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VIEWPOINT

Use of percutaneous ventricular assist device as bridge to high risk combined heart valve surgery

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Introduction

Emergency surgery for mitral valve regurgitation carries a high-risk of perioperative mortality, in particular in the presence of severe systolic dysfunction of either ventricle resulting in cardiogenic shock [1]. Temporary mechanical circulatory support (MCS) can improve the survival of patients with advanced heart failure and is indicated to reverse end-organ hypoperfusion. It can be used as a Bridge-To-Bridge, Bridge-To-Transplant, and Bridge-To-Recovery and has a Class IIa indication according to the latest recommendations of the European Society of Cardiology (ESC) Guidelines [2]. Several devices including the Intra-Aortic Balloon Pump (IABP), veno-arterial extracorporeal membrane oxygenation (va-ECMO) and microaxial flow pumps are available to provide short-term MCS. The IABP is still proposed in the management of cardiogenic shock refractory to medical treatment in the absence of coronary syndrome [2]. In acute mitral regurgitation, IABP improve coronary artery perfusion, helps reduce the severity of mitral insufficiency and increases systemic cardiac output [3].

Microaxial left-sided single ventricular circulatory pumps such as the Impella® CP are an interesting alternative. The Impella® CP is introduced through the aortic valve *via* a percutaneous femoral approach with a 14 F introducer [4]. It provides 3-4 l/min of forward flow into the systemic circulation [5]. This type of mechanical support reduces left ventricular filling pressures through unloading of the left ventricle and improves both systemic cardiac output and coronary blood flow. The Impella has been shown to be effective as a mechanical circulatory support in cardiogenic shock of ischaemic and non-ischaemic origin [6].

The use of a micro-axial pump in the management of post-procedural cardiogenic shock has also been previously described with good results [7]. We present the use of an Impella CP as a bridge to mitral valve replacement and tricuspid annuloplasty surgery in the setting of acute cardiac decompensation.

Case report

We present the case of a 40 years old woman, who was transferred from a peripheral hospital to our institution for acute cardiac decompensation. She presented with an associated hepato-cellular insufficiency and oligo-anuric type I cardio-renal syndrome requiring inotropic support by dobutamine. The patient is not mechanically ventilated but suffers from impaired gas exchange with the need for ventilatory support with a high-flow nasal cannula.

Transoesophageal echocardiography performed at the admission in our centre revealed severe mitral regurgitation due to myxoid degeneration (Carpentier type II) with cord rupture at the level of P2 (Figures 1 and 2). The left ventricle was markedly dilated (end-diastolic diameter of 72 mm) and its systolic function severely impaired (Left Ventricular Ejection Fraction of 25%) (Figure 3). The right ventricle also appeared dilated (end-diastolic basal diameter of 49 mm) and its longitudinal systolic function was impaired (Tricuspid Annular Plane Systolic Excursion of 10 mm). The diameter of the tricuspid annulus was measured at 48 mm and there was moderate tricuspid insufficiency. A surgical mitral valve repair or replacement associated with a tricuspid valve annuloplasty was decided. However, the surgical procedure was deemed at high

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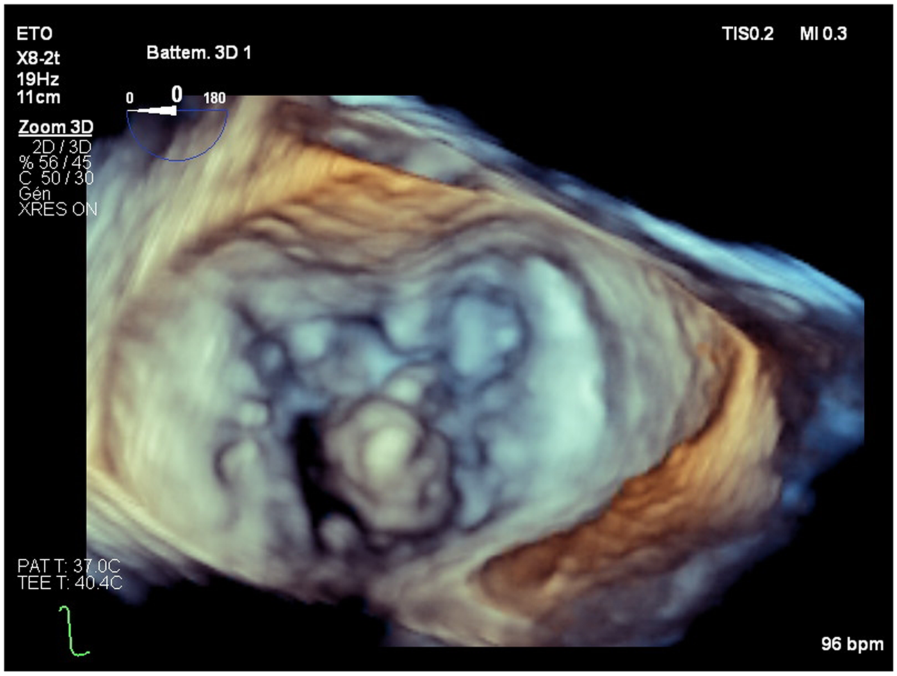

Figure 1. 3D view of mitral valve with P2 flail on cord rupture.

