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Heartmate 3 implantation in small patients: CT-guided chest diameter assessment

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Abstract

In recent years, the Heartmate 3 (HM3) has largely replaced the use of other intracorporeal left ventricular assist devices in the adult field. Because the HM3 is larger than the Heartware Ventricular Assist Device, the general consensus was that for small patients, the Heartware Ventricular Assist Device was the most appropriate implantable device option. Our goal was to describe our experiences with the successful implantation of the HM3 in 2 children, aged 9 and 11. We report on the chest cavity dimensions, as measured on computed tomography, that can be used to assess the feasibility of HM3 implantation in small patients.

Keywords: Congenital • Paediatric • Ventricular assist device • Heartmate

INTRODUCTION

The recent recall of the Heartware Ventricular Assist Device (Medtronic, Minneapolis, MN, USA) has created a challenge for left ventricular assist devices (LVADs) implantation in small patients [1]. The Heartmate 3 (HM3) (Abbott Laboratories, Chicago, IL, USA) has a favourable risk profile but is significantly larger with an outer diameter of the pump body of 50.3 mm, a height of 33.8 mm and a large outflow joint connecting to the outflow graft.

There are several possible measures [age, weight, body surface area (BSA), chest cavity dimensions, etc.] to describe the feasibility of HM3 implantation in smaller patients. We report on the chest dimensions of 2 children, aged 9 and 11, that were successfully implanted with an HM3.

ETHICAL STATEMENT

Informed consent for this case report was waived by our Institutional Review Board.

CASE REPORT

The first patient was an 11-year-old boy, weighing 32 kg with a BSA of 1.19 m². He presented with acute heart failure due to an idiopathic cardiomyopathy and underwent urgent LVAD

implantation with an HM3. The pump was placed in the left thoracic cavity and chest closure was well tolerated without compromising the pump position, as checked by echocardiography. Postoperative computed tomography (CT) illustrated a maximal internal transverse chest diameter of 19.4 cm.

The second patient was a 9-year-old girl, weighing 27 kg with a BSA of 1.04 m², presenting in acute shock due to myocarditis. She underwent cardiopulmonary resuscitation and was supported on veno-arterial extracorporeal membrane oxygenation. After 3 weeks of support, myocardial recovery was considered insufficient to attempt weaning. CT showed a maximal internal transverse chest diameter of 19.5 cm (Fig. 1). We proceeded with implantation of an HM3 LVAD and placement of a temporary right ventricular assist device to support the right ventricle. The left ventricular assist device was explanted 1 week later and the chest closed another 5 days later.

DISCUSSION

The HM3 is a reliable LVAD with low adverse event rates for thrombosis and embolic events [2]. The major limitation to implant the HM3 in small patients is the limited space in the thoracic cavity and the potential danger of compromising the pump position with chest closure. The Advanced Cardiac Therapies Improving Outcomes Network (ACTION) reported on a series of 35 patients with congenital pathology undergoing HM3



Figure 1: The widest internal transverse diameter of the chest (19.5 cm) provides an assessment of the total cavity available to harbour the pump.

implantation [3]. The median age was 15.7 years (8.8–47.3 years), with the lowest patient weight of 19.1 kg and a BSA of 0.78 m².

Ranney *et al.* [4] reported a successful implantation in an 8-year-old, weighing 21 kg. They described that the papillary muscles were excised to prevent inflow obstruction. In our patients, there was no need for specific surgical actions concerning the inflow cannula. In both cases, it turned out that the best orientation of the pump was with the outflow joint turned inferiorly, into the costodiaphragmatic recess. We covered the pump housing with an ePTFE membrane, the membrane was folded several times on itself at the place where the pump housing touches the internal chest wall. In doing so, we hope to avoid chronic pain by alleviating the friction of the pump housing against the chest wall (Fig. 2).

At our centre, the internal transverse diameter of the chest, at the level of the diaphragm, is measured with CT to assess the feasibility of LVAD implantation. In our experience, an internal transverse diameter of at least 19 cm is no contraindication to HM3 LVAD implantation. However, it remains difficult to account for the plasticity of the surrounding organs and for the potential influences of opening and closing of the chest.

Patients come in different sizes and we found the widest internal diameters of the chest, as measured on CT at the level of the diaphragm, an objective and predictive measure to assess the feasibility of LVAD implantation. In time-sensitive cases, this straightforward measurement can be a valuable alternative to more complex options like 3D fitting.

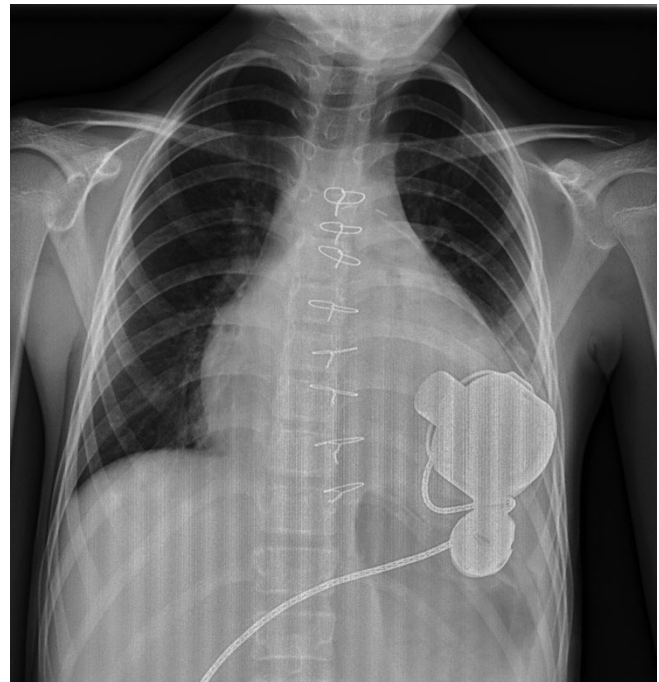


Figure 2: Postoperative chest X-ray of Patient 1 indicating the position of the outflow joint (inferiorly in the costodiaphragmatic recess) and the contact of the pump housing with the lateral chest wall.

Conflict of interest: none declared.

Reviewer information

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