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CASE REPORT

Cesarean Delivery in Extracorporeal Membrane Oxygenation Dependent COVID-19 Parturients: A Case Report

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Abbreviations

ARDS: Acute Respiratory Distress Syndrome; BIS: Bispectral Index; ECMO: Extracorporeal Membrane Oxygenation; FFP: Fresh Frozen Plasma; HD: Hospital Day; ICU: Intensive Care Unit; MTP: Massive Transfusion Protocol; POD: Postoperative Days; Prbcs: Packed Red Blood Cells; VV: Venovenous

Introduction

Obstetric patients have risk factors for severe COVID-19 disease, including obesity, hypertension, and diabetes [1]. Pregnant patients are more likely to be hospitalized, admitted to the intensive care unit (ICU), experience acute respiratory distress syndrome (ARDS), and require invasive ventilation and extracorporeal membrane oxygenation (ECMO) [1,2]. The use of ECMO in pregnant patients with COVID-19-associated respiratory failure offered an option for managing the severe disease-data to optimize timing and method of delivery while on ECMO is limited.

This case report describes two cases of unvaccinated pregnant patients with COVID-19 who progressed to ARDS requiring Venovenous (VV)-ECMO and successfully underwent cesarean delivery. The patients provided Health Insurance Portability and Accountability Act authorization and consent to publish these reports. This article conforms to case report (CARE) guidelines.

Case Description

Patient A

Patient A was an unvaccinated 31-year-old G5P2A2 at 26 weeks gestation, presenting complaints of worsening fatigue, myalgia, cough, fever, and a positive diagnosis of COVID-19. Her medical history included obesity, abdominoplasty, and B cell lymphoma in her right leg with tumor resection and chemotherapy. The previous presentation to the emergency department resulted in a COVID-19 diagnosis, and discharged home after symptomatic relief.

Vital signs on admission were notable for tachycardia, tachypnea, and hypoxia. She was anxious and complained of air hunger but had an unremarkable lung exam. Bilateral ground glass opacities were evident on the chest X-ray. Fetal heart rate was normal. She was admitted to the medical intensive care unit, given signs of respiratory decompensation, and was administered dexamethasone and tocilizumab. On hospital day (HD) 5, she was intubated for increased work of breathing not improved by inhaled nitric oxide. She was treated with cefepime for superimposed Klebsiella pneumonia and intermittently required vasopressors to maintain hemodynamic stability. The maternal-fetal medicine team reviewed daily non-stress tests. On HD 15, the patient underwent VV-ECMO cannulation due to

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continued hypoxic and hypercapnic respiratory failure not improved by prone positioning. Oxygen saturation improved after ECMO cannulation, allowing weaning of ventilation settings and nitric oxide. Unfractionated heparin infusion was initiated with goal anti-Xa levels of 0.3-0.7 IU/mL. On hospital day 19, anticoagulation was discontinued after the onset of hematuria.

At 30 weeks and five days gestation, HD 33, she underwent a primary cesarean delivery for ARDS secondary to severe COVID pneumonia with concern for continued respiratory decompensation while ECMO dependent. The patient was transported to the operating room with the ICU ventilator and ECMO circuit. She was sedated en route with a propofol infusion, a midazolam infusion, and a hydromorphone infusion. She was maintained on the ICU ventilator. Intraoperatively, hemodynamics were monitored via arterial and central venous catheters. Intensive care unit (ICU) ventilator and settings were utilized, and the ECMO team made ECMO adjustments. ICU infusions of propofol, midazolam, and hydromorphone were continued to maintain general anesthesia and supplemented with ketamine and lorazepam boluses. The propofol infusion rate was increased to 150 mcg/kg/min, and she received cisatracurium for paralysis. Anesthetic gases were not used. A bispectral index (BIS) monitor was used to titrate the anesthesia depth. Cesarean delivery produced a live born 1580g female fetus, Apgar's three and five at one and five minutes, respectively. Ten units of oxytocin were given intramuscularly for uterine tone and to limit fluid administration.