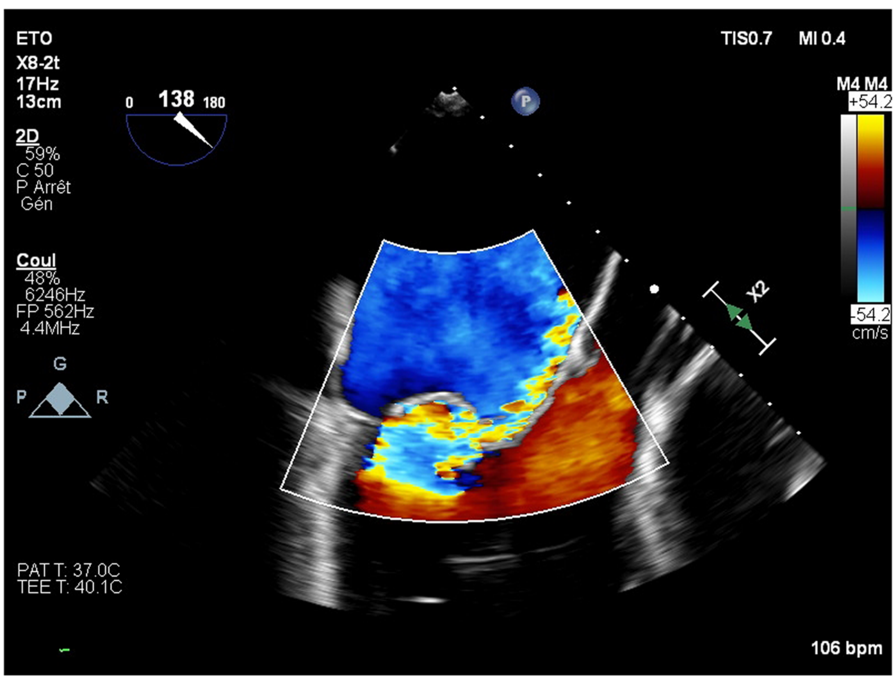

Figure 2. 2D colour view of severe mitral insufficiency with P2 flail.

risk based on a European System for Cardiac Operative Evaluation (EuroSCORE) II of 18% and a Society of Thoracic Surgeons (STS) score of 17.64%. After fluid depletion and initiation of inotropic support with dobutamine, the multidisciplinary Heart Team discussion decided to proceed with implantation of an Impella CP 48 h prior to cardiac surgery (Figure 4). The device was implanted without complication and allowed complete weaning from the inotropic support.

On the day of surgery, the mitral valve was deemed unamenable to repair. A mitral valve replacement with preservation of the mitral subvalvular apparatus was performed in association with a tricuspid annuloplasty (Figure 5). After removal of the aortic cross clamp, the

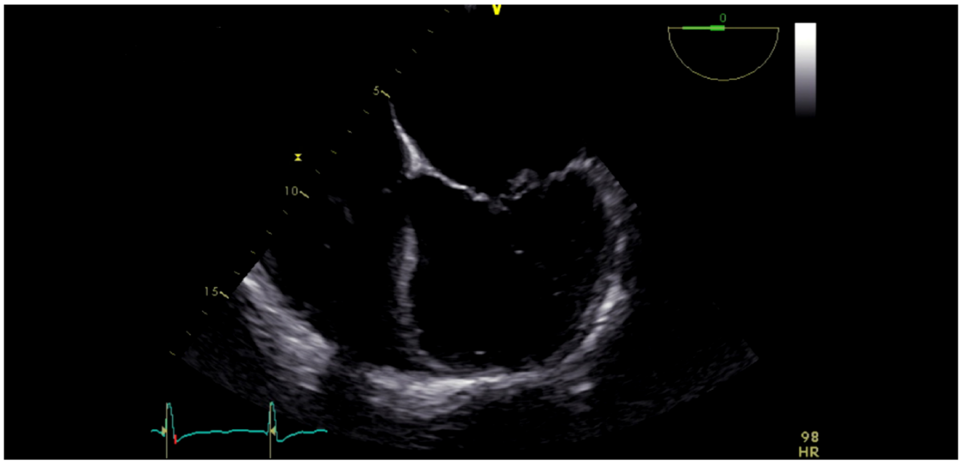

Figure 3. Acute heart failure due to dilated mitral valve disease.

