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Successful use of a percutaneous miniaturized extracorporeal life support system as a bridge and assistance to left ventricular assist device implantation in a patient with severe refractory cardiogenic shock

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Abstract

We present a 51-year-old man with cardiogenic shock in whom a percutaneous extracorporeal life support system (ECLS) was inserted to restore cardiopulmonary stability. After successful stabilization, a left ventricular assist device was implanted, using the ECLS without switching to a conventional cardiopulmonary bypass system to reduce its side effects.

Keywords

circulatory assist devices; LVAD; ECLS; ECMO; cardiogenic shock

Introduction

Implantation of a left ventricular assist device (LVAD) as a bridge to recovery or transplantation is a widely accepted treatment modality. However, in patients with cardiac arrest or severe hemodynamic instability and multi-organ failure, the outcome is poor[1]. Extracorporeal life support (ECLS) is a well-established technology that provides cardiorespiratory support to stabilize severely compromised patients, but is only designed for short-term use[2]. More than a decade ago, it was shown that an LVAD implantation after ECLS placement is possible and does not yield inferior results[3].

Cardiopulmonary bypass (CPB) is routinely required for implantation of VADs. However, CPB is associated with adverse effects, including activation of the systemic inflammatory response syndrome (SIRS), which can result in bleeding, arrhythmias, thromboembolism, neurological disorders, and organ dysfunction[4]. LVAD implantation without CPB has been advocated for small axial pumps, as well as for paracorporeal devices, but did not get wide-spread acceptance as hemodynamic instability may occur and visual inspection of the left-ventricular cavity is not possible during implantation[5,6].

In this report, we describe our first use of a percutaneous ECLS system as a bridge and assistance to LVAD implantation in a patient with severe refractory cardiogenic shock, to reduce the negative effects associated with conventional CPB systems.

Case Report

A 51-year-old man (body surface area: 2.17 m^2) was referred to our institution with cardiogenic shock due to end-stage dilated cardiomyopathy. Despite inotropic support, the cardiac index still remained at 1.5 L/min/m^2. Additionally, he presented with orthopnea, somnolence, and renal and liver failure.

During ECLS implantation, the patient was not intubated. The left femoral artery (17-Fr) and the right femoral vein (23-Fr) were cannulated under local anesthesia using the Seldinger technique and the ECLS system, Cardiohelp, (Maquet CP, Hirrlingen, Germany) was connected to create a pump flow of 2.5-3.5 L/min. The Cardiohelp system consists of a polymethylpentene diffusion membrane oxygenator and a centrifugal pump, with a performance of up to 7 L/min. As the whole system has a biocompatible BIOLINE coating, a pronounced systemic anticoagulation is unnecessary (partial thromboplastin time (PTT) 50–60 sec). Thereafter, the patient recovered

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and shock enzymes normalized. On ECLS, the patient received only 1 unit of packed red blood cells (PRBC).

After 7 days of mechanical support, a pulsatile paracorporeal LVAD (80 mL pump chamber, Berlin Heart Excor, Berlin, Germany) was implanted between the left ventricular apex and ascending aorta. To reduce the negative effects associated with conventional CPB, the LVAD was implanted with the heart beating, using the ECLS as a heart-lung machine. Accordingly, full systemic heparinization was not required; an activated clotting time (ACT) between 200 and 250 sec was deemed sufficient. The ECLS flow was increased to 4.5 L/min. The apex was exposed, using pericardial sutures and lap pads. After placement of multiple buttressed sutures at the cannulation site, ventricular fibrillation was induced. An apical access to the left ventricle was created, and the apex cannula was inserted, fixed, and de-aired without any significant blood loss. The heart was immediately defibrillated thereafter. Then, an Excor arterial cannula was anastomosed to the ascending aorta with continuous 4-0 Prolene. Both cannulae were connected to the Excor pump. After the ventricle was de-aired, the LVAD pump was started and the ECLS was weaned. The ECLS system was removed and, after hemostasis, the chest was closed. Removal of the ECLS cannulae was simple with manual compression of the groin.

Intraoperatively, the patient received 1 unit of PRBC and 3 units of fresh frozen plasma because of blood loss during cannulation of the apex. Total chest tube output at 24 hours was 900 mL. Postoperatively, the patient remained hemodynamically stable without inotropic or antiarrhythmic medication, and was extubated 14 hours later. After 12 hours without bleeding, we started anticoagulation with heparin (PTT 50-60 sec). Long-term anticoagulation consisted of coumarin, together with a platelet aggregation inhibitor at a low dosage.

Intensified physiotherapy helped to transfer the patient to the step-down unit 9 days later. As native cardiac function continued to be very poor, the patient is listed for heart transplantation.

Discussion

The combination of ECLS and LVAD offers many advantages to the physician. Patients with cardiogenic shock can be stabilized by percutaneous implantation of an ECLS. This is a simple and quick procedure which allows selection of suitable candidates for LVAD placement without wasting large amounts of money. Patients recover within days and can even be extubated while being on cardiorespiratory support. If weaning from ECLS is impossible and the patient is eligible for LVAD placement, the latter usually follows within 2 to 5 days. The intention is a bridge to recovery or a bridge to transplantation. Previous studies have reported the successful use of a combined ECLS and LVAD approach to cardiac salvage for circulatory collapse[3,7].

The LVAD implantation using percutaneous miniaturized ECLS without switching to a conventional CPB system is a novel concept. The basic idea is to reduce the side effects associated with conventional cardiopulmonary bypass. The concept also saves additional vascular cannulation and full systemic heparinization, and offers less artificial surface and less priming volume. Thus, at least theoretically, the systemic inflammatory response syndrome should be reduced. The only disadvantage is that visual inspection of the left-ventricular cavity is impossible. In our case, the LVAD implantation and the perioperative anticogulation management were rather simple. Cannulation for LVAD was performed with the aid of the ECLS with the heart beating. A careful implant technique avoided a significant blood loss from spilling. No air embolism or thromboembolism occurred.

In conclusion, our experience suggests that LVAD implantation using percutaneous ECLS support without switching to conventional CPB is a safe alternative in the bridge to bridge concept. This novel approach should be useful in selected patients, especially, high-risk patients with cardiogenic shock who would benefit from the avoidance of the adverse sequels associated with CPB.

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Conflict of Interest Statement

None Declared.

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