CASE REPORTS

TEMPORARY RIGHT VENTRICULAR ASSIST DEVICE AFTER REDO AORTIC VALVE REPLACEMENT AND HEARTMATE 3™ IMPLANTATION – A CASE REPORT

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Abstract

Introduction: *The implantation of the left ventricular assist device Abbott HeartMate 3TM is being increasingly performed for management of end-stage heart failure. LVAD implantation might be associated with early or late right ventricular dysfunction. When severe, a temporary right ventricular support device may need to be implanted. However, these situations are associated with higher mortality. We report a successful case of temporary right ventricular support following HeartMate 3 implantation.*

Keywords: *Heart failure; HeartMate 3; Centrimag system; long-term mechanical circulatory support; temporary right ventricular assistance device*

INTRODUCTION

Long-term mechanical circulatory support with HeartMate 3™ (HM3) (Abbot, Chicago, IL, USA) is an increasingly accepted modality for the treatment of terminal heart failure, either as a bridge to or as an alternative to heart transplantation (destination therapy)[1].

The optimal performance of the HM3 is closely dependent on the patient's native right ventricular function[2,3]. Immediately after insertion, leftward shift of the interventricular septum and the sudden increase in left ventricular output might lead to right ventricular dysfunction and volume overload. Severe pre-implantation right ventricular dysfunction is a contra-indication for LVAD implantation and thorough pre-operative evaluation needs to be conducted. Nevertheless, the incidence of right ventricular failure after left-ventricular assist device (LVAD) implantation ranges between 9 and 44%4. In these situations (10%-15%), temporary right ventricular support (RVAD) might be required2,5. However, this practice appears to be associated with higher postoperative mortality[3].

We report the successful implantation of temporary RVAD after redo aortic valve surgery and LVAD implantation in a patient with end-stage heart failure.

CLINICAL CASE

A 38-years-old male (80Kg/178cm), with terminal left heart failure, on the waiting list for transplantation was admitted to our center with decompensated heart failure. He had a history of mechanical aortic valve re-

placement, cardiac resynchronization therapy with defibrillation (CRT-D) implantation, atrial tachycardia and multiple admissions for acute pulmonary edema episodes. In addition, he had type-II diabetes, hypercholesterolemia, obstructive sleep apnea and latent tuberculosis.

He was treated with furosemide, amiodarone and non-invasive ventilation. The clinical situation failed to improve despite three infusions of levosimendan and patient developed stage II acute kidney injury. At this stage, we decided to implant a HM3 device as bridge to heart transplantation. Pre-operative evaluation of the RV demonstrated a slightly dilated right ventricle with normal global function (RVD1: 44 mm; TAPSE VD: 17mm; S wave: 10cm/s; Load adaptation index: 31.5). The patient was classified as INTERMACS-2 and the EuroSCORE-II preoperative mortality risk estimate was 69%. Preoperative laboratory values are reported in Table 1.

After induction of general anaesthesia, transesophageal echocardiography confirmed the left ventricular dysfunction (ejection fraction 15%) with dilated left heart cavities, severe mitral regurgitation, moderate tricuspid regurgitation and pulmonary hypertension (systolic pulmonary artery pressure 60mmHg). In addition, there was an oscillating mass on the prosthetic aortic valve, compatible with a vegetation.

Cardiopulmonary bypass (CPB) was instituted using double venous cannulation (superior vena cava with 28 Fr (35.6 cm) DLPTM single stage venous cannula with right angle metal tip (Medtronic, Tolochenaz, Switzerland) and right femoral vein with 25 Fr (55cm) percutaneous cannula HLS (Getinge, Maquet Cardiopulmonary GmbH, Rastatt-Germany)) and arterial cannulation in ascending aorta with 24 Fr EZ Glide aortic cannula with curved tip with suture bump (Edwards Lifesciences, Irvine, USA).

