

CASE REPORT

Successful surgical employment of Impella recovery system for right ventricular failure after previous aortic valve replacement

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ABSTRACT

A 58-year-old woman underwent aortic valve replacement. On the second postoperative day the patient referred a sharply chest pain, and an emergent coronary angiography revealed total occlusion of the right coronary artery. An intra-aortic balloon pump was placed and the patient underwent emergent off-pump coronary revascularization of the right coronary artery. Five hours later, due to unstable hemodynamic the extracorporeal membrane oxygenation was implanted without improvement of the right ventricular (RV) function. Then we decided to implant the Impella Right Direct (RD). After 9 days of Impella's insertion the RV was recovered and the device was successfully explanted. After 16 days of Impella explanted the patient was discharged. This case suggest that implantation of Impella RD is clinically feasible, associated with hemodynamic improvement, and facilitate successful bridge-to-recovery in patients with post-cardiotomy RV failure due to myocardial infarction unresponsive to coronary artery bypass grafting, maximal medical therapy, contrapulsation and extracorporeal membrane oxygenation.

INTRODUCTION

Acute right ventricular (RV) failure is associated with significant morbidity and mortality [1], which may develop as a consequence of acute myocardial infarction, pulmonary embolism, myocarditis, ventricular septal defect or post-cardiotomy [2, 3]. Despite optimal medical management, some patients fail to improve and require implantation of a RV assist device. The RV may exhibit a greater capacity for rapid recovery compared with the left ventricle [3]. Recent studies suggests that most of the patients recover sufficient function to allow explantation of the Impella Recovery Right Direct (IRRD) or Right Peripheral was reported [4]. Herein we report a case of successful implantation of the IRRD in a patient with acute RV failure after

previous aortic valve (AV) replacement despite CABG, maximal medical therapy, intra-aortic balloon counterpulsation (IABP) and extracorporeal membrane oxygenation (ECMO).

CASE PRESENTATION

A 58-year-old woman was admitted in our division due to severe AV stenosis with a mean transaortic gradient of 53 mmHg. The coronary angiography demonstrated normal coronary arteries. She underwent AV replacement with a mechanical prosthesis ATS-21. The patient was weaned normally from the cardiopulmonary bypass. On the second postoperative day the patient referred a sharply chest pain, fatigue, vomitus and sweating. ECG

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demonstrated ST elevation in DII, DIII, aVF and V5. Echocardiography demonstrated non-contractile RV. The coronaro-angiography demonstrated a normal visualization of the left coronary and absence of visualization of the right coronary artery. IABP was placed immediately and an emergent off-pump coronary revascularization consisting in a vein graft to the right coronary artery was performed. The patient was transferred to the ICU. Five hours later, the hemodynamic was unstable, and symptoms of tamponade were present, despite maximum medical therapy and IABP. The patients was sent into the operating room. Even with an open sternum, the RV insufficiency was not improved. ECMO was implanted and with an open sternum the patient was sent into the ICU. ECMO support continued for 48 h without improvement of the RV function. Then we decided to support the RV with IRRD (Abiomed, Danvers, MA). After full heparinization we performed the IRRD implantation. Purse string suture was made around the right atrial appendage and the inflow cage was introduced to the right atrium and fixed. In the pulmonary artery (PA) a purse string suture was made in the middle of distance between the pulmonary valve and division of pulmonary branch. The tip of the cannula (outflow tract) was inserted into the PA (Fig. 1). The pump was started with slow rotational speed and flow was adjusted to 3.5 l/min. After this manoeuvre the hemodynamic was improved immediately. With this flow we maximized the hemodynamic while unloading the RV allowing myocardial recovery. The thorax was left open because of a large edema of the RV and to sustain this we used a plastic spacer in both margin of the sternum. To cover the wound we employed povidone-iodine impregnated gauzes and adhesive plastic sheet. The activated clotting time was maintained between 180 and 200s. Daily the sternal wound was revised. Starting from the second day the pump flow was reduced half litre every day controlling RV function by transesophageal echocardiography and monitoring hemodynamic conditions. After 9 days of IRRD the RV was recovered. The decision to remove the device was taken. The patient was sent in the operating room and IRRD was explanted (Fig. 2). First was removed the tip of the

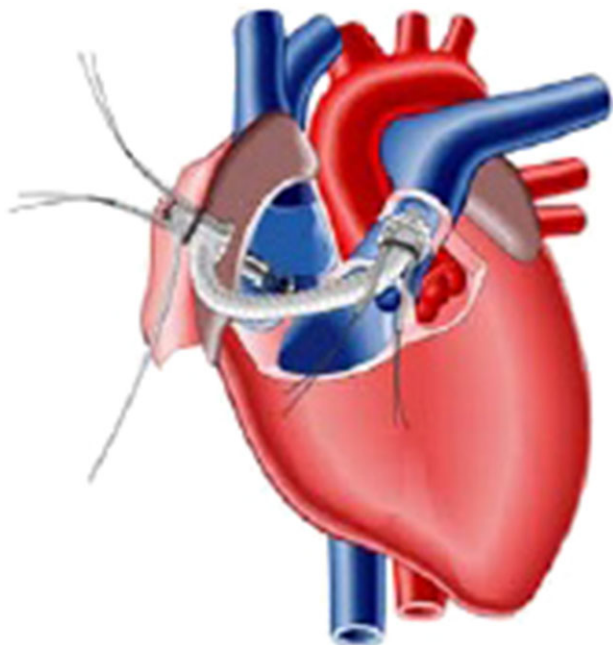


Figure 1: Schematic presentation of the Impella Right Direct implantation.

