Case Report

Extracorporeal Membrane Oxygenation – A Bridge to Life in COVID-19 Complicated Pregnancy

Ramitha Ramachandran, Manjush Karthika[1], Suresh G. Nair

Department of Anesthesiology and Critical Care, Aster Medcity, Kochi, Kerala, India, [1]Department of Health and Medical Sciences, Khawarizmi International College, Abu Dhabi, United Arab Emirates

Abstract

The utility of extracorporeal membrane oxygenation (ECMO) has gained significant attention over the past 25 years. ECMO has revolutionized the management of patients with refractory cardiac and respiratory complications in critically ill patients. We herewith present a case of a 26-year-old pregnant female patient with coronavirus disease-2019 and refractory hypoxemia, who was managed successfully on ECMO.

Keywords: Coronavirus disease-2019, extracorporeal membrane oxygenation, pregnancy

Introduction

Coronavirus disease-2019 (COVID-19) can result in mixed respiratory failure and may require ventilatory and circulatory support.[1] Pregnant patients are categorized as a vulnerable group, where both the mother and newborn are prone to developing secondary complications due to COVID-19.[2] Hormonal variations, altered cardiopulmonary physiology, and immunomodulatory changes during pregnancy increase the chance of developing respiratory infections and may result in severe disease complications.[3,4] Extracorporeal membrane oxygenation (ECMO) is an advanced invasive life support technology used in cardiac, respiratory, or complex cardiorespiratory failure when other conventional treatments fail.[5]

We present the case of a 26-year-old, 31-week pregnant patient with severe COVID-19 complications who was admitted to our hospital and required ECMO support during her hospital stay.

Case Report

A 26-year-old, 31-week pregnant female with no known comorbidities other than gestational diabetes and a clinical history of miscarriage 7 years ago presented to a local hospital with fever. She was tested COVID-19 positive and was admitted immediately, considering her physiological status. In view of progressively worsening respiratory distress, she was shifted to a Government Medical College hospital for step-up care and was initiated on bi-level mode of noninvasive ventilation (NIV). She was also initiated on meropenem, considering her multiple hospital visits and clinical status before sending blood cultures. Hydrocortisone and insulin were also started. As her respiratory status worsened despite NIV support, she was intubated and initiated on invasive ventilation. The patient was then transported to our center for advanced management on the 6th day of the diagnosis of COVID-19.

On arrival at the emergency department, the patient had an oxygen saturation of 80% on inspired oxygen concentration (FiO_2) of 1.0 and positive end-expiratory pressure (PEEP) of 16 cmH2O. A chest X-ray (CXR) showed complete opacification of both the lungs [Figure 1]. Lung ultrasound was done to rule out pleural effusion. An arterial blood gas taken was consistent with mixed respiratory failure and severe hypoxemia (pH: 7.15, PaO_2: 77.9 mmHg, $PaCO_2$: 66.1 mmHg, HCO_3: 22.8 meq/L, lactate: 3.17, and HCO_3: 24.3 mEq/L), with a PaO_2/FiO_2

Access this article online	
Quick Response Code:	**Website:** www.ijrc.in
	DOI: 10.4103/ijrc.ijrc_59_22

Address for correspondence: Dr. Suresh G. Nair, Department of Anaesthesiology and Critical Care, Aster Medcity, Kochi, Kerala, India. E-mail: sureshgnair57@gmail.com

How to cite this article: Ramachandran R, Karthika M, Nair SG. Extracorporeal membrane oxygenation – A bridge to life in COVID-19 complicated pregnancy. Indian J Respir Care 2022;11:270-3.

