Austin Journal of Anesthesia and Analgesia

Open Access

Austin Publishing Group

Case Report

Anesthesia Care for the Change of Extra-Corporeal Membrane Oxygenation to Left Ventricular Assisted Device in a Patient with Multiple Organ Failure Leading To Improvement in Organ Function and Outcome: A Case Report

Ma WWZ[1], Suhitharan T[2]*, Shah SS[3] and Kothandan H[3]

[1]Sing health Anesthesiology Residency, Singapore

[2]Department of Surgical Intensive Care, Division of Anesthesiology, Singapore General Hospital, Outram Road, Singapore

[3]Department of Anesthesiology, Singapore General Hospital, Outram Road, Singapore

***Corresponding author:** Suhitharan T, Department of Surgical Intensive Care, Division of Anaesthesiology, Singapore General Hospital, Outram Road, Singapore

Received: June 01, 2020; **Accepted:** June 25, 2020; **Published:** July 02, 2020

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.

Keywords: Extra-Corporeal Membrane Oxygenation; Left Ventricular Assist Device; Multi Organ Failure; Anesthesia

Abbreviations

LVAD: left Ventricular Assist Device; ECMO: Extra-Corporeal Membrane Oxygenation; HF: Heart Failure; MOF: Multi Organ Failure; EQUATOR: Enhancing the Quality and Transparency of Health; IABP: Intra-Aortic Balloon Pump; LVEF: Left Ventricular Ejection Fraction; CRRT: Continuous Renal Replacement Therapy; PAP: Pulmonary Artery Pressure; TEE: Trans Esophageal Echocardiography; RV: Right Ventricle; CBP: Cardiopulmonary Bypass; iNO: inhaled Nitric Oxide;

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.

While prevailing literature describes the anesthetic management of patients undergoing Left Ventricular Assist Devices (LVADs) implantation as a bridge to recovery or transplant, there is a paucity of data on anesthetic considerations in patients with pre-operative Multi-Organ Failure (MOF) requiring LVAD as destination therapy. This case report describes the LVAD insertion in a patient with multi-organ dysfunction and discusses pertinent anesthetic challenges. Our patient is not alive at the time wiring this manuscript, institutional review board approval was obtained for the publication with the waiver of patient consent. This manuscript adheres to the applicable Enhancing the Quality and Transparency of Health (EQUATOR) guideline.

Case Presentation

A 66-year-old chronic smoker with no past medical history presented to the emergency department with massive anterior ST-segment elevation myocardial infarction secondary to left main coronary disease. 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) through femoral venous and arterial canulation.

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. He was reviewed by the heart failure team for consideration of LVAD as destination therapy in view of his age and good premorbid function.

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 monitorings and defibrillator/pacing pads were

Citation: Ma WWZ, Suhitharan T, Shah SS and Kothandan H. Anesthesia Care for the Change of Extra-Corporeal Membrane Oxygenation to Left Ventricular Assisted Device in a Patient with Multiple Organ Failure Leading To Improvement in Organ Function and Outcome: A Case Report. Austin J Anesthesia and Analgesia. 2020; 8(2): 1090.

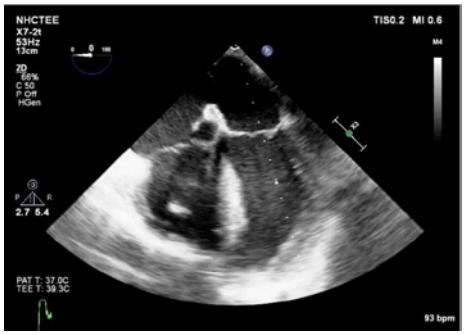

Figure 1: TOE image-apical 4 chamber view.

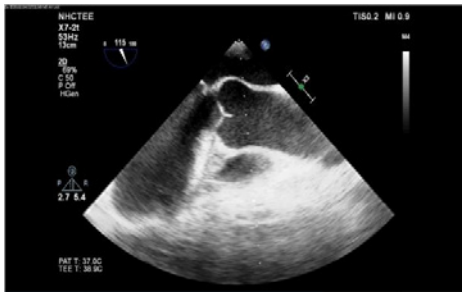

Figure 2: TOE image-parasternal long axis view.

