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8-1-2020

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Right Ventricular Device HeartWare Implant to the Right Atrium with Fixation to the Chest Wall in Patient with Biventricular Support

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The best treatment for patients with severe biventricular failure is heart transplantation. When a heart donor is not imminently available, long-term biventricular support as a bridge to transplant is the only realistic option. Total artificial heart (Syncardia, Tucson, AZ) and continuous flow durable biventricular assist device implantation are the two mid-term support options.^{1,2} Reports demonstrate comparable survival with total artificial heart and biventricular pump support as bridge to transplant.^{3,4} Although the left ventricular assist device implant technique is standardized, there are few right ventricular assist device (RVAD) surgical implant techniques described; both the right ventricle and the right atrium can be used for the pump implant.^{2,5} We describe a HeartWare (HW) (Medtronic, Fridley, MN) implant technique at the right atrium with pump fixation to the right anterior chest wall that prevents suction events and functions well until heart transplant occurs.

Technique

A 40-year-old male INTERMACS 1 with end-stage nonischemic cardiomyopathy was approved for left ventricular assist device (LVAD) implant as bridge to transplant. At the time of a HeartMate 3 LVAD (Abbott, Chicago, IL) implant, he underwent concomitant replacement of the aortic valve with tissue pericardial prosthesis and tricuspid valve ring annuloplasty for moderate aortic and tricuspid regurgitation. Because of severe right ventricular failure at the index procedure, temporary right ventricular support was instituted with Centrimag (Abbott), as previously described.⁶ The right ventricle did not recover and the patient underwent an HW RVAD implant. After initiation of cardiopulmonary bypass with bicaval venous drainage, the HW ring was secured with multiple Ethibond pledgeted circumferential sutures at the right atrial appendix (**Figures 1 and 2**). Two felt rings (Teflon; Dupont Co., Wilmington, DE) were placed between the right atrial wall and the ring to avoid deep penetration of the inflow cannula in the right atrium. A right atrial wall opening was created at the junction of atrial appendix-right atrial body with a cruciate incision followed by a circular opening and the HW

pump was secured to the ring. The HW RVAD outflow graft was connected to the preexisting main pulmonary artery graft in end-to-end fashion with continuous 5-0 Prolene suture. Three No. 2 Prolene sutures were tied around the HW RVAD pump at the ring-pump junction 60° apart. A counter incision at the right fourth rib anterior chest wall level was made and the sutures were passed around the third and fourth ribs after opening the right pleural space. The HW RVAD and its outflow graft were wrapped with a GoreTex membrane (Flagstaff, AZ) to facilitate RVAD explant in the future (**Figures 1 and 3**). The RVAD outflow graft was left long enough to take a gentle curve on the lateral wall of the heart. The RVAD drive line was exited at the patient's right subcostal area and was connected to the pump controller. The RVAD and LVAD were started at a speed of 1,800 and 3,000 r/min, respectively, and gradually increased at 2,400 and 5,000 r/min, respectively, after separation from cardiopulmonary bypass. The three heavy Prolene sutures were tied around the third and fourth ribs after sternal approximation under transesophageal guidance to ensure optimal inflow RVAD cannula position at a safe distance from the interatrial septum. The final RVAD and LVAD speed was adjusted to ensure neutral position of the intra-atrial septum on transesophageal imaging. The patient had an uneventful recovery. After a period of rehabilitation, he underwent a successful heart transplant in 6 months. The RVAD was easily detached from the chest wall by cutting the anchoring stitches that were placed during the index procedure (**Figure 1**); both assist devices were functioning well until they were explanted. In our experience of five patients with the same technique of biventricular implant, we have not experienced any HW RVAD thrombosis during 5 months of median follow-up period. One patient expired from massive intracerebral hemorrhage.

Comment

Implant of the RVAD in the inferior wall of the right ventricle can potentially be problematic because the tricuspid subvalvular apparatus can obstruct the RVAD inflow cannula opening leading to RVAD pump thrombosis. When the HW is implanted at the anterior surface of the right ventricle, the assist device may compress the right ventricular outflow causing low RVAD flow and subsequent pump thrombosis.^{2,5} During our early experience with long-term biventricular support, we had one case of HW RVAD thrombosis that was implanted at the inferior wall of the right ventricle. Implantation of the RVAD in the right atrium avoids inflow cannula obstruction by the tricuspid valve sub valvular apparatus and right ventricular compression. Tran *et al.*⁷ described a case series of 11 patients with excellent results with biventricular support after implant

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Submitted for consideration November 2019; accepted for publication in revised form January 2020.

Disclosure: The authors have no conflicts of interest to report.

