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Comprehensive Management of Severe Intestinal Bleeding in a Patient Supported for 94 Days by the Biventricular Levitronix CentriMag System

Ivan Netuka, MD, PhD,[1] Ondrej Szarszoi, MD, PhD,[1] Jiri Maly, MD, PhD,[1] Marek Adamira, MD,[1] Daniel Turek, MD,[1] Josef Besik, MD, PhD,[1] Marian Urban, MD,[1] Hynek Riha, MD,[2] Tomas Kotulak, MD,[2] Jan Pirk, MD, DSc[1]

Departments of [1]Cardiac Surgery and [2]Cardiac Anaesthesiology, Institute for Clinical and Experimental Medicine, Prague, Czech Republic

ABSTRACT

The use of short-term mechanical circulatory support during postcardiotomy acute heart failure provides an opportunity to stabilize the patient's hemodynamic state while determining the best long-term strategy. Because all of these devices require anticoagulation treatment of various intensities, management of major bleeding can be critical for the overall outcome of the therapy. In this regard, the newest generation of magnetically levitated centrifugal-flow pumps affords several potential advantages in terms of thrombogenicity and eventual discontinuation of anticoagulation treatment. We report the use of a short-term biventricular assist device (Levitronix CentriMag) for 94 days in a 55-year-old man with refractory ventricular arrhythmias after combined heart surgery. Despite serious complications while the patient was on the assist device, including severe intestinal bleeding with the necessity of discontinuing anticoagulation for 10 days and, ultimately, hemicolectomy, the circulatory support was completed with successful heart transplantation.

INTRODUCTION

We describe the use of a short-term biventricular assist device (CentriMag; Levitronix, Waltham, MA, USA) for 94 days in a 55-year-old man with complex heart disease. Despite serious complications, including severe intestinal bleeding with the necessity of discontinuing anticoagulation treatment for 10 days and, ultimately, hemicolectomy, the circulatory support was completed with successful heart transplantation. The treatment strategy and its potential benefits in such cases are discussed.

CASE REPORT

A 55-year-old man with a history of ischemic heart disease and type 2 diabetes was referred to our center for further evaluation. An echocardiography evaluation showed a highly dilated left ventricle with an ejection fraction of 13%, an end-diastolic volume index of 221 mL/m^2, and both mitral and tricuspid regurgitation (grades 3 and 4). A coronary angiography examination revealed left main stenosis and triple-vessel disease. Despite a poor ejection fraction and a 69% perfusion defect, a 57% viability of the myocardium was documented in a perfusion magnetic resonance imaging scan. Because of the underlying heart disease, the patient developed progressive heart failure with symptoms of New York Heart Association classes III to IV. After a complex clinical examination, the patient underwent combined valve surgery and coronary artery bypass grafting.

The operative procedure was performed with standard cardiopulmonary bypass (CPB). Owing to severe calcifications, the mitral valve was not suitable for valvuloplasty and was replaced with a bileaflet mechanical prosthesis (Bicarbon no. 27; Sorin, Milan, Italy). Bypass grafts were performed on the anterior descending, obtuse marginal, and posterior descending coronary arteries. Following removal of the aortic cross-clamp, a De Vega tricuspid valvuloplasty was performed. The total CPB time was 135 minutes, and the cross-clamp time was 80 minutes. The patient was weaned from CPB with moderate inotropic support (0.3 mg/kg milrinone per minute, 0.08 mg/kg norepinephrine per minute). The early postoperative course was uneventful; the patient was hemodynamically stable with a cardiac index 2.5 L/min per m^2 and was extubated 12 hours after surgery. On postoperative day (POD) 1, the patient had recurrent ventricular fibrillation that required repeated defibrillation. He was reintubated, and an intra-aortic balloon pump was inserted. Despite comprehensive metabolic and pharmacologic management, the electrical instability worsened, and hemodynamic support was required. A Levitronix CentriMag ventricular assist device was placed in a biventricular fashion. The procedure was performed on CPB with the heart fibrillating despite multiple attempts at cardioversion. The cannulae were tunneled and fixed subcostally as described previously [De Robertis 2006; John 2007]. Once biventricular support had been initiated, the speed of each pump was optimized to provide a cardiac index of >2.5 L/min per m^2. Anticoagulation with heparin was gradually started and was maintained at a target activated partial thromboplastin time (aPTT) ratio of 2.0. Despite refractory ventricular fibrillation, the patient recovered while on the biventricular assist device and started to rehabilitate.