Received: 17-03-2022 **Revised:** 17-04-2022
Accepted: 24-04-2022 **Published:** 28-07-2022

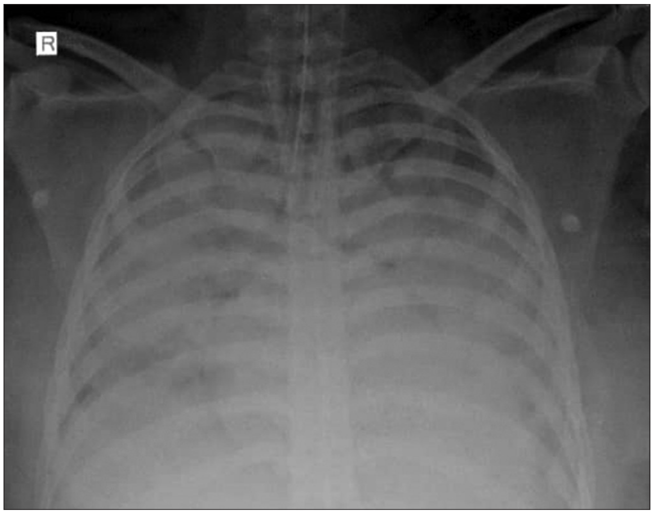

Figure 1: CXR on admission. CXR: Chest X-ray

ratio of 78 and a Murray lung injury score of 4. Her blood chemistry showed neutrophilic leukocytosis, elevated D-dimer (3800 ng/ml), elevated C-reactive protein (242 mg/L), and low hemoglobin (7.6 gm%).

She was moved to the intensive care unit and was attended by a team of multidisciplinary specialists, including critical care professionals, obstetricians, infection control specialists, and anesthesiologists. A central line and an arterial line were placed immediately, and resuscitation measures were initiated. The multidisciplinary team briefed the family members regarding the critical condition, need for emergency cesarean section, and venovenous ECMO (VV-ECMO) requirement. The echocardiogram done before the induction of anesthesia showed good biventricular function and mildly elevated pulmonary artery pressures (pulmonary artery systolic pressure: 25 mmHg). Immediately, after delivery of a live baby girl under general anesthesia, oxytocin was started. The uterus contracted well, and no additional drugs were required. Considering her deteriorating oxygenation status and worsening respiratory mechanics even postdelivery, a decision was made to start the patient on VV-ECMO. She was initiated on ECMO after adequate surgical hemostasis was achieved. A 20F venous cannula was inserted through the right femoral vein with its tip located at the inferior vena cava (IVC) – right atrial (RA) junction. The position was confirmed with transesophageal echocardiography. The venous return cannula was inserted through the right internal jugular vein with the tip positioned at the superior vena cava – RA junction. Unfractionated heparin at a dose of 1 mg/kg was given before insertion of the IVC cannula. VV-ECMO was initiated with a flow of 3.2–3.9 L/min, sweep the gas flow of 4 L/min, and an initial FiO_2 of 1.0.

The ventilator parameters were reduced to a tidal volume (V_T) of 4 ml/kg of ideal body weight (IBW), respiratory rate of 10 breaths/min, and PEEP of 12 cmH2O. The static lung compliance (Cstat) was found to be 15 ml/cmH_2O. Norepinephrine at 0.1 μ/kg/min was also started to optimize the blood pressure. Her oxygen saturation immediately improved on ECMO, and she remained hemodynamically stable. She was continued on meropenem. Remdesivir was started, and methylprednisolone 80 mg infusion over 24 h was started as per the hospital and the state health department protocol.

