Venoarterial Extracorporeal Membrane Oxygenation Support as a Bridge to Heart Transplant: Report of 3 Cases

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Abstract

Heart transplant is the only definitive treatment of end-stage heart failure. Venoarterial extracorporeal membrane oxygenation may be used as a bridge to heart transplant. Among 31 patients who underwent heart transplant between January 2014 and June 2016, we present our experiences with 3 patients who received venoarterial extracorporeal support as a bridge to heart transplant. The first patient was a 51-year-old male with ischemic dilated cardiomyopathy. Transplant was performed after 6 days of extracorporeal support, and the patient was discharged and alive at follow-up. Patient 2 was a 12-year-old girl with dilated cardiomyopathy who presented with cardiac arrest. Extracorporeal support was initiated during cardiopulmonary resuscitation. She had full neurologic recovery and remained on the wait list. She received a transplant 22 days after resuscitation. She survived and was alive at day 220 posttransplant. The third patient was a 50-year-old male with ischemic dilated cardiomyopathy requiring venoarterial extracorporeal support. Percutaneous balloon atrial septostomy was performed for left ventricle venting. He underwent transplant on day 28 after intensive care unit admission. He died 29 days after release from the hospital. Regarding patients on heart transplant wait lists who are worsening despite optimal medical therapy, venoarterial extracorporeal membrane oxygenation support is a safe and viable last resort.

Key words: Cardiac failure, Extracorporeal assist, Preoperative and transplant

Introduction

Heart transplant is the only definitive treatment of end-stage heart failure for pediatric and adult patients.1,2 Venoarterial extracorporeal membrane oxygenation (VA-ECMO) is one of several mechanical circulatory support devices used for patients with refractory cardiac failure (RCF). The advantages of ECMO over other percutaneous devices are its ease of insertion and its ability to support right, left, or biventricular failure at high blood flows.3 This technique may be used as a bridge to heart transplant in both pediatric and adult patients.2,4 Venoarterial extracorporeal membrane oxygenation is increasingly used as a short-term circulatory support in patients with RCF, providing a bridge to heart transplant.5 We present our experience with 3 patients who received VA-ECMO as a bridge to emergency heart transplant in the intensive care unit (ICU).

Case Reports

We retrospectively screened the data of 31 heart transplants performed between January 2014 and June 2016 at our center. Among these were patients who were admitted to the ICU before heart transplant who did not respond to optimal medical therapy and required VA-ECMO for circulatory support.

Case 1

A 51-year-old male patient with ischemic biventricular dilated cardiomyopathy was admitted to the ICU for RCF. His RCF did not improve with pharmacologic therapies, and VA-ECMO support was initiated. Right femoral vein and left femoral artery cannulations with a leg perfusion cannula were performed percutaneously. Heart transplant was...
performed after 6 days on VA-ECMO support. Duration of surgery was 7 hours. There was no need for extracorporeal support during the postoperative period. He was discharged from the ICU on postoperative day 12 and hospital on postoperative day 19. At follow-up, the patient was alive on posttransplant day 307.

**Case 2**
A 12-year-old girl with biventricular dilated cardiomyopathy of unknown cause was admitted to the ICU because of no response to medical therapy and worsening heart failure. She had a cardiac arrest 10 days after ICU admission. Venoarterial extracorporeal membrane oxygenation was initiated during cardiopulmonary resuscitation (CPR). Left femoral vein and right femoral artery with leg perfusion cannulas were inserted percutaneously. She had full neurologic recovery and remained on the heart transplant wait list. Peripheral VA-ECMO was continued for 15 days. However, she had lower leg ischemia on day 25 after admission. Peripheral VA-ECMO support was converted to central VA-ECMO and continued for 7 days. The patient received a heart transplant on day 32 in the ICU and did not require ECMO support postoperatively. Duration of surgery was 7 hours. Her ECMO-related complications were lower limb ischemia without major sequels, amputation of 3 fingertips due to thrombosis of digital arteries from the arterial cannula, and bleeding during central VA-ECMO. She was discharged from the ICU on day 66. The patient was alive on posttransplant day 220.

**Case 3**
A 50-year-old male patient with ischemic biventricular dilated cardiomyopathy was admitted to the ICU for worsening heart failure symptoms despite medical treatment. Although he initially improved with optimal pharmacologic therapy, he developed cardiogenic shock 5 days after ICU admission, and VA-ECMO was commenced. Left femoral vein and right femoral artery with leg perfusion cannulae were used for vascular access. Percutaneous balloon atrial septostomy was performed for left ventricle venting. Peripheral VA-ECMO support was continued for 23 days. He underwent heart transplant on day 28 of ICU admission. Duration of surgery was 9 hours. There was no need for extracorporeal support during the postoperative period. He was discharged from the ICU on postoperative day 42 and hospital on postoperative day 49. He died 29 days after release from hospital at home (postoperative day 78).

**Discussion**
In this report, we present our experiences with 3 patients who received VA-ECMO as a bridge to heart transplant in the ICU. All patients were treated in our ICU during the perioperative period. All patients were on the wait list of the National Organ Procurement Organization Registry as candidates for emergency heart transplant after VA-ECMO support. All peripheral VA-ECMOs were done with percutaneous cannulation using ultrasonography guidance. Venoarterial extracorporeal membrane oxygenation was performed under analgesia and sedation with local anesthesia for patients 1 and 3. Patient 2 was intubated during the procedure because of cardiac arrest. All patients were discharged from the hospital with no major long-term complications, except for patient 2 who received ECMO support. Patients 1 and 2 are still alive and periodically supervised by our center. Patient 3 died 29 days after discharge from hospital at home.