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. Trans Esophageal Echocardiography (TEE) post-induction showed a dilated left ventricular cavity, LVEF 10-15%, and normal size Right Ventricle (RV) with low-normal RV global systolic function (Figure 1,2).

Anesthesia was maintained with oxygen/air mixture and sevoflurane. Cardiopulmonary Bypass (CPB) was commenced upon achieving full heparinization. CRRT was continued while on CPB. TEE was used to guide the placement of the inflow cannula at left ventricular apex, to assess post-LVAD function and to facilitate weaning off CPB. Following LVAD insertion a normal-velocity laminar flow into LVAD cannula was noted. Inhaled Nitric Oxide(iNO) 40 parts-per-million and milrinone 0.5mcg/kg/min were initiated to optimize the inflow prior to weaning CPB. Noradrenaline 0.03mcg/kg/min and adrenaline 0.05mcg/kg/min were commenced to circumvent vasoplaegia. Total CPB duration was 68 minutes. Post-bypass Hb was 6.8g/dL. After adequate reversal with protamine, a total of 975ml packed red blood cells (including pump and cell-salvaged blood), 598ml pooled platelets, 531ml fresh frozen plasma and 129ml cryoprecipitate were transfused.

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. Tracheostomy was performed 12 days post-operatively due to prolonged intubation and copious secretions. He was discharged from intensive care unit 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 development 32% chance of developing MOF with a 71% mortality rate for those develop MOF [5]. However, our patient`s MOF is mainly contributed by refractory cardiogenic shock. Placement of 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 and utility of the TEE. 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 were maintained in view of the risk of coagulopathy needing blood transfusion and its associated risks. Judicious transfusion in turn can be guided by point-of-care tests such as activated clotting time and thromboelastography [7]. TOE is useful in facilitating LVAD placement, dynamic assessment of pre and post-LVAD heart and device functions, and facilitates ECMO/CPB weaning including de-airing measures.

Ultrafiltration via CPB is beneficial for volume management by reducing hemodilution due to excess pump prime and pre-existing fluid overload [8]. It is known to preserve intravascular platelets and clotting factors, thereby promoting hemostasis and reducing transfusion requirements [9]. It also decreases complement activation, thereby attenuating the inflammatory response [10] with consequent improvements in post-operative cardiac [11], pulmonary [12] and neurologic [13] functions. Ultraflitration was done via CPB in this case.

CPB weaning to full LVAD support is gradually achieved by

lowering CPB flows with incremental increases in LVAD flow by increasing pump speed with continuous TEE and hemodynamic monitoring. CPB weaning is especially challenging in patients with reduced end-organ reserves. Vigilance and a constant communication between anesthesiologist surgeons and per fusionists are crucial. With adequate filling and optimal unloading, the LV can be entirely supported by LVAD outflow. Meticulous titration of fluids is necessary to prevent under-filling or over-distension of the right heart, and is performed via direct inspection, CVP and PAP trends.

Significant RV dysfunction occurs in approximately one-third of patients undergoing LVAD implantation and is a predictor of early and late mortality [14]. RV dysfunction may manifest as LVAD suction events with the insufficient forward flow, hypotension, as well as an increased central venous pressure. RV function is optimized with meticulous fluid management, gentle unloading of the LV with gradual 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 such as inhaled Nitric Oxide (iNO). Furthermore, avoidance of hypoxia, hypercarbia, acidosis, high positive end-expiratory pressures further help in maintaining PVR and RV function. Despite not having a preexisting RV dysfunction and avoidance of factors increasing the PVR intra operatively, our patient required milrione and iNO to improve the forward flow, which were weaned off with in 24 hours.

Coagulopathy and bleeding are common postoperative complication. Standard laboratory tests and point of care tests to supplement standard laboratory tests of hemostatic function (eg, thromboelastography) are recommended for rapid assessment of causes of coagulopathy and responses to treatment such as transfusion of blood products or administration of a hemostatic agent.