Her anticoagulation status was managed with fourth hourly activated partial thromboplastin time which was maintained at 1.5 times normal. Viscoelastic testing was done every morning for the first 5 days, and blood products were replaced according to the test results as well as clinical evidence of bleeding. Hemoglobin levels of above 8–9 g/dl were maintained, and there was no significant vaginal or surgical bleeding. Initial albumin level was 2 g/dl, for which human albumin 20% infusion was administered which was stopped on the 2nd postoperative day (POD) when the levels improved to 3.3 g/dl. Daily sedation breaks were given, and Glasgow Coma Scale was assessed to rule out any neurological deficits. CXRs on the following days showed objective improvement. The patient was started on enteral nutrition by the 2nd POD, once the lactate started dropping below 5 mmol/L. An initial caloric intake of 700 kcal/day was gradually increased to 1200–1400 kcal/day with 80–100 g of protein. The patient had a new onset of fever for which blood cultures were sent which were reported negative. A bronchoalveolar lavage taken grew acinetobacter, for which polymyxin B was added. By the 5th POD of ECMO, there was a significant improvement in the oxygenation status, and the FiO_2 on the ECMO and the ventilator were reduced to 0.6 and 0.5, respectively [Table 1]. The sweep gas flow rate was maintained between 4 and 5 L/min according to the PaCO2 levels. A negative fluid balance was maintained with continuous furosemide infusion, and blood sugar levels were maintained below 150 mg%. Anticipating the need for prolonged mechanical ventilation, percutaneous tracheostomy was done on POD 7, when the FiO_2 was 0.4 on ECMO and on the ventilator [Table 1]. The sweep gas flow rate was gradually reduced, and ventilator settings were increased to maintain adequate oxygenation and ventilation. On the 8th day of ECMO, she was completely weaned off from the ECMO support and was de-cannulated without any complications. CXR showed marked improvement [Figure 2] and Cstat improved to 25 ml/cmH2O. She was continued on tracheostomy ventilation and was gradually weaned off to pressure support ventilation and then to oxygen via T-piece. Her vasopressors were stopped on POD 2, antibiotics were stopped on the 10th POD, remdesivir after 5 days, and the steroids were tapered after 4 days. She was initiated on chest physiotherapy and incentive spirometry through a tracheostomy tube. The conventional incentive spirometer was modified by attaching a partially cut 10 ml syringe as an adaptor to suit the tracheostomy tube adaptor. On the 13th day of admission, the tracheostomy tube was decannulated and she was shifted out of the ICU to the step-down unit. The patient was discharged on the 20th day of hospital admission and a CXR taken on the day of discharge showed normal lung fields [Figure 3].

Table 1: Trend of arterial blood gas values

	pH	paO_2	pCO_2	HCO_3	*P/F* ratio	Lactate
5th day of ECMO	7.45	74	54	37	123	2.3
1st day of tracheostomy (POD 7)	7.45	74	50	34	185	1.3
On the day of ECMO Decannulation	7.46	84	42	29	210	1.6

ECMO: Extracorporeal membrane oxygenation, POD: Postoperative day

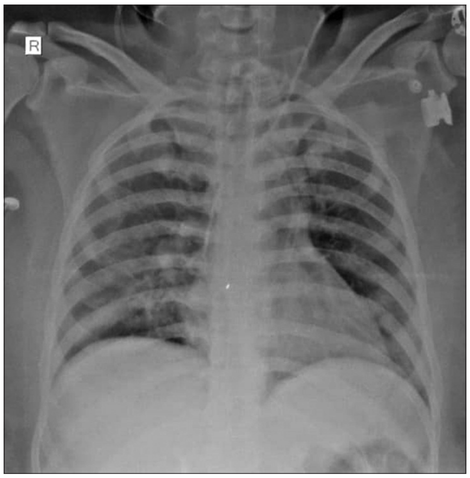

Figure 2: CXR before the decannulation from ECMO. CXR: Chest X-ray, ECMO: Extracorporeal membrane oxygenation

