echocardiography and found a dilated and severely dysfunctional heart with an estimated ejection fraction of less than 15%. Concomitantly, haemodynamically significant ventricular arrhythmias persisted. Liver function was significantly reduced and liver function tests (LFTs) were elevated, most probably due to organ hypoperfusion and congestion injury following two-fold CPR. Bleeding diathesis and diminished kidney function were the result. Oxygenation was maintained at a FiO_2 of 100%. Stabilisation in the next 12 hours could not be reached despite high-dose inotrope infusion. Due to the terminal haemodynamic state, no further diagnostic procedures were employed and the girl was transferred to the consultant cardiac surgeon to discuss the remaining options.

Despite multi-organ failure and inherent haemodynamic instability, we decided to implant a LVAD system to support the prominently dysfunctional left ventricle. This decision was made due to the acuity of presentation, history of two-fold CPR and the young age of the patient following discussions with the parents who opted for aggressive surgical therapy, with the knowledge of the minute chances of survival and the International Society of Heart and Lung Transplantation (ISHLT) recommendations.^{1,2} We refrained from infusing immunoglobulines or cortisone, due to potential deleterious side-effects on haemodynamics, the advanced state of disease, controversial literature reports and to avoid septic complications in sight of the planned LVAD implantation.^{3,4}

The lung function was unaffected and the choice for an atrio-arterial bypass system was made. The operation was

carried out on the following day (TK) and involved partial cross-clamping of the ascending aorta, implantation of an 8 mm Dacron graft as an extension of the efferent cannula and insertion of the afferent cannula into the left atrium. The system used was the Levitronix CentriMag® (Levitronix® Waltham, MA, USA). Circulation was commenced following de-airing of the system while maintaining the activated clotting time (ACT) at 180 to 200 seconds. The cannulae exited the body through sub-xiphoidal incisions. Antibiotic coverage was started and biopsies of the ventricles were obtained. Haemostasis was laborious and the chest tube drainage after sternal closure borderline. The girl was transferred to the ICU for further monitoring. We contacted the National Heart Centre, reported the patient's case, sent blood for cross-matching and completed evaluation for heart transplant back-up. Haemorrhage continued despite administration of clotting factors, fresh frozen plasmas (FFPs) and one-time bolus of Novo Seven® (Novo Nordisk Healthcare Inc. Princeton, NJ, USA). Inotropes could be reduced to moderate doses over the first night. Due to persistent haemorrhage, explorative re-sternotomy and aggressive haemostasis with local haemostatics was performed. Following mass transfusions, the right ventricle exhibited deteriorating function and NO-ventilation was started with 20 ppm. On postoperative day 2, packing of the pericardium with hot towels and temporary closure under compression relieved bleeding, while the liver function started recovering. On postoperative day 4 the renal urinary output re-occurred. The LVAD device was maintained in operation at 2500 RPM propelling a volume of 3.5 litres per minute. On the 6th postoperative day the liver and renal panel showed clear recovery. During the phase of intractable bleeding, we decided to allow the system to run on a minimal ACT of 160. The NO-ventilation could also be weaned and daily echocardiographic controls revealed gradual recovery of both ventricles with a re-established sinus rhythm. The bioptic results returned with evidence of extensive lymphocytic infiltration consistent with acute viral myocarditis. Polymerase chain reaction (PCR) revealed an Enterovirus 71 infection.

On postoperative day 8, the NO ventilation, inotrope infusions and ventilation state were at a level we considered appropriate to start weaning the heart from the LVAD system. On postoperative day 10, we decided to explant the device. During the explantation, we interrupted the operation of the device, following heparinisation and observed heart

function for about 30 minutes. Decannulation and sternal closure followed. The following course was uneventful, the patient was extubated 2 days later, her neurological state was intact and she recovered further during the subsequent days. Seven weeks following the procedure, she is enrolled in school activities with a gradually increasing fitness level.

Fatal acute dilative cardiomyopathy can often be preceded by flu-like symptoms and progress to heart failure with devastating outcome after various intervals.⁵ Frequently, this is the typical pattern of presentation of (for the most part) young patients and a viral aetiology is presumed. In some cases, LVAD, biventricular assist device (BiVAD) implantation or transplantation are the only options. Devices in such cases are mostly intended as bridge-to-transplantation. The choice of such an extensive surgical procedure implements consent of the family and profound alertness and cooperation of all clinical teams involved. Further, it is recommended in accordance with international guidelines.² We decided to proceed to LVAD implantation due to the young age of the patient, strong parental support and the acute pre-mortal state of presentation. Post-explantation assessment of the device parts revealed no clots, despite low ACT operation for at least 3 days (155 to 170 seconds). This is, however, the first time in Singapore that a child was treated in this fashion. Moreover, the rare case of recovery and explantation following left ventricular assistance occurred (bridge-to-recovery). Finally, the nature of disease was particularly aggressive and is known to have caused deaths in the region. The necessity of consolidation of the countries' resources and know-how to form a coordinated heart failure surgical treatment (Assist Device and Heart-and-Lung-Transplantation) programme is as relevant as never before.

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