Conclusion

Implantation of LVAD salvages a dying patient with MOF, snatching their life from the jaws of death. Criteria for LVAD for destination therapy implantation are evolving and will include patients who are too sick. It is important to understand the anesthetic implications and intra-operative goals of patients who undergo LVAD implantation. This entails a multi-disciplinary, multi-systems assessment, use of various monitoring modalities and treatment adjuncts to mitigate end-organ failure .To our knowledge, this is a first reported case of a successful destination therapy LVAD implantation in a patient with pre-existing multi organ failure.

References

1. Cleland JG, Gemmell I, Khand A, Boddy A. Is the prognosis of heart failure improving? European Journal of Heart Failure.1999; 3: 229-241.
2. Rose EA, Gelijns AC, Moskowitz AJ, Heitjan DF, Stevenson LW, Dembitsky W, et al. Long-term use of a left ventricular assist device for end-stage heart failure. New England Journal of Medicine. 2001; 345: 1435-1443.
3. Khazanie P, Rogers JG. Patient selection for left ventricular assis devices. Congest Heart Fail. 2011; 17: 227-234.
4. Landis ZC, Soleimani B, Stephenson ER, El-Banayosy A, Pae W.E. Severity of End-Organ Damage as a Predictor of Outcomes After Implantation of Left Ventricular Assist Device. American Society of Artificial Internal Organs (ASAIO) Journal. 2015; 61: 127-132.
5. Frazier OH, Myers TJ, Westaby S, Gregoric ID. Use of the Jarvik 2000 left ventricular assist system as a bridge to hearttransplantation or as destination therapy for patients withchronic heart failure. Ann Surg. 2003; 237: 631-637.
6. Hesham Saad, Mostafa Aladawy. Temperature management in cardiac surgery. Global Cardiology Science & Practice. 2013; 1: 44-62.
7. Karkouti K, Callum J, Wijeysundera DN, Rao V, Crowther M, Grocott HP, et al. Point-of-Care Hemostatic Testing in Cardiac Surgery: A Stepped-Wedge Clustered Randomized Controlled Trial. Circulation. 2016; 134: 1152-1162.
8. Silverstein ME, Ford C.A, Lysaght MJ, Henderson LW. Treatment of severe fluid overload by ultrafiltration. NEJM. 1974; 291: 747-751.
9. Boldt J, Kling D, von Bormann B, Zuge M, Scheld H, Hempelmann G. Blood conservation in cardiac operations. Cell separation versus hemofiltration. The Journal of Thoracic and Cardiovascular Surgery. 1989; 97: 832-840.
10. Sakurai H, Maeda M, Murase M, Koyama T, Hayakawa M. Hemofiltration removes bradykinin generated in the priming blood in cardiopulmonary bypass during circulation. Annals of Thoracic and Cardiovascular Surgery. 1998; 4: 59-63.
11. Coraim FI, Wolner E. Continuous hemofiltration for the failing heart. New Horizons. 1995; 30: 725-731.
12. Meliones JN, Gaynor JW, Wilson BG, Kern FH, Schulman SR, Shearer IR, et al. Modified ultrafiltration reduces airway pressures and improves lung compliance after congenital heart surgery. Journal of the American College of Cardiology. 1995; 25: 217A.
13. Skaryak LA, Kirshbom PM, DiBernardo LR, Kern FH, Greeley WJ, Ungerleider RM, et al. Modified ultrafiltration improves cerebral metabolic recovery after circulatory arrest. The Journal of Thoracic and Cardiovascular Surgery. 1995; 109: 744-752.
14. Cyrille NB, Tran AL, Benito Gonzalez T, Villablanca PA, Briceno DF, Vucicevic D, et al. Predictors and Outcomes of Right Ventricular Failure in Patients With Left Ventricular Assist Devices. J Cardiothorac Vasc Anesth. 2017; 31: 1132.