Figure 3: CXR on discharge. CXR: Chest X-ray

Discussion

Acute respiratory distress in the obstetrical population due to COVID-19 is not common. In one of the reviews published, only 6380/400,066 (1.6%) pregnant patients admitted for delivery developed COVID-19, and only 86 of them required ventilator support.[6] Some of the physiological changes in pregnancy include elevated diaphragm, decreased total lung capacity, functional residual capacity, lung compliance, and increased minute ventilation; and these changes make them more susceptible to hypoxemia. Managing acute respiratory distress syndrome (ARDS) in pregnant patients is not significantly different from that of nonpregnant patients, focusing on lung-protective ventilation with a low V_T of 4–8 mL/kg IBW, plateau pressure <30 cmH2O, and appropriate PEEP.[7,8] As per the current guidelines from the Society for Maternal-Fetal Medicine, improved lung mechanics by early childbirth is theoretic, and remain unclear whether early delivery offers any significant improvement.[9] Hence, it is suggested that the decision of labor must be as per the individual cases, based on the maternal and gestational age and the fetal status. Some of the considerable indications for induced delivery include cardiopulmonary derangements, worsened ARDS, and barotrauma.[10,11] Our patient was in severe respiratory failure during admission and was not responding to conventional management. She had a poor oxygenation index with PaO2/FiO_2 ratio relating to severe ARDS, blood gas values consistent with mixed respiratory failure, and a Murray lung injury score of 4. The indication for delivery here was maternal decompensation with poor oxygenation status due to severe ARDS. We also decided to place the patient directly on ECMO after the cesarean section considering her poor pulmonary status, rather than take a wait-and-watch approach.

In ARDS patients, ECMO facilitates gas exchange and alleviates ventilator-induced lung injury.[12] In pregnant ARDS patients complicated by COVID-19, who fail the conventional treatment, ECMO is indicated to facilitate the cardiopulmonary function, and it acts as a bridge until the life-threatening issues are resolved.[13]

ECMO is considered in pregnant patients after balancing risk–benefit ratio related to the outcome of both the mother and fetus.[2] In our case, the 31 weeks of gestational age was supporting the decision to plan for an emergency cesarean section, and activation of ECMO to support the mother. The survival rate of newborns at 29 weeks of gestational age has been reported as high as 98%,[14] as was in our case. Literature from China reported bleeding and infection as the leading cause of death in COVID-19 patients treated with ECMO.[15] Regular viscoelastic testing (ROTEM, Instrumentation laboratory, Massachusetts, United States) for coagulation abnormalities and correction with appropriate coagulation factors resulted in no major bleeding issues in our patient.

ECMO patients are recommended for early ambulation unless there are contraindications, including unstable cardiac or pulmonary status, increased vasopressors in the past 12 h, or chugging on the ECMO circuit. Mobilization is possible even on low dose of inotropic support.[16] However, safety is of the primary concern for ECMO patients and team effort matters during the mobilization. In our case, the perfusionist/respiratory therapist was primarily responsible for the ECMO system, the respiratory therapist was in charge of the airway and ventilation, and the nurse took care of all the lines, drains, and monitors of the patient, and the whole activity was under the close supervision of an intensivist.

Tracheostomy was de-cannulated only after complete recovery of lung function (13th day of admission). After 20 days of hospital stay, our patient was discharged without any impairment of functional ability.

Although there are no sufficient guidelines regarding the use of ECMO in pregnancy or postpartum, many observational and anecdotal reports indicated that ECMO is useful in pregnant patients with severe respiratory distress secondary to COVID-19. Our case adds to the multiple reports of successful outcomes in pregnant patients with cardiorespiratory complications.[17,18]

Conclusion

Our case report is an example of the utility of ECMO in COVID-19 complicated ARDS in a pregnant patient. As COVID-19 continues to affect thousands of patients worldwide, and regardless of the limited evidence and literature, pregnancy should not be considered a contraindication for ECMO support if other measures fail.

