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Case Reports

Enhanced Left Ventricular Recovery in Treatment of Mitral Regurgitation With Severe Left Ventricular Dysfunction

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Abstract

A 73-year-old male patient presented with shortness of breath at rest resulting from new-onset severe primary mitral regurgitation with a flail posterior leaflet, left ventricular dysfunction, and cardiogenic shock. After initial stabilization in the intensive care unit, multiple treatment options were considered for this patient, all associated with significant mortality. Ultimately, operative mitral valve repair with Impella 5.5 placement was performed for postoperative hemodynamic support. Surgical repair provided elimination of mitral regurgitation. Impella support was maintained for 7 days to provide unloading of the left ventricle. After device removal, the patient had sustained left ventricular recovery with significantly improved ejection fraction. Full left ventricular support and unloading may decrease operative risk and promote left ventricular recovery in patients with severe mitral regurgitation and left ventricular dysfunction. This case emphasizes the value of ventricular unloading to facilitate the recovery of left ventricular function as a treatment option for patients with challenging cases of severe mitral regurgitation and left ventricular dysfunction.

Keywords: Mitral regurgitation; left ventricular dysfunction; mitral valve

Introduction

The management of severe mitral regurgitation (MR) with concomitant severe left ventricular dysfunction (LVD) presents a challenge given the significant mortality associated with current therapies. Current treatment options include guideline-directed medical therapy (GDMT), transcutaneous edge-to-edge repair (TEER), surgical repair, and placement of a durable left ventricular assist device (LVAD). In the case of severe MR with severe LVD, the use of GDMT provides little hope for recovery of ventricular function.[1] Transcutaneous edge-to-edge repair has demonstrated a higher survival rate than that with medical management alone but is still associated with high mortality.[2] Surgical mitral valve (MV) repair is the gold standard for treatment of MR; however, postcardiotomy cardiogenic shock is a potential complication.[3] Treatment with durable LVAD placement is reserved for patients who are not candidates for the above-described approaches.[4] This article reports a successful case of left ventricular (LV) recovery using an Impella 5.5 (Abiomed) endovascular assist device at the time of surgical MV repair.

Case Report

A 73-year-old male patient with a history of hypertension, hyperlipidemia, and moderate primary MR with preserved LV function presented to the emergency department with recent onset of dyspnea on exertion and at rest. Physical examination revealed tachypnea, rapid irregular heart rate, and a laterally displaced cardiac impulse. The

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patient had a holosystolic murmur and bilateral basilar rales upon auscultation. He was admitted to the cardiac intensive care unit.

An electrocardiogram revealed atrial flutter with a rapid ventricular rate of 134 bpm. A chest x-ray showed pulmonary vascular congestion and cardiomegaly. A transesophageal echocardiogram demonstrated a left ventricular ejection fraction (LVEF) of 20% with severe MR caused by a flail posterior leaflet (Carpentier type 2) and normal right ventricular function (Fig. 1). Synchronized cardioversion was performed at the time of transesophageal echocardiogram with return to normal sinus rhythm. Left ventricular end-diastolic diameter (LVEDD) was 6.0 cm. An echocardiogram from 11 months earlier showed moderate MR, LVEF of 60%, and LVEDD of 5.0 cm. A left heart catheterization demonstrated nonocclusive coronary artery disease. A right heart catheterization showed pulmonary artery hypertension and a cardiac index of 1.63 L/min/m^2. Laboratory values were significant for elevated creatinine levels (1.37 mg/dL), elevated lactate dehydrogenase levels (525 U/L), and elevated liver enzymes.

A diagnosis of severe MR with severe LVD and cardiogenic shock was made. Medical management in the cardiac intensive care unit included 7 days of amiodarone, inotropic support, and diuretics for optimization. The patient was presented to the structural heart team,