Persistent oozing and coagulopathy were noted during surgery, and the patient became hypotensive, and a mass transfusion protocol (MTP) was initiated. Resuscitation included four packed red blood cells (pRBCs) and three fresh frozen plasma (FFP) units. Due to persistent bleeding, cryoprecipitate was transfused. ROTEM results confirmed that the patient was appropriately resuscitated. After hysterotomy closure, assurance of surgical hemostasis, and completion of the case, the patient was paralyzed for transport to the ICU. Blood loss was estimated to be 1500 mL due to hysterotomy and coagulopathy. No surgical complications were noted. ECMO adjustments are summarized in Table 1.

On postoperative day (POD) 1, she was noted to have abdominal distension and hypotension with bedside ultrasound showing hemoperitoneum. Due to uterine serosal bleeding, she returned to the operating room to evacuate an estimated 3-liter hemoperitoneum. Massive transfusion protocol was activated, and she received four units of pRBCs, five units of FFP, one unit of platelets, one unit of cryoprecipitate, and vasopressor support. Uterine serosal, abdominal wall, and rectus muscle bleeding were identified. Her abdomen was left open with a laparotomy drain while she recovered in the ICU. She returned to the operating room for abdominal washout procedures and wound vacuum replacements. On POD 10, patient A underwent bedside tracheostomy for prolonged intubation. She was decannulated from VV-ECMO on HD 56. She successfully transitioned to a trach collar and was decannulated from tracheostomy on HD 57. On POD 53, HD 85, she underwent a left anterior thigh skin graft placement to her mid-abdominal wound. On HD 91, she was discharged home.

Patient B

Patient B was a 30-year-old G2P1A0, at 24 weeks gestation, admitted for severe COVID-19, presenting with cough, fevers, and chills. She left the hospital against medical advice two days after admission but returned several hours later with worsening symptoms. Her medical history included a prior preterm cesarean delivery for severe preeclampsia, class III obesity, and post-traumatic stress disorder (PTSD). She was tachycardic, tachypneic, and hypoxic on admission, with patchy pulmonary opacities on a chest X-ray. She was given dexamethasone, remdesivir, ceftriaxone, and azithromycin for superimposed bacterial pneumonia, nitrofurantoin for cystitis, and transferred to the ICU for acute hypoxic respiratory failure. Daily fetal surveillance was deferred, given extreme prematurity. On HD 4, she was intubated for worsening hypoxemia despite inhaled nitric oxide. On HD 7, VV-ECMO was initiated with improved PaO_2 (Table 1). An unfractionated heparin infusion was started. Anticoagulation was discontinued on HD 32 due to rectal bleeding requiring endoscopic clipping. On HD 41, she underwent a bedside tracheostomy for prolonged intubation and experienced nasal and oropharyngeal bleeding two days later.

At 30 weeks gestation, she was diagnosed with severe preeclampsia for worsening transaminitis and new refractory hypertension. Repeat cesarean delivery

Table 1: ECMO settings.

	Patient A	Patient B
Initial Settings		
Flow	3.87 LPM	5.3 LPM
Speed	2800 RPM	3600 RPM
Sweep	2.5	4
FdO_2	100%	100%
Pre-Operative		
Flow	5.65 LPM	4.95 LPM
Speed	3750 RPM	3600 RPM
Sweep	10.5	10
FdO_2	100%	100%
Post-Operative		
Flow	6.4 LPM	5.75 LPM
Speed	5100 RPM	4100 RPM
Sweep	7	13
FdO_2	100%	100%

was performed. The patient was transported to the operating room with the ICU ventilator and ECMO circuit. She was sedated on a propofol infusion, a hydromorphone infusion, and a continued magnesium sulfate infusion. General anesthesia was initiated by increasing her propofol infusion to 150 mcg/kg/min, and she was paralyzed with rocuronium. She was maintained on the ICU ventilator. Anesthetic gases were not used. A BIS monitor was used to monitor the depth of anesthesia. Cesarean delivery produced a live born 1360g female fetus, Apgar's five and seven at one and five minutes, respectively. The patient received five units of pRBCs, three units of FFP, and one unit of platelets in the operating room. The estimated blood loss was 1500 mL due to coagulopathy. No surgical complications were noted. The patient was transferred to the ICU. ECMO adjustments are summarized in Table 1.