Declaration of patient consent

The authors certify that they have obtained consent from the patient and family. In the consent form, the patient has given her consent for the images and other clinical information to be reported in the journal. The patient understands that her name and initials will not be published and due efforts will be made to conceal her identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Quintero A, Vinck EE, Pérez LE, Escobar JJ, Rendón JC, Uribe JD. Extracorporeal membrane oxygenation and emergency C-section for a pregnant COVID-19 positive patient. Perfusion. 2021:2676591211049769.
2. Rushakoff JA, Polyak A, Caron J, Parrinella K, Salabat R, Wong M, *et al.* A case of a pregnant patient with COVID-19 infection treated with emergency c-section and extracorporeal membrane oxygenation. J Card Surg 2021;36:2982-5.
3. Chen YH, Keller J, Wang IT, Lin CC, Lin HC. Pneumonia and pregnancy outcomes: A nationwide population-based study. Am J Obstet Gynecol 2012;207:288.e1-7.
4. Center for Disease Control and Prevention (CDC): Data on COVID-19 during pregnancy. 2020. Available at https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/special-popula-tions/pregnancy-data-on-covid-19.html. [Last accessed on 2022 Feb 14].
5. Barrantes JH, Ortoleva J, O'Neil ER, Suarez EE, Beth Larson S, Rali AS, *et al.* Successful treatment of pregnant and postpartum women with severe COVID-19 associated acute respiratory distress syndrome with extracorporeal membrane oxygenation. ASAIO J 2021;67:132-6.
6. Jering KS, Claggett BL, Cunningham JW, Rosenthal N, Vardeny O, Greene MF, *et al.* Clinical characteristics and outcomes of hospitalized women giving birth with and without COVID-19. JAMA Intern Med 2021;181:714-7.
7. Campbell LA, Klocke RA. Implications for the pregnant patient. Am J Respir Crit Care Med 2001;163:1051-4.
8. Fan E, Del Sorbo L, Goligher EC, Hodgson CL, Munshi L Walkey AJ, *et al.* An official ATS/ESICM/SCCM clinical practice guideline: Mechanical ventilation in adult patients with acute respiratory distress syndrome. Am J Respir Crit Care Med 2017;195:1253-63.
9. Society for Maternal-Fetal Medicine. Management Considerations for Pregnant Patients with COVID-19. https://www.smfm.org/covidclinical. [Last accessed on 2022 Feb 12].
10. Stephens AJ, Barton JR, Bentum NA, Blackwell SC, Sibai BM. General Guidelines in the management of an obstetrical patient on the labor and delivery unit during the COVID-19 Pandemic. Am J Perinatol 2020;37:829-36.
11. Schnettler WT, Al Ahwel Y, Suhag A. Severe acute respiratory distress syndrome in coronavirus disease 2019-infected pregnancy: Obstetric and intensive care considerations. Am J Obstet Gynecol MFM 2020;2:100120.
12. Australia and New Zealand Extracorporeal Membrane Oxygenation (ANZ ECMO) Influenza Investigators, Davies A, Jones D, Bailey M, Beca J, Bellomo R, *et al.* Extracorporeal Membrane Oxygenation for 2009 Influenza A (H1N1) Acute Respiratory Distress Syndrome. JAMA 2009;302:1888-95.
13. Hou L, Li M, Guo K, Wang W, Li B, Li J, *et al.* First successful treatment of a COVID-19 pregnant woman with severe ARDS by combining early mechanical ventilation and ECMO. Heart Lung 2021;50:33-6.
14. Hornik CP, Sherwood AL, Cotten CM, Laughon MM, Clark RH, Smith PB. "Daily mortality of infants born at less than 30 weeks' gestation." Early Hum Dev 2016;96:27-30.
15. Henry BM, Lippi G. Poor survival with extracorporeal membrane oxygenation in acute respiratory distress syndrome (ARDS) due to coronavirus disease 2019 (COVID-19): Pooled analysis of early reports. J Crit Care 2020;58:27-8.
16. Rickelmann C, Knoblauch DJ. Incorporating safe patient-handling techniques to mobilize our most complex patients on extra corporeal membrane oxygenation. Crit Care Nurs Q 2018;41:272-81.
17. Moore SA, Dietl CA, Coleman DM. Extracorporeal life support during pregnancy. J Thorac Cardiovasc Surg 2016;151:1154-60.
18. Naoum EE, Chalupka A, Haft J, MacEachern M, Vandeven CJM, Easter SR, *et al.* Extracorporeal life support in pregnancy: A systematic review. J Am Heart Assoc 2020;9:e016072.