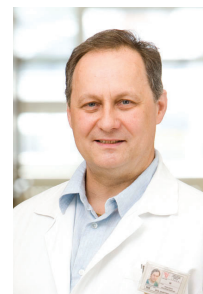


Levitronix CentriMag Pump as Perioperative Left Ventricular Support in a Patient with Critical Aortic Stenosis, Mitral Regurgitation, and Cardiogenic Shock

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ABSTRACT

Severe aortic stenosis (AS) has a poor prognosis when associated with left ventricular dysfunction and congestive heart failure. Despite a relatively high operative mortality, most patients with severe AS and a depressed left ventricular ejection fraction (LVEF) should be considered candidates for aortic valve replacement. The CentriMag left ventricular assist system (Levitronix) can be used for perioperative or postcardiotomy circulatory support for the failing heart. In this case report, we report the successful use of the Levitronix CentriMag device as perioperative support in a high-risk patient with severe AS, significant mitral insufficiency, and a poor LVEF with advanced organ failure.

INTRODUCTION

Severe aortic stenosis (AS) has a poor prognosis when associated with left ventricular dysfunction and congestive heart failure, the mean life expectancy being <2 years without surgical correction. Left ventricular dysfunction is a major prognostic indicator of outcome in patients undergoing aortic valve replacement (AVR) for AS [Connolly 1997]. Despite a relative high operative mortality, most patients with severe AS and a depressed left ventricular ejection fraction (LVEF) should be considered candidates for AVR. The benefit of AVR for these patients is greatest when systolic dysfunction is primarily caused by afterload mismatch from actual valvular stenosis and is least likely in the presence of primary contractile dysfunction unrelated to valvular disease. In a recent study, Halkos et al [2009] reported the in-hospital mortality rate for AVR patients with an LVEF between 25% and 40% to be 14.5%. Other factors predictive of operative and postoperative mortality are coexistent coronary artery disease, age, a low transvalvular gradient [Lund 1997; Connolly 2000],

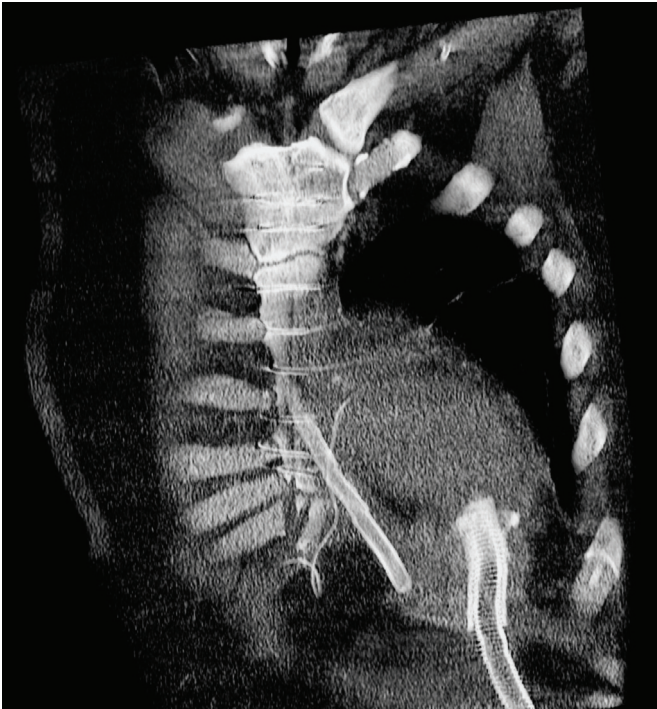
emergent status, peripheral vascular disease, renal disease, chronic obstructive pulmonary disease [Grossi 2008], cardiopulmonary bypass, and cross-clamp time [Halkos 2009]. A careful consideration of the cumulative effect of these multiple risk factors is necessary to optimize outcome for individual patients. There are limited studies of severe AS in high-risk patients with poor LVEF and mechanical support. We report the successful use of the Levitronix CentriMag left ventricular assist system (Waltham, MA, USA) as perioperative support in a high-risk patient with severe AS, significant mitral insufficiency, and a poor LVEF with advanced organ failure.

