Case Report

Anesthesia for left ventricular assisted device insertion in a patient with multiple organ failure

ABSTRACT

Technological advances in mechanical circulatory support have enabled more patients with end-stage heart failure to benefit from left ventricular assist devices (LVAD). Indications for LVAD implantation have evolved to include patients who are deemed unsuitable for cardiac transplantation, otherwise known as destination therapy. This case report describes such patient with multi-organ failure who underwent LVAD insertion after nine days of extra-corporeal membrane oxygenation, intra-aortic balloon pump and maximal inotropic support. Strategies for perioperative management, as well as intra-operative monitoring and interventions are discussed.

Key words: Anesthesia; extra-corporeal membrane oxygenation; left ventricular assist device; multi organ failure

Introduction

With the rising prevalence of heart failure (HF), limited conservative options for terminal HF patients coupled with high readmission rates and a significant one-year mortality rate of nearly 50%,[1] ventricular assist devices are increasingly accepted as a standard-of-care treatment in end-stage HF. Its use is favored by improved outcomes, lower complication rates, especially with newer-generation devices, and scarcity of heart donors for transplantation. This case report describes the LVAD insertion in a patient with multi-organ dysfunction and discusses pertinent anesthetic challenges.

Report

A 66-year-old chronic smoker with no past medical history presented to the emergency department with massive anterior ST-segment elevation myocardial infarction. This was complicated by cardiogenic shock, ventricular tachycardia, and pulseless electrical activity, requiring 30 minutes of cardiopulmonary resuscitation. He was transferred to our institution following insertion of drug-eluting stent and intra-aortic balloon pump (IABP) with maximal inotropic support, for initiation of Veno-Arterial extra-corporeal membrane oxygenation (VA-ECMO). The initial cardiac assessment revealed left ventricular ejection fraction (LVEF) of 10–15% with impaired right ventricular systolic function. ECMO weaning was unsuccessful at 9 days post cardiac arrest. During his stay in the intensive care unit, he developed non-oliguric acute kidney injury requiring continuous renal replacement therapy (CRRT), critical illness neuromyopathy, ventilator-associated pneumonia, and pancreatitis with gastrointestinal malabsorption requiring total parenteral nutrition.

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Following extensive multi-disciplinary discussions, the patient was scheduled for Heartmate II LVAD implant and ECMO explant. Prior to the induction of anesthesia arterial and central venous pressures, 5-lead electrocardiogram, esophageal and rectal temperature monitoring and bispectral index were applied in addition to the standard monitoring and defibrillator/pacing pads were placed. Anesthesia was induced with a combination of midazolam, fentanyl, sevoflurane and rocuronium and the patient was ventilated using pressure-control mode. An 8.5Fr Swan Ganz pulmonary artery catheter was floated through right internal jugular vein. Anesthesia was maintained with oxygen/air mixture and sevoflurane. Cardiopulmonary bypass (CPB) was commenced upon achieving full heparinization. CRRT was continued while on CPB. Following LVAD insertion a normal-velocity laminar flow into LVAD cannula was noted. Inhaled nitric oxide (iNO) 40 parts-per-million and milrinone 0.5 mcg/kg/min were initiated to optimize the inflow prior to weaning CPB. Noradrenaline 0.03 mcg/kg/min and adrenaline 0.05 mcg/kg/min were commenced to circumvent vasoplaegia. Total CPB duration was 68 minutes.

The patient was weaned off nitric oxide and milrinone on post op day 1 subsequently, Noradrenaline on 3rd post-operative day. Renal, hepatic, and gastrointestinal function recovered after a week. He was discharged from ICU 24 days after surgery and was discharged home after inpatient rehabilitation on 149th day of admission. Our patient had a good quality of life for 3 years since LVAD implantation but succumbed to out of hospital collapse possibly due to LVAD failure.

Discussion

Growing advocacy for LVADs as mean of destination therapy is supported by the landmark REMATCH trial, where patients with LVAD implantation achieved more than 2-fold survival benefit over maximal medical therapy.[2] However, a higher in-hospital mortality is reported in patients with pre-existing renal/hepatic dysfunction, poor nutritional status, right heart failure, infection, and coagulopathy. Any severe end organ failure is considered an absolute contraindication for LVAD placement.[3]

Our patient was in MOF with pre-operative SOFA scores predicting a 1-year mortality risk of at least 36%,[4] Which was not in favor of the placement of LVAD. Furthermore, placement of LVAD itself is associated with 32% chance of developing MOF with a 71% mortality rate for those with MOF.[5] However, implantation of a LVAD was the only option to sustain his life or providing him a chance to recover from MOF. A shared decision for LVAD placement was made after a multidisciplinary meeting involving cardiologist, cardiothoracic surgeon, renal physician, intensivist and anesthesiologist.

Anesthesia for LVAD placement in a patient with MOF is challenging in view of continuing the vital organ support in addition to fulfil the general goals for the LVAD placement, which include; (1) maintaining hemodynamic stability by supporting unassisted right ventricle, (2) employing special monitoring techniques to optimize LVAD settings and cardiac performance, (3) balancing coagulation-anticoagulation requirements to prevent bleeding diathesis and thrombo-embolic complications, (4) treating arrhythmias, acid-base and electrolyte disturbances expeditiously. Furthermore, special attention is given to intra-operative temperature goals. Hypothermia has been favored as a cytoprotective strategy in surgical procedures requiring CPB, to confer neuro- and cardio-protection and to facilitate cardioplegia.[6] However, hypothermia is associated with impaired wound healing, infection, coagulopathy, and arrhythmias. In our patient, low-normal temperatures of 35-36°C was maintained.

Ultrafiltration via CPB is beneficial for volume management,[7] preservation of intravascular platelets and clotting factors, thereby promoting hemostasis and reducing transfusion requirements.[8] It also decreases complement activation, thereby attenuating the inflammatory response with consequent improvements in post-operative cardiac, pulmonary, and neurologic functions.[9] CPB weaning to LVAD is especially challenging in patients with MOF. Vigilance and a constant communication between anesthesiologist surgeons and perfusionists are crucial. With adequate filling and optimal unloading, the LV can be entirely supported by LVAD.

Significant RV dysfunction occurs during one-third of LVAD implantations and is a predictor of mortality.[10] RV dysfunction may manifest as insufficient forward flow, hypotension and increased central venous pressure. RV function is optimized with meticulous fluid management, gentle unloading of the LV with titration of LVAD speeds, optimizing the RV contractility with inotropes like Milrinone or adrenaline and by reducing the pulmonary vascular resistance (PVR) with pulmonary vasodilators like inhaled nitric oxide (iNO). Furthermore, avoidance of hypoxia, hypercarbia, acidosis, high positive end-expiratory pressures helps in maintaining PVR and RV function. Despite not having a preexisting RV dysfunction our patient required milrione and iNO to improve the forward flow, which were weaned off within 24 hours.

In conclusion, implantation of LVAD salvages a dying patient with MOF, snatching their life from the jaws of death. It

is important to understand the anesthetic implications and intra-operative goals of patients who undergo LVAD implantation.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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