cannula inserted in the PA (Fig. 3) and then the inflow end of the cannula (Fig. 4). We examined the inner surface of the graft after removal and a thin epithelized layer of the inner surface was found without any thrombus formation (Fig. 5). Both extremities of the device were examined carefully (Figs 6 and 7). A careful hemostasis was performed (Fig. 8). Ten hours after the operation the inotropes were stopped. One day later, the sternum was closed. Four days later the patient was extubated and 16 days after IRRD explanted the patient was discharged in good clinical conditions.

COMMENTS

Acute RV failure is an increasingly common clinical problem and despite optimal medical management, some patients fail to improve and require implantation of a RV assist device, which improves end-organ perfusion and provides an opportunity for reversal of multisystem organ failure. The IRRD is a microaxial pump designed for temporary RV support. Schmidt et al. [5] first described its use in 2003, employing such a device in 8 patients and later Christiansen et al. [6] in other two patients. Subsequently,

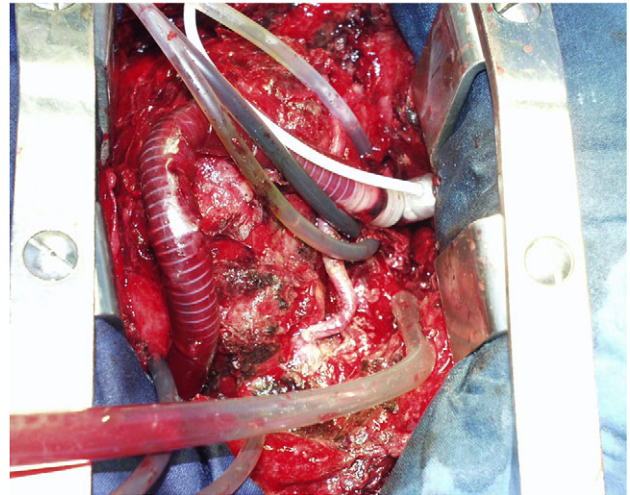


Figure 2: The Impella Right Direct implanted.

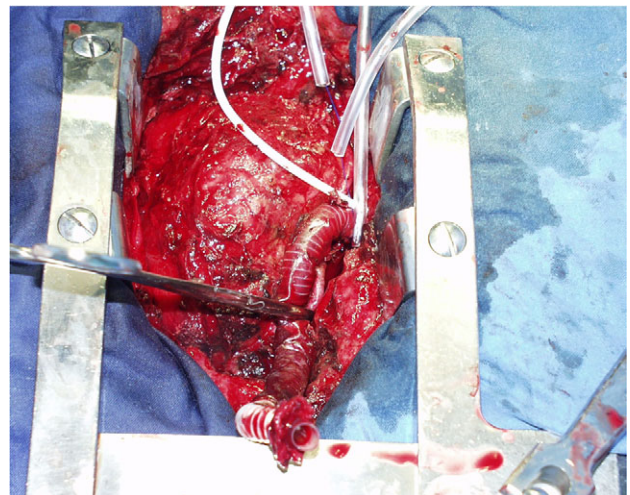


Figure 3: Removal of the outflow tip of the device.

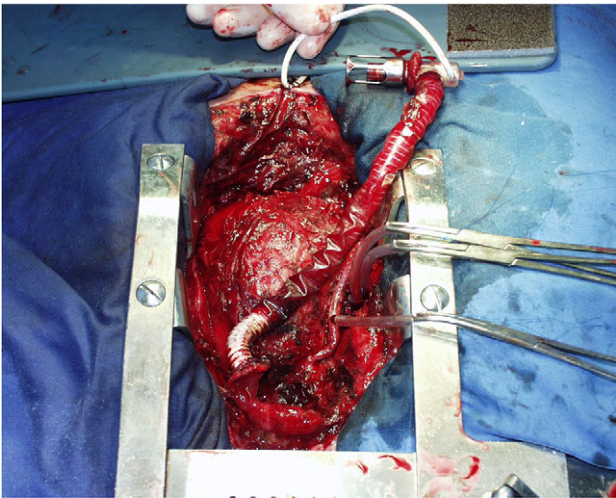


Figure 4: Removal of the inflow tip of the device.



Figure 7: The inflow tip of the device.