Venoarterial extracorporeal membrane oxygenation represents an effective therapy for RCF and cardiac arrest. It is used in RCF patients as a bridge to decision, a bridge to candidacy, and a bridge to heart transplant. Its routine use for urgent heart transplant is not widely accepted in most transplant centers because of limited duration for this support.\(^6\) In our country, a heart allocation system provides priority status granted to the sickest patients. This system is similar to some European countries and the United States.\(^5\) In our report, all 3 patients were admitted to our ICU for medical treatment. None of them were on the national wait list. All patients showed no improvements despite optimal medical therapy with advanced hemodynamic monitoring. Our team decided to perform VA-ECMO as a salvage therapy. Patient 2 had cardiac arrest and required extracorporeal CPR. We enrolled all 3 patients to our heart allocation system after VA-ECMO support and considered these patients as urgent candidates for heart transplant, giving them high priority.

Extracorporeal membrane oxygenation cannulation has traditionally been performed by cardiothoracic surgeons in the operating room with open access. They use both peripheral and central...
approaches. Recently, other specialists (anesthesiologists and intensivists) have performed cannulation by a percutaneous approach guided with USG in the ICU. The most frequently used cannulation site is the femoral vessel. Barth and associates reported their experience on 242 patients with emergent venoarterial extracorporeal life support. They used femoral veins for cannulation. They also stated that femoral cannulation provided reliable access in emergency conditions. The femoral route was used in our patients for VA-ECMO support at the bedside. Peripheral VA-ECMO support can be used as a bridge to urgent heart transplant. In a large cohort of 242 patients, 8 underwent urgent heart transplant. The mean duration of extracorporeal life support was 6.3 ± 4.6 days. In our investigation of 31 heart transplant procedures, 3 patients underwent urgent heart transplant. The mean duration of VA-ECMO support was 17.0 ± 9.5 days (range, 6-23 d) in our patients.

Pediatric patients awaiting transplant frequently require bridge to heart transplant with mechanical circulatory support. In a recent large analysis of 2777 pediatric heart transplant patients, 617 (22%) had mechanical circulatory support, with 189 (30%) receiving VA-ECMO support. Similar to this report, patient 2, who was a 12-year-old girl, required VA-ECMO support when she underwent emergency heart transplant. Because of ischemic complications, peripheral and central types of VA-ECMO support were used for this patient.

Lasa and associates studied the effectiveness of extracorporeal CPR after failed conventional CPR in pediatric patients. They concluded that for children who receive in-hospital CPR for more than 10 minutes, extracorporeal CPR was associated with improved survival with favorable neurologic results compared with conventional CPR. Despite better prognosis with this type of extracorporeal support, there have been few reports regarding urgent heart transplant after extracorporeal CPR. We used VA-ECMO support during CPR for our pediatric patient (patient 2) because heart failure, and she underwent emergency heart transplant after 22 days.

Extracorporeal mechanical circulatory support has several complications. First, the ECMO circuit activates the coagulation, fibrinolytic, and complement systems. The activation of these pathways results in both bleeding and thrombotic complications. Bleeding is the most common complication of extracorporeal support. During treatment of anticoagulation, the risk of bleeding must be balanced with the risk of thrombosis. Thrombosis can occur in any part of the ECMO circuit. All 3 patients received anticoagulation agents with intravenous unfractionated heparin infusion. Anticoagulation administration was monitored with activated clotting time at the bedside. The targeted level of activated clotting time was 180 seconds. There were no bleeding and thrombotic complications in patients 1 and 3. Patient 2 had thrombosis of digital arteries during peripheral ECMO support and bleeding during central extracorporeal support. We were able to treat these complications, with no major long-term effects except for amputation of 3 fingertips.

Left ventricular distension during VA-ECMO can have several potential complications. Increased myocardial wall stress and oxygen demand due to increased end-diastolic volume and reduced coronary perfusion pressure can result in impaired ventricular recovery or worsening of injury. To evaluate adequate left ventricular decompression, echocardiography can be helpful. When pharmacologic measures are not able to provide adequate decompression, some mechanical techniques like left ventricular venting, atrial septostomy, and additional mechanical support devices can be considered. Patient 3 had left ventricular distention during extracorporeal support. This complication was treated by balloon atrial septostomy at the coronary angiography unit.

Peripheral cannulation of femoral vessels is associated with increased risk of limb ischemia. In cases with femoral artery cannulation, this risk can be remedied with insertion of a distal perfusion or drainage cannula to provide antegrade arterial perfusion. In our 3 patients, a distal perfusion cannula with anterograde route was inserted before femoral arterial ECMO cannulation. Patients were examined daily with Doppler ultrasonography for adequate arterial circulation in the arterial side. Despite these measures, patient 2 developed limb ischemia. This complication was treated with decannulation and conversion to central VA-ECMO.

In a large series, temporary or short-term mechanical circulatory support before heart transplant as a preoperative bridging have been reported to have comparable or good postoperative outcomes compared with VA-ECMO. We have limited experience regarding extracorporeal support.
for bridge to urgent heart transplant. However, our patients were successfully transplanted after support with VA-ECMO. We had no inpatient mortality.

In conclusion, for patients on heart transplant wait lists who are worsening despite optimal medical treatment, VA-ECMO support is a safe and viable last resort.

References