In a first operative stage, the mechanical aortic valve was replaced with a pericardial valve (TrifectaTM 29, St Jude Medical Inc.,St.Paul, MN, USA). Then, following aorta clamp release, the HM3 device was implanted in the apex of the left ventricle. The ejection cannula was implanted in the right anterolateral face of the ascending aorta after lateral clamping of the ascending aorta. At this stage, severe right ventricular dysfunction was noted. A temporary RVAD with Centrimag® system (CMs) (Levitronix LLC, Waltham, MA) was inserted. This insertion required a pulmonary arteriotomy, where a 10mm Hemashield graft (Maquet, Inc, Wayne, NJ) was sutured to the pulmonary artery using a continuous Prolene 5-0 suture (Johnson & Johnson Medical Ltd.; Livingston, West Lothian, United Kingdom). The graft was tunneled percutaneously in the right mid-clavicular line, at the level of the hypochrondrium. This prosthesis was then cannulated by a 19 Fr (15cm) percutaneous arterial cannula HLS (Getinge, Maquet Cardiopulmonary GmBh, Rastatt-Germany) and connected to the infusion line of the CMs, reinforced with several tie bands. For venous drainage, the 25 Fr percutaneous previously placed in the right femoral vein was used and connected to the drainage line of the CMs (Figure1)6, 7. Following this double implantation, the CPB could be weaned, and the patient was transferred to ICU with the implanted LVAD and temporary RVAD (total CPB duration 152min, aortic cross-clamping 65min).

On admission, he was sedated, intubated but free from inotropic or vasopressor support. Empiric antibiotic therapy (co-amoxicillin and gentamycin) was administered for 72hrs until negative cultures enabled to rule out the infectious nature of the lesions visualized on the prosthetic valve. The patient could be extubated on post-operative day (POD) 2. Serial echocardiographic and clinical evaluation of right ventricular function were conducted and finally, temporary RVAD could be removed at bedside on POD-8. The patient was discharged from the ICU on POD-16 and from the hospital on POD-21.

Twenty-five months after HM3 implantation, heart

Table 1 **Laboratory values and circulatory assistances configurations.**

	Admission	Immediate post-op	POD-8 (post temporary RVAD removal)
Leukocytes (G/L)	12.9	11.3	16.4
Platelets (G/L)	262	149	301
aPTT (s)	76	49	61
Fibrinogen (g/l)	4.6	2.7	-
Urea (mmol/l)	16	13.5	4.7
Creatinine (umol/l)	183	187	61
eGFR (ml/min/1,73m2)	36	35	>60
CRP (mg/l)	22	20	143
NT-proBNP (ng/l)	49'995	-	-
CK (U/L)	45	428	41
ASAT (U/L)	165	716	36
ALAT (U/L)	137	357	53
HM3 (LVAD) settings			
RPM	-	5600	6200
Flow (l/min)	-	5	5.5
PI	-	3.7	3.6
Power (watts)	-	4.1	5
Centrimag (RVAD) settings			
RPM	-	3800	-
Flow (l/min)	-	4.95	-

aPTT- activated Partial Thromboplastin Time; eGFR- Estimated Glomerular Filtration Rate; CRP- C-Reactive Protein; NT-proBNP – N-Terminal pro hormone B-type natriuretic peptide; CK- Creatine Kinase; ASAT- Aspartate aminotransferase; ALAT- Alanine transaminase; HM3- HeartMate 3TM; RPM- pump speed in revolutions per minute; PI- pulsatility index; LVAD- left-ventricular assist device; RVAD- right ventricular support.

