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Extracorporeal Membrane Oxygenation for Post Cardiotomy Acute Right Ventricle Failure in Adults

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Abstract

Myriad surgical and medical remedies including Extracorporeal Membrane Oxygenation (ECMO) are being employed for acute right ventricle with varying results. Very few cases have been documented in literature regarding the role of VA ECMO for right ventricular failure after open heart surgery. We retrospectively analyzed all cases eliciting VA ECMO for post-operative right heart failure over a period of 24 months. Data was completely delineated for demography, pre-operative patient status at length, brief venipuncture course, indications for VA ECMO and its outcome after institution.

Keywords

Open Heart Surgery, Right Ventricular Failure, VA ECMO

1. Introduction

The significance of right ventricle function in patients undergoing open heart surgery is increasingly being evaluated and getting established over the years. Fulminant RV dysfunction incidence after cardiac surgery is said to be 0.1% but is a harbinger of high morbidity and mortality [1]. Severe RV failure may occur after CABG, valve surgery, adult congenital cardiac surgery, cardiac transplantation and LV assist device implantation. The treatment strategies employed to offset RV failure include optimization of preload and afterload, rhythm control, possible reversal of the etiological factors, prudent inotropy, venoarterial ECMO, RV assist devices, atrial septostomy and cardiac transplant. Extracoporeal membrane oxygenation (ECMO) is a well-documented salvage for cardiac, respiratory and septic shock states [2]. However, limited data is at hands regarding

ECMO use for post cardiotomy isolated right heart failure. We present our analysis of VA-ECMO incorporation as a rescue for refractory RV failure after open heart surgery in our setup. Their hospital stay was analyzed retrospectively.

Case: 1

A 52-year-old male weighing 66.5 kg was referred for surgery with chronic NYHA class III dyspnea. He was diagnosed to have severe rheumatic mitral stenosis, severe aortic regurgitation and severe tricuspid regurgitation with SVD. The pulmonary artery pressure was 90 - 95 mm Hg, EF was 55% with normal biventricular dimensions. Right heart cath was not performed preoperatively. Both aortic and mitral valves were replaced with mechanical prostheses whereas tricuspid valve annuloplasty was done with 50 mm Miniband and LAD was bypassed with LIMA. CPB time was 175 minutes and cross clamp time was 148 minutes. Post bypass TEE showed well-functioning prostheses, good EF but moderately dilated RV with high PAP. He had stable initial post op course in ICU and was extubated the next day. He developed fast unstable AF; was cardioverted and had to be ventilated again. He had a very unstable hemodynamic thereafter and was reopened only to find a poorly contracting RV. He was left open chested and after unsuccessful employment of optimal fluid therapy, nitric oxide and inotropes were eventually placed on central venoarterial ECMO with an aim to rest the RV. While being on ECMO, the platelet count dropped to 25,000 which was treated with platelet replacement. He was weaned off ECMO successfully after four days after creation of a TEE guided fenestrated interatrial patch and ECMO discontinued thereafter in the OR. He was discharged to home eventually with good RV function and a PAP of 40 mm Hg.

Case: 2

A 40-year-old female weighing 64 kg was referred for surgery with longstanding NYHA class III dyspnea. She was diagnosed to have moderate mixed rheumatic mitral valve disease, severe tricuspid regurgitation, PASP 25 mm Hg and normal EF and ventricular dimensions. The patient had undergone PTMC in the remote past. MV commissurotomy with a pericardial patch to PML was performed initially but deemed unsatisfactory on competency testing. Mitral valve replacement with a tissue valve was performed along with TV annuloplasty with a 50 mm Miniband. Patient was weaned off CPB TEE showed a good result. But she was defibrillated thrice for VF during the chest closure. Shortly after arrival to ICU, her hemodynamics became very unstable. TEE showed well-functioning prosthesis but poorly contracting RV. She was reopened, was found to have poor RV contractility. She did not respond well to optimal fluid therapy, nitric oxide and inotropes were placed on central VA-ECMO. She was weaned off ECMO successfully after two days followed by sternal closure. She was discharged to home with Echo showing good left ventricular function but severely reduced RV function and a PAP of 35 mm Hg.

Case: 3

A 40-year-old male, a known hypertensive with compromised renal function was referred for mitral valve surgery. His preop ECHO showed dilated LV di-

mensions with an EF of 40% and PAP of 65 mm Hg and severe tricuspid regurgitation. He had a mitral valve replacement with a tissue valve along with tricuspid annuloplasty. He had labile hemodynamics after CPB. Post op TEE showed severely dilated RV with poor function. After a failed second CPB run patient was hooked to central VA-ECMO. Patient needed mediastinal cleaning once for residual clots. He was successfully detached from ECMO after 4 days followed by sternal closure the next day. He was discharged to home with an EF of 35% with near normal RV.