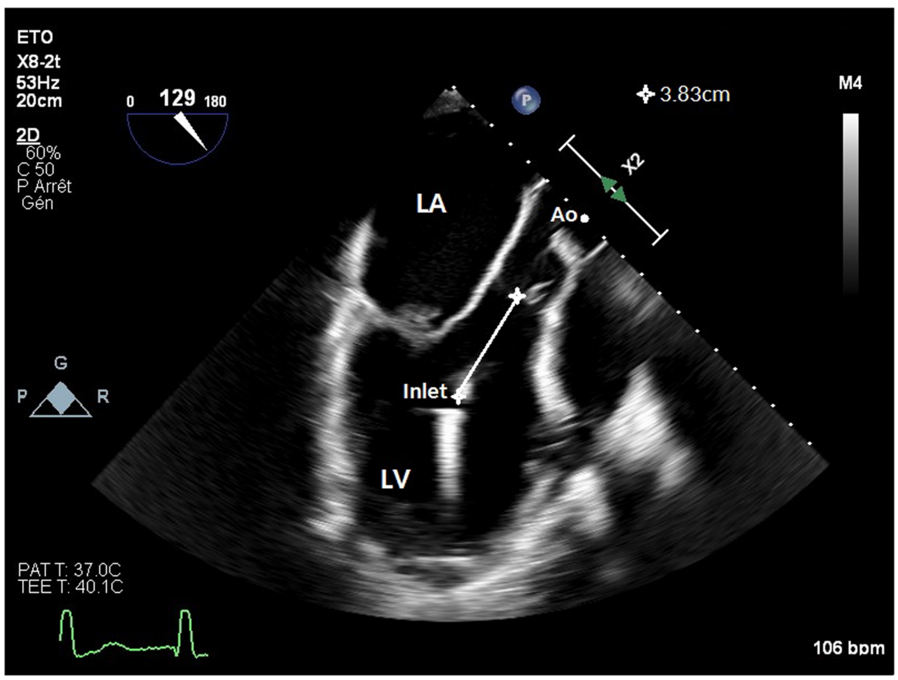

Figure 4. Inlet positioned in the middle of the ventricle, 40 mm from the aortic valve.

microaxial flow pump was repositioned under echo-guidance and the extracorporeal circulation weaning was facilitated by a low dose of dobutamine. The patient was extubated on post-operative day 2 and could be completely weaned from the mechanical support on postoperative day 4 after she had achieved stable haemodynamic parameters at the lowest level of support (P2 setting of the Impella CP). The length of stay in ICU was 12 days. The patient was discharged home on the 30th postoperative day. She had no complications related to the microaxial pump implantation. The 3-month post-operative follow-up showed a positive evolution with complete recovery from acute renal failure and return to sinus rhythm under maximal medical treatment.

Discussion

In this case report, we present the use of Impella® CP as a bridge to combined mitral and tricuspid valve surgery in a patient at very high risk of postoperative low cardiac output syndrome. Emergency surgical management is indicated in acute severe mitral regurgitation [8]. The indication for tricuspid annuloplasty concomitant with left-sided valve surgery has been given a Class IIa in 2021 ESC guidelines [8,9].