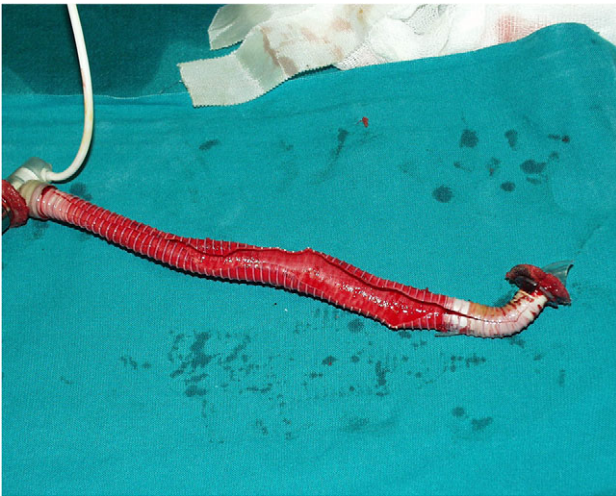


Figure 5: There are no thrombus inside the device.

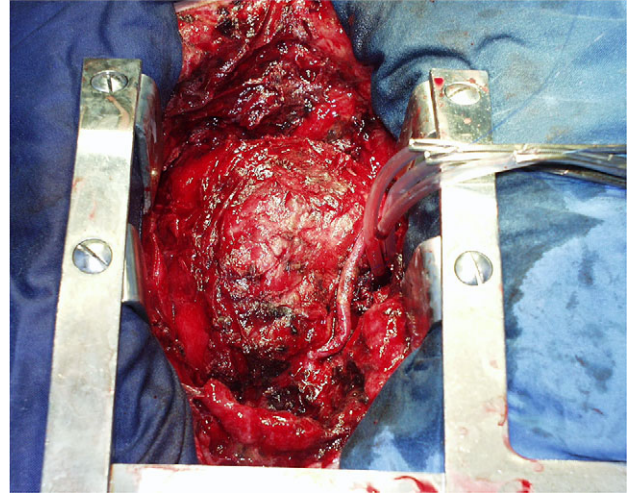


Figure 8: After removal of the device.



Figure 6: The outflow tip of the Impella device.

the device has been used post-cardiotomy, post-transplant, and post left ventricular assist device implantation [7].

We have described the employment of the IRRD in a patient with RV failure due to myocardial infarction post AV replacement, unresponsive to CABG. There is growing evidence to suggest that the IRRD can be successfully used for the treatment of refractory acute RV failure. The reasons why we choose this device were: (i) easy to insert, (ii) accommodates patients of all size (flow rate up to 5.5 l), (iii) minimal anticoagulation, (iv) minimal hemodilution, (v) minimal destruction of blood or plasma components, (vi) possibility of sternal closure and (vii) reduction of myocardial workload and oxygen consumption.

Important aspects of blood pumps are lifetime, costs, adaptability to diverse applications and patient requirements, rapid and easy deployment, thrombogenicity, flow characteristics and blood damage [8]. The major advantages of the IRRD are its small size, the simple design, the low energy requirements, and the avoidance of a priming volume. These figures lead to a reliable pump function without technical failures and may result in a reduced number of transfusion requirements which is

reported to be excessively high in patients with ECMO support [9]. Flow and pressure characteristics, shear stress, blood exposure times to artificial surfaces and the size of the pump are important factors contributing to hemolysis.

The effects of pulsatile and non-pulsatile flow on pulmonary vasculature remains controversial. Some studies demonstrated beneficial effects of pulsatile flow [10], others could not confirm these results [11]. However, the pulsatile flow results in a decreased pulmonary vascular resistance. This might be due to release of endothelium-derived relaxing factor by rhythmic stimulation of endothelial cells through oscillating changes in vessel wall shear stress [10]. This effect of pulsatile flow does not appear to improve pulmonary gas exchange, peak inspiratory pressure, mean PA pressure, oxygenation capacity and development of pulmonary edema [11]. It seems to be justified to support the RV with non-pulsatile flow devices, especially when support duration is limited to a few days as in patients with post-cardiotomy failure.

The main disadvantage of the IRRD is that implantation requires a sternotomy and direct cannulation of the right atrium and PA. This increases the risk of bleeding and infection and necessitates an additional operation for device explantation. These risks are not insignificant, considering that patients requiring implantation of an RV assist device are frequently critically ill with multisystem organ failure and may be coagulopathic due to hepatic congestion and/or the presence of anti-platelet medications [7]. The Impella Right Peripheral is an alternative to IRRD which allows the percutaneous implantation of the device. The Margey et al. [12] used this device for temporary RV mechanical circulatory support in a similar patient presenting with an inferoposterior ST-segment elevation myocardial infarction, who despite revascularization, optimized medical therapy, IABP, remained in profound cardiogenic shock.

We have described the clinical outcome in our patient with refractory acute RV failure supported with the IRRD. Our findings suggest that implantation of these devices is clinically feasible, associated with hemodynamic improvement, and facilitate successful bridge-to-recovery in most patients with post-cardiotomy RV failure due to myocardial infarction unresponsive to CABG, maximal medical therapy, IABP and ECMO.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the publication of this article.

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