Case: 4

A 53-year-old female, weighing 83 kg, diabetic and hypertensive was referred for CABG and mitral valve surgery. She had 3VD on coronary angiogram and Echo showed an EF 60%, Moderate MR and PAP 30 mm Hg. She underwent CABG (LIMA+2) along with mitral valve Duran band annuloplasty. CPB time was 144 minutes and cross clamp time was 106 minutes. She was weaned off CPB uneventfully. However, shortly afterwards her BP started dwindling with multifocal arrhythmias which culminated in 2 episodes of VF which were promptly defibrillated. Her RV appeared ballooned with poor contractility. Post op TEE revealed severely dilated RV with poor systolic function. A well-functioning mitral valve was with no comment on PAP. She had an IABP and was transferred to ICU open chested. She had a very unstable course in the ICU despite of optimal fluid therapy, Nitric Oxide and inotropesand was eventually placed on central VA-ECMO. Serial echocardiograms in the meanwhile showed Severe RV dysfunction. Her platelets count drifted to as low as 2000 but without alarming bleeding and was managed with platelets replacement. Her first trial to wean off ECMO was a failure after five days but resulted in success after 24 more hours followed by sternal closure. She had superficial sternal wound infection which was treated well without surgical intervention. She was discharged to home after three weeks with a normal right ventricle on echo. According to the operating surgeon her acute RV dysfunction was a resultant of mismanaged myocardial protection.

2. ECMO Setup

The ECMO circuit consisted of Maquet console with adapter and Rotaflow 32 centrifugal pump with Quadrox PLS hollow fiber coated membrane oxygenator, PLS tubing set and a mechanical gas blender. All patients were placed on central VA-ECMO with right atrial venous drainage and ascending aortic return with no venting. Constant patient/circuit temperature was regulated by Maquet oxygenator heat unit HU 35. All patients were anticoagulated with heparin maintaining an ACT between 160 - 220. However, if the platelets count was less than 100,000 an APTT of 2 - 3 times normal was aimed at.

3. Discussion

Acute right ventricular failure is an infrequent but potentially fatal complication after open heart surgery in adult. Its occurrence has been well established after

surgeries for coronary artery disease, valvular heart disease, adult congenital cardiac corrective procedures, constrictive pericarditis and pulmonary embolism. Optimization of right ventricular preload along with afterload reduction of RV has been the main stay in managing RV failure in these circumstances. Due to a lower level of vascular tone, vasoactive medicines have not been very promising to reduce the afterload due to lower pulmonary vascular tone unlike the systemic circulation. All the same offsetting the conditions that enhance the pulmonary vascular resistance and sane employment of pulmonary vasodilators without causing deleterious systemic effects are still the standard measures to help treat this malady. Failure of these measures may entail judicious use of inotropy to enhance RV contractility. The use of extracorporeal life support is on a constant rise to help patients who have acute RV failure and are pessimistically responsive non surgical steps in addition to addressing the precipitant of RV failure [2]. Mechanical support in patient with fulminant RV dysfunction has been well addressed by using right ventricular assist device (RVAD) and ubiquitously reported [3]. Extracorporeal life support specifically vevovenous (VV) and venoarterial (VA) Extracorporeal membrane oxygenation has been used successfully in patients with RV failure following massive pulmonary embolism, chronic thromboembolic pulmonary hypertension and pulmonary arterial hypertension [4]-[11]. Likewise RVAD utility for RV failure following cardiac surgery is established beyond limits [12]. However, RVAD support in these cases may lead to acceleration of pulmonary hypertension and lung heamorrhage [13]. Moreover, RVAD may not permit increased pulmonary blood flow along with the risk of pressure related lung injury while left sided filling stays low. Whereas, using VA-ECMO will not only decompress the struggling RV, it will decrease the PA pressure along with increase in left sided pressures and facilitate preservation and restoration of end organ functions C [14] [15] [16] [17] [18].

Institution of ECMO has got numerous incurrent complications such as bleeding, infection, organ malperfusion, mechanical failure and coagulopathy. Incidentally we encountered a significant fall in platelets number in two patients entailing platelets replacement. One patient developed superficial sternal wound infection which was handled successfully with serial dressings and appropriate antibiotics.

We opted for VA-ECMO in our patients as VV-ECMO would keep the RV loaded rendering it inadequately rested. Likewise we selected central cannulation for the institution of VA-ECMO for two reasons. It was much easier and quicker to initiate central ECMO in an already split sternum avoiding a new surgical site and its possible complications. Secondly we believe that retrograde ECMO flow may increase the LV afterload potentiating biventricular failure.

4. Limitations

We realize that our study encompasses a small patient group and the data analyzed was a retrospective one.

5. Conclusion

We elucidate the VA-ECMO may be considered as a suitable approach to address post cardiotomy RV failure irrespective of the etiology. This management strategy entails further clinical work up with a view to establish its role in critical post cardiotomy isolated RV failure.

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