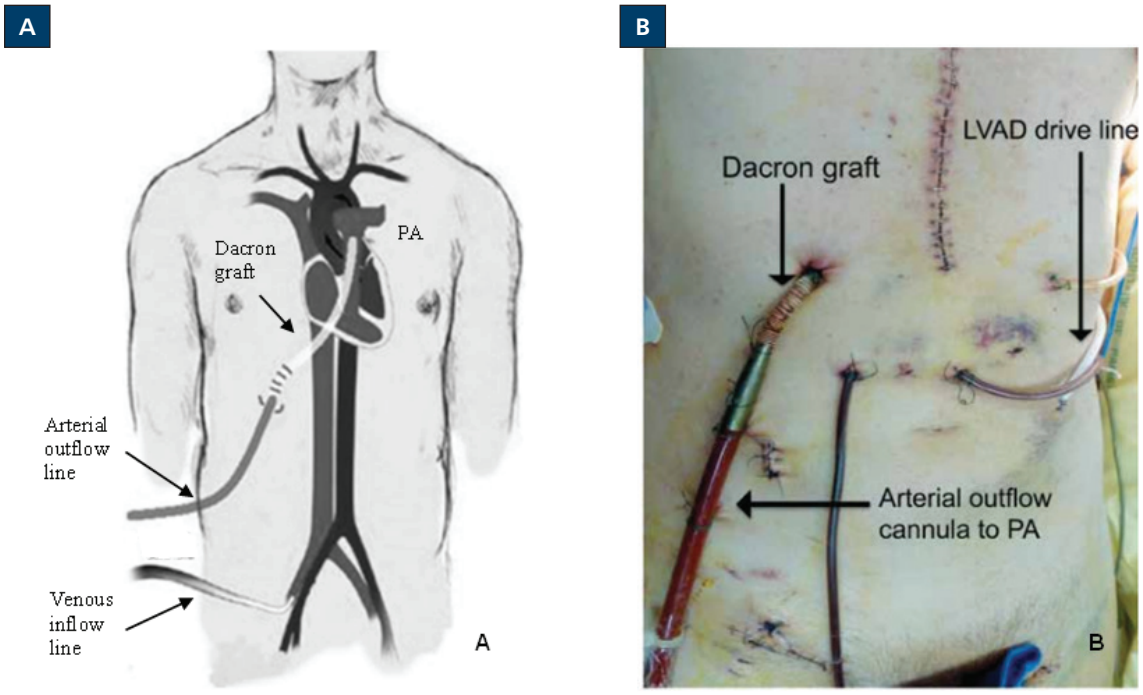

Figure 1 *A- Schematic illustration of the temporary RVAD system with cannulation bydracon graft between the right femoral vein and the pulmonary artery. B- Patient front view with dacron graft tunneled under the right costal margin and LVAD drive line. Legends: PA- pulmonary artery; LVAD – left ventricular assist device.*

transplantation was successfully performed.

DISCUSSION

Temporary RVAD might be required after LVAD implantation in case of CPB weaning failure attributable to right ventricle dysfunction (RVd) despite inotropic support8. In a multicentric study, incidence of RVd post LVAD implantation was 20% (requiring RVAD in 6%). Mortality for these patients was 41%3. This high mortality is likely to be related to high risk profile patients but also perhaps to a high incidence of thromboembolic events, stroke rate and postoperative bleeding complications.

In our case, after HM3 implantation, the first signs of right ventricular dysfunction appeared, accompanied by changes to the pre load and post load of the HM3.

We decided to implant a temporary RVAD in our patient. The early installation of temporary support was crucial to the success of our case.

The central reflection for the success of this type of interventions has to do with the early identification of patients likely to develop right ventricular failure.

According to Kromos et al, the INTERMACS score seems to predict the need for temporary RVAD as patients with low scores (1-2) had 2-3 times greater risk of requiring temporary RVAD compared to those with high (>3)

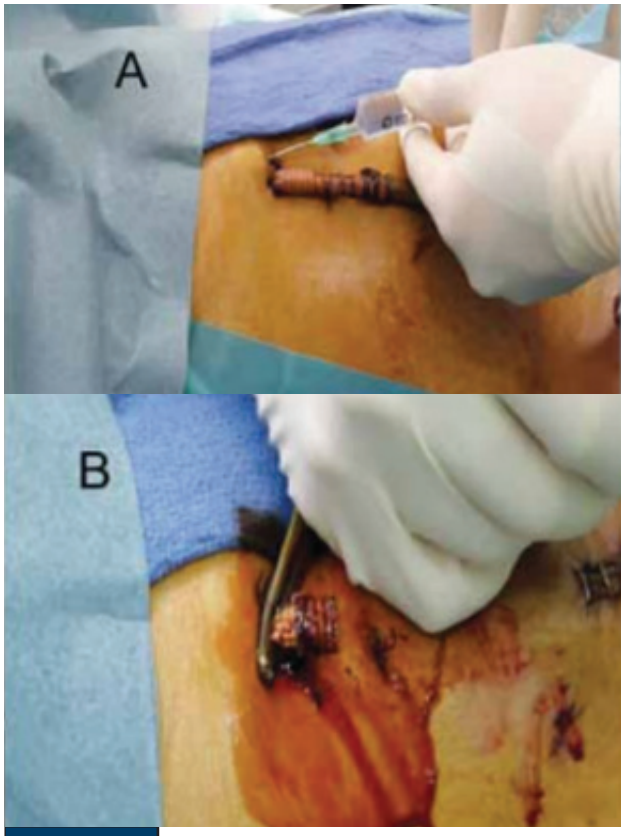

Figure 2 *A- Retrieval of the device under local anesthesia. B- Retraction of the dacron graft into the mediastinum*

scores. In this series, other predictors for the need for temporary RVAD were elevated white-blood-cell counts, serum urea, and preoperative ventilatory support[3].

