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Case Report

The Role of ECMO in High-Risk Cardiac Surgery: A Case Report

Jaytesh Parashar[1], Ganesh Shivnani[2], Shivansh Dutt[3]

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ABSTRACT

Background: Refractory cardiogenic shock patients requiring urgent surgical intervention carry very high operative mortality risk. Intermediary measures aimed at reducing this high operative risk can give them an opportunity for successful outcome of surgery. In the absence of any specific guidelines in such critical scenarios, timely intervention is crucial. We present a case of severe aortic stenosis with cardiogenic shock, which demanded a surgical aortic valve replacement but was considered a very high risk if operated immediately.

Methods: To alleviate the risk, patient was first managed with preoperative extracorporeal membrane oxygenation (ECMO) support and after stabilization proceeded to the required definitive surgical procedure.

Results: The operative risk was substantially reduced with ECMO support which was also used for recovery from post cardiotomy shock.

Conclusions: Patients with a need for surgery presenting in cardiogenic shock are sometimes categorized as inoperable. In these cases, ECMO support before surgery buys time for decision making and planning further courses of action. ECMO support rescued our patient from a critical inoperable state and helped navigate him to the required surgical management with acceptable risk thus giving a chance at better recovery.

KEYWORDS

• Extracorporeal Membrane Oxygenation • ECMO • Cardiogenic Shock • Aortic Stenosis.

Author's Affiliation:

[1] Associate Consultant, Department of Cardiothoracic and Vascular Surgery, Sir Ganga Ram Hospital, New Delhi, India.

[2] Department of Cardiothoracic and Vascular Surgery, Sir Ganga Ram Hospital, New Delhi, India.

[3] Department of Cardiothoracic and Vascular Surgery, Sir Ganga Ram Hospital, New Delhi, India.

Corresponding Author:

Jaytesh Parashar, Associate Consultant, Department of Cardiothoracic and Vascular Surgery, Sir Ganga Ram Hospital, New Delhi, India.

E-mail: drjayteshparashar@gmail.com

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INTRODUCTION

Background: Cardiogenic shock (CS) is defined as a state of circulatory failure because of low cardiac output which results from failure of either single or both ventricles. A new acute ischemic or non-ischemic event, or the progression of chronic underlying heart disease are the major etiologies for CS. This state can cause severe cellular and metabolic derangements, multisystem organ dysfunction, as well as mortality.[1] The rate of hospitalized deaths in these cases can go as high as 80%.[2] The incidence of CS due to severe aortic stenosis (AS) has been reported to be as high as 7 – 10%.[3] Due to lack of available data pertaining to Indian population, the exact association of CS with AS cannot be determined and treatment protocols remain undefined. Vasopressors and inotropes are the first line of management in these patients but are frequently ineffective. To augment the cardiac output of these patients, we may require a temporary mechanical circulatory system e.g. intra-aortic balloon pump , Veno-arterial extracorporeal membrane oxygenation (VA-ECMO), or ventricular assist devices therapy.[1] The ECMO can be used as a bridge to recovery (BTR) and bridge to decision (BTD), the decisions being either surgery, ventricular assist devices, interventional procedures or cardiac transplant.[2]

We present a case of a very severe AS which presented to emergency ward in CS carrying risk of high operative mortality, thus was first stabilized using emergency VA-ECMO therapy and post-stabilization was taken up for surgical aortic valve replacement (SAVR) with an acceptable operative risk.

CASE PRESENTATION

A 57-year-old man presented to the emergency ward with sudden exacerbation of breathlessness from past two hours. He had been a known case of AS for the past three years and was on regular follow-up with his consulting physician. On examination, he was found to be in refractory CS and respiratory distress. He was immediately intubated and put on mechanical ventilatory support along with initiation of high dose vasopressors. He had severe metabolic acidosis and was anuric. Trans-esophageal Echocardiography suggestive of very severe AS [aortic valve area: 0.4 cm^2, peak gradient: 72 mm Hg, Dimensionless Velocity Index (DVI): 0.2] with bi-ventricular failure and severe pulmonary artery hypertension. It was difficult to maintain the systolic blood pressure above 90 mmHg, despite increasing the vasopressors dosage. In accordance with the critical state of the patient, he carried a very high operative mortality risk (Table 1) if taken up for an immediate SAVR procedure.

Table 1: Patients pre-operative mortality risk scores. (All scores and inferences were derived from online available calculators)

Scores	Online source	Pre-ECMO Score	Post-ECMO Score	Inference
EuroSCORE II (European system for cardiac operative risk evaluation)	https://www.euroscore.org/index.php?id=17	31.93%	-	Expected Mortality of 31.93%
SOFA score (Sequential Organ Failure Assessment)	https://www.mdcalc.com/calc/691/sequential-organ-failure-assessment-sofa-score	16	10	Reduction of expected mortality pre-ECMO of 95% to 50% after ECMO support
SAVE score (Survival after Veno-Arterial ECMO)	https://www.elso.org/savescore/index.html	-7	-	Predicted Survival pre-ECMO was 30%

VA-ECMO was planned as a BTR for refractory CS as well as BTD for SAVR. This was initiated via right axillary arterial (17 Fr) and percutaneous femoral venous cannula (27 Fr). After 18 hours of VA-ECMO with inline hemofilter support (Figure 1) and protected lung ventilation strategy, his metabolic derangements were brought to stability. After stabilization and re-assessment of operative risk the patient was taken up for SAVR via median sternotomy. Arterial and venous ECMO cannula were disconnected from the loop and connected to cardiopulmonary bypass circuit. The ECMO tubing loops were joined and turned into a closed self-circulation system. Left atrial vent was placed from right superior pulmonary vein and antegrade cardioplegia was utilized to achieve cardiac arrest. Intraoperatively, the aortic valve was found to be a heavily calcified tri-leaflet valve

with extremely small orifice supporting the etiology of CS in this patient. The diseased aortic valve was excised and replaced with 23 size mechanical aortic prosthesis. Rest of the operation was carried out in the standard manner of SAVR. Thereafter, the arterial and venous cannulas were connected to VA-ECMO circuit, and the circulatory support was continued in the recovery period.