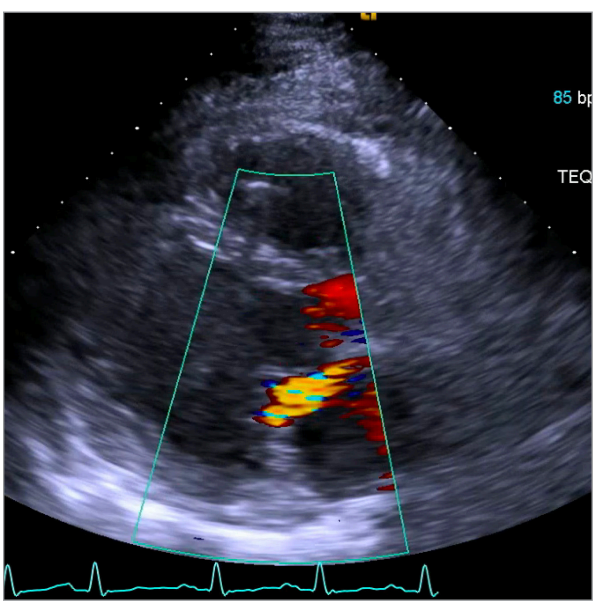

Fig. 1 A preoperative transthoracic echocardiogram with Doppler shows severe mitral regurgitation and left ventricular dysfunction.

Supplemental motion image is available for Figure 1.

Abbreviations and Acronyms

GDMT	guideline-directed medical therapy
LV	left ventricular
LVAD	left ventricular assist device
LVD	left ventricular dysfunction
LVEDD	left ventricular end-diastolic diameter
LVEF	left ventricular ejection fraction
MR	mitral regurgitation
MV	mitral valve
TEER	transcutaneous edge-to-edge repair

and all therapeutic options were considered, including continued GDMT, TEER, surgical repair, and durable LVAD placement. Operative MV repair was thought to be the best approach because of the patient's recent normal LV function and the potential for recovery of native heart function. The Society of Thoracic Surgeons–predicted operative mortality was 16.1% because of concerns for postcardiotomy shock. Therefore, temporary postoperative percutaneous LV support via Impella 5.5 placement was used to mitigate this risk.

For placement of the Impella device, a right infraclavicular incision was performed that allowed for anastomosis of a 10-mm graft to the right subclavian artery. Using standard techniques, a 0.018-inch guidewire was then positioned through this graft into the LV. A full sternotomy approach was used to perform a triangular resection of the P2 leaflet with placement of an annuloplasty ring. After removal of the aortic cross-clamp, the Impella 5.5 was positioned into the LV. The patient was then weaned from cardiopulmonary bypass onto full Impella support. Hemodynamics were normal without inotropes. Transesophageal echocardiogram showed no residual MR.

In the early postoperative period, the patient was maintained on full Impella support (P9). Serial echocardiograms with progressively decreased Impella support showed significant recovery of LV function. Pump-derived data demonstrated improved native heart function based on calculated cardiac power. On postoperative day 7, the patient had an LVEF of 40% with normal filling pressures, and the Impella was removed in the intensive care unit with the use of a local anesthetic. The patient remained hemodynamically stable without the need for inotropic support (Table I). Repeat transthoracic echocardiogram studies before discharge showed sustained recovery of LV function, decreased LVEDD to 5.5 cm, and the absence of MR (Fig. 2). Right heart catheterization on postoperative day 10 demonstrated improved hemodynamics (Table II). After GDMT titration, the patient was discharged to home 10 days postoperatively.

Four months after his operation, the patient reported resolution of symptoms and no abnormalities on physical examination. The patient has since returned to work full time and is continuing outpatient cardiac rehabilitation with return to moderate exercise.

Discussion

The treatment of MR in the presence of severe LVD is often a complex decision. All current therapies are associated with significant mortality. Strategies include GDMT, TEER, surgical repair or replacement, or placement of a durable LVAD.

In this case, the patient was receiving GDMT at the onset of cardiogenic shock. Therefore, continued use of GDMT was not considered a viable option. The use of TEER was considered; however, a multicenter analysis of patients in cardiogenic shock with severe MR treated