Severe intestinal bleeding requiring massive blood transfusions occurred on POD 17. Anticoagulation treatment was completely stopped. Nevertheless, the bleeding continued despite a normalized aPTT level. Once the bleeding was localized to the cecum, a computed tomography angiogram revealed

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Correspondence: Ondrej Szarszoi, MD, PhD, Department of Cardiac Surgery, Institute for Clinical and Experimental Medicine, Videnska 1958/9, Prague 4 – 140 21, Czech Republic; 420261362726; fax: 420241721362 (e-mail: onsz@medicon.cz).

the cause of the hemorrhage to be a mural arteriovenous malformation. Repeated superselective embolizations of the superior mesenteric artery were performed, unfortunately without success. A surgical reexploration via a midline laparotomy and a right-sided hemicolectomy were performed, and the bleeding subsequently subsided. A diagnosis of arteriovenous malformation was later verified histologically. The anticoagulation was discontinued for a total of 10 days.

A later echocardiography evaluation showed thrombus in the whole of the left ventricle; nevertheless, the left atrium was thrombus free. Anticoagulation was reestablished and maintained at a target aPTT ratio of 2.0 for the rest of the support. In view of the situation, the patient was listed for high-urgency heart transplantation.

Despite the lack of any evidence for a thromboembolic event or clot formation within the system, the pump heads were replaced and inspected on POD 75. A negligible fibrin layer on the inner surface, without thrombus formation, was observed.

After 94 days of circulatory support, the patient underwent heart transplantation. Despite the huge thrombus in the left ventricle, no clinically relevant embolization occurred. Thereafter, the patient experienced an uneventful recovery; he reached full ambulation within 1 month of the surgery and was discharged on POD 31. At the 1-year follow-up, the patient was in New York Heart Association functional class II with satisfactory graft function and no signs of rejection. He has remained free of abdominal complaints.

DISCUSSION

In cases of refractory ventricular fibrillation, there are essentially 2 emergency strategies for using short-term assist devices. The first is to establish extracorporeal membrane oxygenation as a venoarterial circuit via either intrathoracic or peripheral cannulation [Khan 2008]. The major limitation of this approach is the necessity of continuously maintaining an adequate level of anticoagulation, which can be a limiting factor for the comprehensive treatment of severe bleeding complications similar to what we have described. Another clinical problem is that the peripheral cannulation approach, particularly femoral cannulation, limits the possibilities for adequate rehabilitation [Saeed 2007].

We propose that these drawbacks can be effectively ameliorated by using the concept of inserting a biventricular CentriMag assist device. The CentriMag is a versatile short-term assist device used for univentricular, biventricular, and extracorporeal membrane oxygenation support. Despite the fact that the system has been licensed for a support period of 30 days, there are reports of >2 months of support with this device [De Robertis 2008; Gregoric 2008]. It has unique characteristics. Because of the magnetic levitation of the rotor, which avoids friction and thermal damage, the risk of thrombus formation and hemolysis is reduced [Favaloro 2008]. Encouraging clinical data support the use of low-level or even no-anticoagulation regimens if they are imposed by severe bleeding complications. In our situation, anticoagulation was completely stopped for 10 days without any relevant signs of embolization or thrombus formation within the pump heads or tubing. Moreover, use of this strategy, in contrast to femoral cannulation, enables the safe and effective mobilization of patients, which is likely to improve subsequent outcomes if prolonged support can be expected.

The treatment of intestinal bleeding from an arteriovenous malformation is often complicated by nature. The effect of superselective coiling of a feeding artery can be unsatisfactory, owing to a rich collateral supply. On the other hand, extensive embolization bears the risk of bowel ischemia and subsequent necrosis. Finally, surgical resection is a major procedure that can lead to catastrophic sequelae, particularly when it is undertaken in the presence of permanent anticoagulation.

In our patient, thrombus formation within the ventricle represented a particular clinical problem. This situation precluded conversion to a long-term assist device, which would otherwise have been indicated. At the time of transplantation, the risk of systemic embolization was avoided by placing a cross-clamp as early as possible on the ascending aorta proximal to the outflow conduit of the left ventricular assist device.

In summary, our report suggests that the Levitronix CentriMag demonstrates durability and effectiveness, even for months of support, and enables relatively safe discontinuation of anticoagulation if substantial bleeding complications appear. The upper limit for the time of use of the device and the threshold of adequate coagulation have yet to be defined. This extended duration of support should be performed with pump/tubing changes occurring at recommended 4- to 6-week intervals. To the best of our knowledge, we have documented the longest circulatory support with this device that subsequently led to successful heart transplantation.

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