CASE REPORT

A 55-year-old patient was admitted to a regional hospital with symptoms of bilateral heart failure, unsuccessful therapy, and progression of renal and hepatic failure; he was later transferred to our hospital. The patient's relevant medical history included combined aortic valve disease, systemic hypertension, and stroke. A physical examination revealed the following: signs of bilateral congestion with anasarca; weight, 124 kg; sinus tachycardia, 125/min; blood pressure, 90/70 mm Hg. An echocardiography evaluation revealed a heavily calcified aortic valve with severe stenosis (aortic valve area, 0.36 cm²/m²) and mild insufficiency, a dilated left ventricle with a globally severely diminished systolic function and an LVEF of <20%, and a calcified mitral valve with significant insufficiency and pulmonary hypertension. The right ventricle appeared dilated and dysfunctional with mild tricuspid regurgitation. Hemodynamic measurements after 3 weeks of combined inotropic and diuretic support confirmed critical AS (peak aortic valve gradient, 70 mm Hg; mean aortic valve gradient, 49 mm Hg; aortic valve area, 0.36 cm²/m²), severe pulmonary hypertension (mean pulmonary artery pressure, 55 mm Hg; transpulmonary gradient, 20 mm Hg; pulmonary vascular resistance, 6.9 Wood units), and low cardiac output (cardiac index, 1.4 L/min per m²). A coronary angiogram indicated no significant irregularities. Organ damage consisted of renal failure (creatinine clearance, 0.35 mL/s) and hepatic failure (total bilirubin, 50 μmol/L; aspartate transaminase, 5.93 μmol/L; alanine transaminase, 6.13 μmol/L); the concentration of brain-type natriuretic peptide was 4080 ng/L.

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Computed tomography scan demonstrating the inflow cannula in the apex of the left ventricle and the outflow cannula to the ascending aorta.

Despite combined inotropic support and diuretic therapy, signs of severe heart failure persisted with hemodynamic values for shock. We opted for surgery with standby hemodynamic support with a Levitronix CentriMag left ventricular assist system, because the logistic EuroSCORE was 64.75% and we expected severe complications in the postoperative course.

The patient underwent urgent replacement of the aortic and mitral valves with 25-mm and 29-mm Bicarbon Heart Valve Prostheses (Sorin Group, Saluggia, Italy), respectively, and the introduction of cannulas for the Levitronix CentriMag (the inflow cannula in the apex of the left ventricle and the outflow cannula in the ascending aorta; Figure). We were prepared for an easy exchange of this short-term device to the Heart Mate II (Thoratec Corporation, Pleasanton, CA, USA) as a long-term assist device in the event that recovery of the left ventricle was unsuccessful. We gradually increased the pump speed to achieve an adequate flow rate of 3 L/min, with caution exercised to avoid pulmonary overflow by monitoring the pulmonary artery diastolic pressures. The patient was weaned without complications from cardiopulmonary bypass with the aid of low-dose inotropic support (milrinone, 0.3 $\mu\text{g}/\text{kg}$ per minute; dobutamine, 5.0 $\mu\text{g}/\text{kg}$ per minute; norepinephrine, 0.15 $\mu\text{g}/\text{kg}$ per minute). A transesophageal echocardiography examination showed good right ventricular function, an improved left ventricular function, and a good position of the apex cannula. The patient was extubated on postoperative day 1. When the patient exhibited signs of right ventricular and

renal failure on postoperative day 3, we administered levo-simendan and sildenafil and began continuous venovenous hemofiltration (CVVH) for the next 10 days. On postoperative day 10, we observed ventricular tachycardia after attempting to decrease the flow rate of the left ventricular assist device to 2 L/min and had to return the flow rate to 4 L/min. After improvement in the patient's right ventricular and renal functions, we stopped CVVH. At 26 days after implantation, we removed the Levitronix CentriMag device in the operating theater under transesophageal echocardiographic control. The cardiac index was >3 L/min per m^2 , the LVEF was 35% to 40%, and there was mild right ventricular dysfunction and pulmonary hypertension. On postoperative day 32, the patient was moved to a normal ward. We then initiated more-intensive rehabilitation, which was followed in the regional hospital. After 2 weeks, the patient was discharged home in a stable and good condition. Echocardiography examinations performed during ambulatory control in our hospital at 2, 6, and 11 months after surgery showed an LVEF of 40% and normal function of both prosthetic valves.

DISCUSSION

We assessed our patient as high risk, with almost all of the factors for an ominous postoperative course [Vánky 2006]. Another reason for nonpharmacologic support was the failure of inotrope therapy before surgery. In light of the high pulmonary vascular resistance (6.9 Wood units), the patient was contraindicated for orthotopic heart transplantation. For these reasons, we decided on standard surgery with perioperative mechanical support and selected the Levitronix CentriMag left ventricular assist system as a less expensive and less invasive short-term device, with the possibility of converting to long-term support. Another reason for this approach was our very good experience with this pump in 30 or more previous cases. The Levitronix CentriMag is a magnetically levitated extracorporeal centrifugal-flow pump with relatively easy handling and no stringent requirements for anticoagulation [John 2007]. By using this strategy, we avoided the urgent placement of ventricular assist devices, which are usually used later in the critical phases of the postoperative course. The dependence of the patient on pump support on postoperative day 10 confirmed our expectations, and we believe this backup was very important for the successful resolution of most complications.

CONCLUSIONS

The perioperative application of a mechanical assist device is not a common approach for high-risk cardiac surgery in patients with a severely impaired left ventricular function. It is usually used as a backup in case of postcardiotomy failure. In highly specific cases with the failure of preoperative drug support and a high probability of an ominous postoperative course, this approach has been demonstrated to be helpful in bridging the critical phases of the postoperative course.

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