In our case, the preoperative evaluation suggested normal RV function. But, like the INTERMACS score, the preoperative evaluation of the RV has limitations. It is therefore sensible to take a preventive approach that facilitates rapid installation of circulatory support.

We used the CMs as temporary RVAD. This system, approved in Europe in 2002, can provide mechanical circulatory support for right, left or biventricular dysfunction or be integrated in an extracorporeal membrane oxygenation system[9]. According to our experience, it is easy to setup, implant and explant. In addition, its magnetically levitated rotor minimizes blood trauma.

The femoral vein cannulation performed at the beginning of the intervention allowed us to quicky install the temporary RVAD and minimize the consequences of the right insufficiency.

The cannulation of the pulmonary artery using a Hemashield prosthesis allows immediate chest closure and rapid weaning from mechanical ventilation. In addition, the cannula could easily be removed under local anesthesia with oversewing of the prosthesis using a double suture line (Prolene 4-0) (Figure2)[7].

In conclusion, we report the successful implantation of temporary RVAD in a patient at high risk of peri-operative complications. This implantation enabled to successfully wean CPB and resulted in an uncomplicated post-operative course.

REFERENCES

1. Mendes V, Cerca C, Crosset M, Kirsh M. Two Years of Experience in the Implantation of Heartmate III. Rev Port Cir Cardiotorac Vasc. 2017 Jul-Dec;24(3-4):120. PMID: 29701352.
2. Nowacka A, Hullin R, Tozzi P, Barras N, Regamey J, Yerly P, Rosner L, Marcucci C, Rusca M, Liaudet L, Kirsch M. Short-term single-centre experience with the HeartMate 3 left ventricular assist device for advanced heart failure. Eur J Cardiothorac Surg. 2020 Sep 1;58(3):511-518. doi: 10.1093/ejcts/ezaa075. PMID: 32236472.
3. Kormos RL, Teuteberg JJ, Pagani FD, Russell SD, John R, Miller LW, Massey T, Milano CA, Moazami N, Sundareswaran KS, Farrar DJ; HeartMate II Clinical Investigators. Right ventricular failure in patients with the HeartMate II continuous-flow left ventricular assist device: incidence, risk factors, and effect on outcomes. J Thorac Cardiovasc Surg. 2010 May;139(5):1316-24. doi: 10.1016/j.jtcvs.2009.11.020. Epub 2010 Feb 4. PMID: 20132950.
4. Argiriou M, Kolokotron SM, Sakellaridis T, Argiriou O, Charitos C, Zarogoulidis P, Katsikogiannis N, Kougioumtzi I, Machairiotis N, Tsiouda T, Tsakiridis K, Zarogoulidis K. Right heart failure post left ventricular assist device implantation. J Thorac Dis. 2014 Mar;6 Suppl 1(Suppl 1):S52-9. doi: 10.3978/j.issn.2072-1439.2013.10.26. PMID: 24672699; PMCID: PMC3966152.
5. Bhama JK, Kormos RL, Toyoda Y, Teuteberg JJ, McCurry KR, Siegenthaler MP. Clinical experience using the Levitronix CentriMag system for temporary right ventricular mechanical circulatory support. J Heart Lung Transplant. 2009 Sep;28(9):971-6. doi: 10.1016/j.healun.2009.04.015. PMID: 19716053.
6. Niclauss L, Roumy A, Kirsch M. Semi-Percutaneous Short-Term Support of Right Heart Failure in Acute Aortic Dissection. Science Repository. 2021 Apr. doi:10.31487/j.SCR.2021.04.07
7. Lenoir M, Quessard A, N'guyen A, Kirsch M. Simplified temporary right ventricular support after implantation of a left ventricular assist device. Heart Surg Forum. 2013 Jun;16(3):E152-4. doi: 10.1532/HSF98.20131003. PMID: 23803240.
8. Reid G, Mork C, Gahl B, Appenzeller-Herzog C, von Segesser LK, Eckstein F, Berdajs DA. Outcome of right ventricular assist device implantation following left ventricular assist device implantation: Systematic review and meta-analysis. Perfusion. 2021 Jun 11:2676591211024817. doi: 10.1177/02676591211024817. Epub ahead of print. PMID: 34112048.
9. Griffith KE, Jenkins E, Stulak J, Paugh T, Pagani FD. Long-term use of the CentriMag® Ventricular Assist System as a right ventricular assist device: a case report. Perfusion. 2012 Jan;27(1):65-70. doi: 10.1177/0267659111424634. Epub 2011 Oct 24. PMID: 22025358.