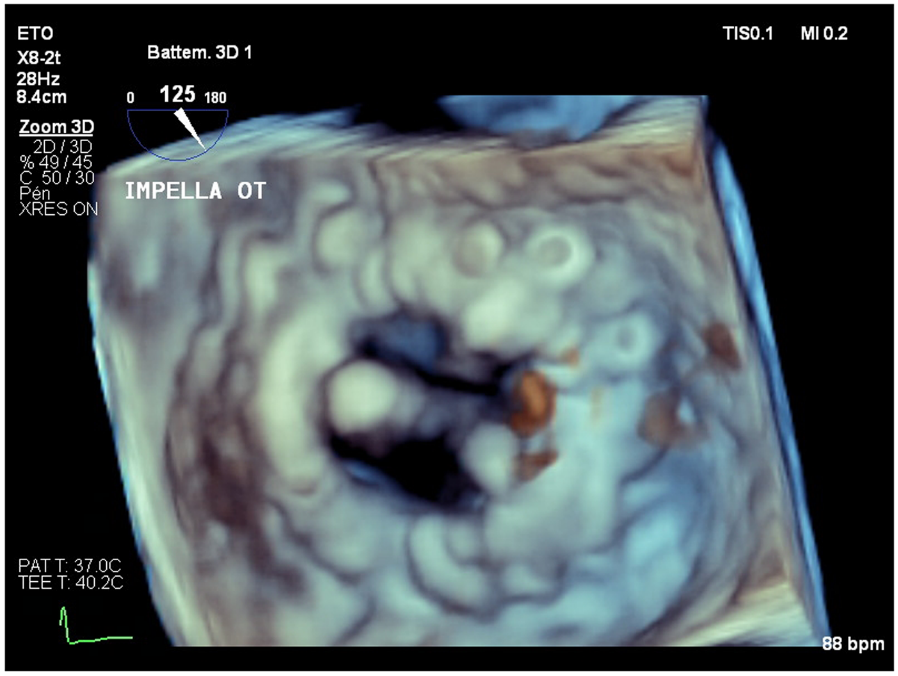

Figure 5. 3D view of the mitral bioprosthesis.

The choice of using a micro-axial pump as a bridge to cardiac surgery was motivated by several arguments. Firstly, by its effect of reducing left ventricular end-diastolic filing pressures, percutaneous assistance shift the left ventricular pressure-volume loop from the right to the left by reducing wedge pressure, wall tension and myocardial oxygen consumption. Reduction of these 3 factors improves coronary flow and oxygen demand/supply ratio [10]. The reduction of left ventricular end-diastolic filing pressures improves gaz exchange by reducing pulmonary oedema. This allowed the weaning of the high-flow nasal cannula in our patient. Left ventricular decongestion reduces Wedge pressures and associated pulmonary hypertension facilitating right ventricular ejection by reducing right ventricular afterload [11]. Which is interesting for facilitating the return of right ventricular function in preoperative cardiac surgery. Finally, the micro-axial pump improves systemic flow, reduces venous congestion and favours liver and renal recovery [12].

In this case report, the use of the microaxial transvalvular aortic pump may also have facilitated weaning from the extracorporeal circulation with low-dose of inotropic support. The use of Impella has previously been described as a bridging circulatory support to cardiac surgery with good results [13,14].

In the case of biventricular systolic dysfunction the use of Venoarterial Extracorporeal Membrane Oxygenation (VA-ECMO) would have been possible as proposed in the 2020 EACTS/ELSO/STS/AATS consensus [15]. Impella® in combination with VA-ECMO (called ECmella or ECpella [16])has shown its usefulness as a left ventricular unloader and return of systolic function with reduced in-hospital mortality compared to a group of patients on VA-ECMO without left unloading [17–20]. A VA-ECMO in postcardiotomy for mitral valve surgery has been shown by Pingpoh and Co to have a higher risk of in-hospital mortality compared to VA-ECMO postcardiotomy for non-mitral heart surgery [21]. In their series, the authors show that the two most common causes of death in the mitral valve surgery group were multi-organ dysfunction resulting from uncontrollable bleeding and thrombosis of left-sided cardiac chambers. Intracardiac thrombosis is not only facilitated by the presence of a newly implanted mitral valve prosthesis but also by the reduced blood flow through the mitral and aortic valves. This flow reduction results from the pre-existing left ventricular systolic dysfunction and the increased afterload caused by the retrograde injection of VA-ECMO.

Based on this observation, it seemed legitimate to us to optimise perioperative management in order to avoid the use of VA-ECMO in postcardiotomy. In the event that a VA-ECMO is required, we would have obtained an immediate left ventricular unloading with a sufficient transmitral flow to limit the risk of the appearance of intracardiac thrombus.

Percutaneous edge-to-edge mitral valve repair has been described as a method of managing acute mitral regurgitation in patients in cardiogenic shock when the surgical risk is considered prohibitive with good results [22–24]. Nevertheless, in view of the young age of the patient and the need for a combined procedure on the tricuspid valve, the most suitable option for the patient seemed to be a combined surgical valve procedure under percutaneous ventricular assistance.

In this paper, we report the use of a percutaneous ventricular assist device as a Bridge to combined mitral and tricuspid valve surgery for acute primary mitral regurgitation. The impella® CP allowed easy weaning from the extracorporeal circulation with moderate inotropic support. The device could be weaned at day 4 post-operatively and discharge from the hospital at day 30. We did not experience any complications related to the use of the Impella during intraoperative management. Impella CP can be safely used for the perioperative management of combined valve surgery. Randomised trials are needed to confirm the usefulness and place of Impella CP in the perioperative management of high risk cardiac surgery.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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