On POD 1, the ECMO team noted difficulty achieving flows. Given the evidence of hemodynamic instability, she returned to the operating room to evacuate an estimated 5 L hemoperitoneum. MTP was initiated with the total administration of eight units of pRBCs, four units of FFP, two units of platelets, and 1 unit of cryoprecipitate. Vesicouterine fold bleeding was identified. Her abdomen was packed, and she returned to the ICU. She made subsequent trips to the operating room for intra-abdominal washouts and wound vacuum placements. On HD 51, she was decannulated from VV-ECMO.

On HD 59, Patient B developed generalized seizures. Neurological imaging showed a right frontal cortical subarachnoid hemorrhage without a structural lesion. She was started on antiepileptic medication. Patient B developed benzodiazepine and dexmedetomidine withdrawal symptoms due to long-term infusions. After placement on benzodiazepine and clonidine taper, escitalopram and psychotherapy were started for post-traumatic stress disorder. The patient was decannulated from tracheostomy and started inpatient rehabilitation. Patient B and her newborn were discharged home on HD 99.

Conclusions

We describe the deliveries of two patients on the same day with ARDS and respiratory failure requiring ECMO by the same team of surgeons, anesthesiologists, and critical care specialists with successful outcomes. Care of these complex patients requires a multidisciplinary team.

Intraoperative anesthesia management involves consideration of preoperative medical and hemodynamic status, surgical blood loss, coagulopathy, and obstetric complications. Intravenous anesthetics helped maintain hemodynamic stability, which is critical in the setting of an ECMO-dependent patient undergoing surgery. Despite the increased diffusion distance for gas exchange due to inflammation and edema from ARDS, volatile anesthetics have superior diffusion properties because of their lipophilicity and result in less agitation and earlier extubation than intravenous anesthetics [3,4]. The worsening clinical status and the attempt to keep the patients stable for surgery led to the decision to use the ICU ventilator and intravenous agents. Both patients received a tracheostomy. This corroborates with other COVID-19 case series to improve pulmonary dynamics and reduce sedation requirements [5].

Both patients experienced anxiety from being diagnosed with COVID-19, the repercussions of this disease, and separation from their newborns. Psychiatric and psychology teams provided individual psychotherapy sessions and encouraged group sessions with other survivors of COVID-19 and antidepressant medications.

The patients and fetuses tolerated ECMO support during pregnancy, suggesting that pregnancy should not be considered a contraindication to cannulation and initiation of ECMO [6]. ECMO-associated coagulopathy can occur even without chemoprophylactic or therapeutic anticoagulation, which has particular implications for pregnant and postpartum patients [6-8]. There are no current guidelines explicitly addressing the prevention of coagulopathy and bleeding complications in pregnancy and operative delivery for ECMO patients [9]. While there are limited case reports justifying the best practice for anesthetic administration during cesarean delivery while on ECMO, the success of these two cases may provide additional information for anesthesiologists in the future. Further studies with larger sample sizes and longer follow-ups are needed to establish best practices in these patients.

ECMO-induced coagulopathy resulting in bleeding was the major complication for both patients despite discontinuing anticoagulation before surgery. Coagulopathy was highlighted in the previous case reports [4-6]. Close surveillance of the surgical site, and the ECMO machine are vital in promptly recognizing internal hemorrhage. Preterm delivery and NICU admission remain the most common neonatal complications, consistent with our cases [8].

Financial Disclosures

None.

Conflicts of Interest

None.

Authors Contribution

Sannoor S Syed: This author helped review the literature, plan and manage the cases, and draft and revise the manuscript; Abigail O Souryal: This author helped review the literature, manage the cases, and draft and edit the manuscript; Emily H Adhikari: This

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