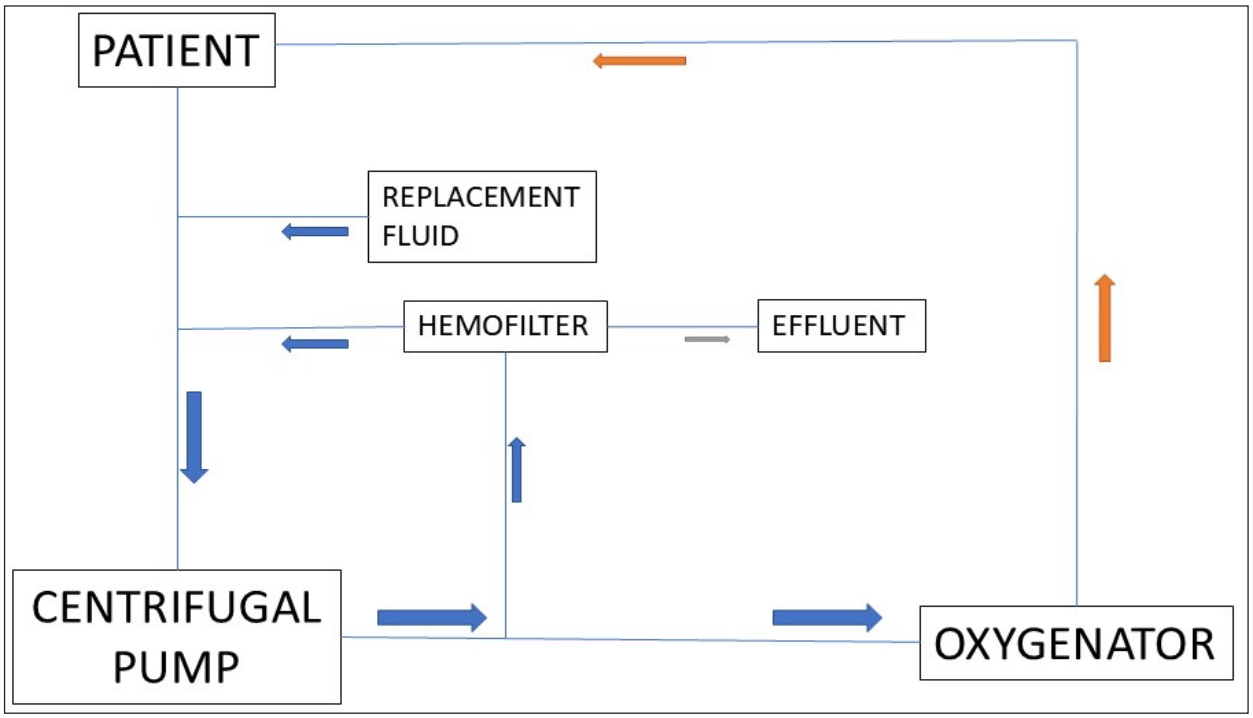

Figure 1: Schematic diagram for ECMO circuit with inline hemofilter

In the 24 hours following the VA-ECMO support, the patient was successfully weaned and de-cannulated. In view of intermittent complete heart block, he required Dual chamber permanent pacemaker implantation. His need for prolonged ventilatory support necessitated tracheostomy which was removed after 6 weeks. He also needed renal replacement therapy for a month. He was discharged from the hospital after 52 days. At present, after a year, he is on regular follow-up and relatively free from any cardiac related complications.

CONCLUSION

Salvage valve replacement procedures carry a very high operative mortality risk in the context of multiple organ failure and CS.[2] Utilization of ECMO in an inoperable patient as a bridge to stabilize the critically ill status and perform open heart surgery increases the chances of a successful outcome. As there are no defined guidelines for the term "inoperable patient", certain risk factors such as advanced age, CS, pulmonary edema and severe comorbidities may be considered to have increased risk of operative mortality and are managed on a case-to-case basis.

Our patient had severe metabolic acidosis, refractory CS and acute renal failure because of which his operative mortality risk was very high. Pre-operative support with VA-ECMO certainly improved the chances of successful outcomes of the designated surgery in our patient. Post-operative continuation of ECMO support not only supported post cardiotomy recovery but also the recovery of other affected organs from CS. However, duration of VA-ECMO support is not immune from its own set of limitations. According to the study by Cheng *et al,* 30.4% of patients on VA-ECMO for CS had significant infection.[4] In order to circumvent these limitations, we kept our duration of VA-ECMO support as short as possible thus providing desired outcome while minimizing the risk of associated infective complications. Integrated infection control measures like hand hygiene and infection surveillance also

help to reduce the complications related to infections in ECMO patients.[5]

As the literature on the utilization of ECMO for bridging of an inoperable patient to an acceptable risk for the cardiac surgical procedure is limited, therefore, these types of cases are managed as per surgeon's experience. The decision of the duration of support must be based on the patient's clinical status. The above case report emphasizes the role of pre-operative ECMO as a bridge to destined surgery which reduces the operative mortality risk from that of a moribund to an acceptable level.

List of abbreviations

CS	Cardiogenic shock
AS	Aortic stenosis
SAVR	Surgical aortic valve replacement
VA-ECMO	Veno-arterial Extracorporeal Membrane Oxygenation
BTR	Bridge to recovery
BTD	Bridge to decision
DVI	Dimensionless Velocity Index

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