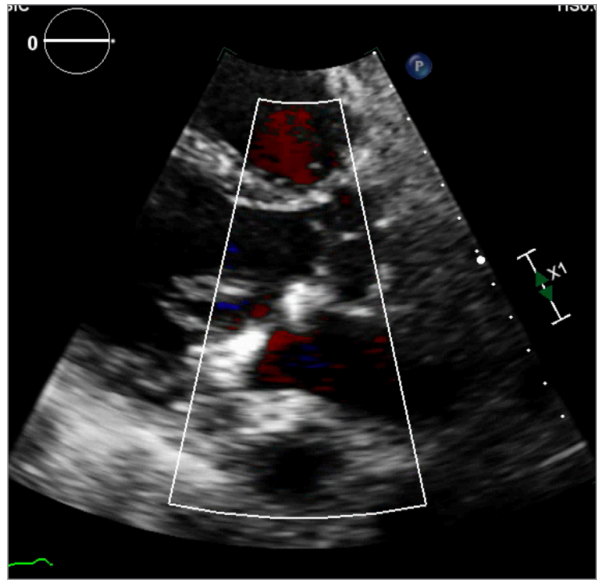

Fig. 2 A transthoracic echocardiogram with Doppler on postoperative day 10 shows resolution of mitral regurgitation and improved left ventricular function.

Supplemental motion image is available for Figure 2.

TABLE I. Trending Stages of Cardiogenic Shock

	Preoperative	Postoperative day 3 with Impella	Postoperative day 10 after Impella removal
Lactic acid level, mmol/L	4.8	0.8	0.7
No. of inotropes	2	0	0
SCAI Classification	C	A	A

SCAI, Society for Cardiovascular Angiography and Interventions.

TABLE II. Hemodynamic Values Preoperatively and on Postoperative Day 10

	Before surgery	Postoperative day 10
Cardiac output (thermodilution), L/min	3.59	5.98
Cardiac index (thermodilution), L/min/m^2	1.63	2.78
Cardiac power output, W	0.76	1.09
Central venous pressure, mm Hg	12	7
Mean pulmonary artery pressure, mm Hg	33	18
PCWP, mm Hg	22	12
PAPi	2.50	2.14
LVEF, %	20-25	40-45
LVEDD, cm	6.0	5.5
Mitral valve EROA, cm^2	0.56	0

EROA, effective regurgitant orifice area; LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; PAPi, pulmonary artery pulsatility index; PCWP, pulmonary capillary wedge pressure.

with TEER demonstrated a mortality rate of 15.6% in hospital, 29.5% at 90 days, and 42.6% at 1 year.[5] Left ventricular assist device placement is another option in the case of severe LVD, but this also carries a significant morbidity and mortality risk and is reserved for patients who are not considered candidates for the other listed options.[6] Therefore, operative MV repair was chosen as the best option for this patient particularly given an echocardiogram from 11 months earlier that showed a normal LVEF.

Surgical MV repair in LVD carries a high mortality risk. Postcardiotomy cardiogenic shock is a significant risk that requires the use of high-dose inotropes or mechanical circulatory support. Nielsen et al[7] investigated the effect of the intraoperative and postoperative use of inotropes in cardiac surgery and found that patients exposed to inotropes had a higher 30-day mortality as well as a higher 1-year mortality rate. An intra-aortic balloon pump is another option in the setting of severe LVD, although an Impella 5.5 device was used for this patient to provide LV unloading and hemodynamic support.

Percutaneous mechanical support has the potential to significantly affect operative mortality for patients with MR in the presence of severe LVD. There is commonly an acute worsening of LV function after MV procedures. The Impella 5.5 is capable of full left-sided cardiac support, allowing for LV unloading and the potential for heart recovery. Impella support is increasingly used in patients with acute decompensated heart failure as a bridge to a durable LVAD, transplant, or recovery.[8] Therefore, it was thought that the use of Impella support after surgical MV repair would provide this patient with hemodynamic support during the postoperative period and potentially support LV recovery. In patients with severe MR and LVD, the Impella 5.5 may improve outcomes by achieving LV unloading and stable hemodynamics, which may allow for LV recovery.

In summary, severe MR with severe LVD is a challenging problem, as all current therapies are associated with significant mortality. Operative therapy is associated with a high mortality primarily because of postcardiotomy shock. This article describes the use of an Impella 5.5 device at the time of successful MV repair in a patient with severe LVD who demonstrated marked recovery of LV function. The advantages of this strategy are (1) complete elimination of MR, (2) full left-sided circulatory support, (3) LV unloading, (4) improved patient mobility, (5) progressive weaning based on serial echocardiograms and pump-derived data, (6) removal at bedside using local anesthetic, and (7) advanced therapies remaining an option. Clinical trials will be needed to determine if this approach will improve outcomes in these select patients.

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