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DOI: 10.1097/MAT.0000000000001143

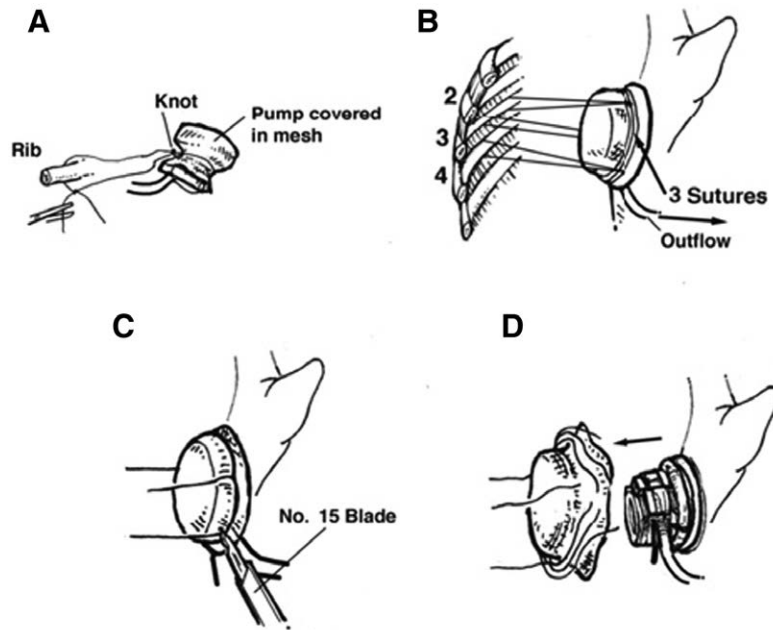


Figure 1. Schematic presentation of RVAD anchoring to the chest wall and mobilization during subsequent heart transplant. **A:** Pump is wrapped with Goretex membrane. One Prolene suture is tied at the base of the pump and around the third rib. **B:** Pump is suspended from the chest wall with three Prolene sutures. **C:** The Prolene sutures are cut with a No. 15 blade after sternal re-entry during LVAD explant-heart transplant. **D:** The pump is unwrapped after cutting all three suspension sutures during heart transplant. LVAD, left ventricular assist device; RVAD, right ventricular assist device.

of HW RVAD in the right atrium. Intrapericardial placement of the RVAD can be possible with the use of more spacers and adequate volume resuscitation. Fixation of the RVAD from the chest wall may overcome the potential suction event if the patient is volume depleted during the postoperative period. The addition of another surgical incision at the right anterior chest wall can cause some discomfort that improves with time

as the surgical wound heals. The anchoring sutures may cause some residual discomfort that completely resolves when they are cut during the heart transplant. We decided to use HW for RVAD support because the size of the inflow cannula is smaller than HeartMate 3. Caution should be exercised during

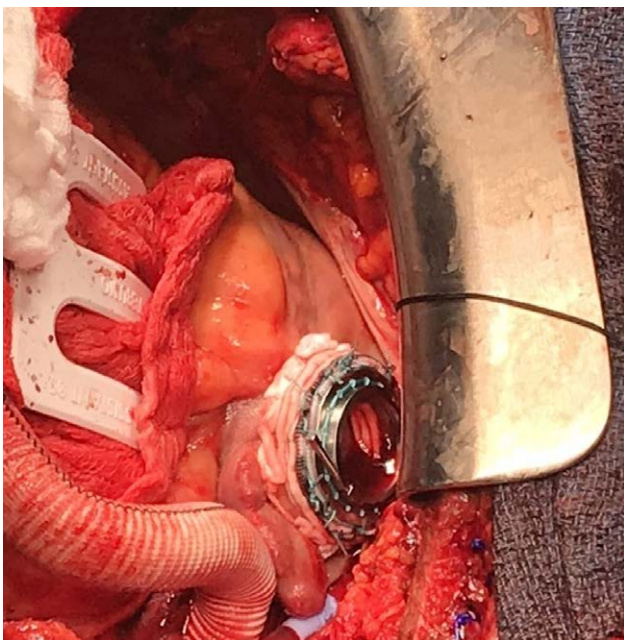


Figure 2. The HeartWare ring is secured with multiple circumferential pledgeted sutures at the base of the right atrial appendix.



Figure 3. The HeartWare pump is wrapped with Goretex membrane. Three Prolene sutures are tied at the base of the pump securing the Goretex and each suture arm is around the third or fourth rib.

explant of the HW RVAD; placement of sternal retractor following sternal division before the HW is detached from the chest wall may transmit undue traction and tear the right atrium. Detachment of the HW from the chest wall is simple: Exposure is obtained with gentle elevation of the right hemisternum with an internal mammary retractor, followed by cutting the three anchoring sutures to the chest wall and removal of the wrapping Goretex membrane. We believe that the HW RVAD technique described is reliable when biventricular support is necessary and the explant technique is safe and reproducible at the time of the transplant.

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