

Anesthesia management in a post Covid-19 obstetric patient-What we need to know

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Abstract

The outbreak of the coronavirus disease (COVID)-19 pandemic has led to unprecedented challenges globally. At the outset of the receding second wave and third wave of COVID-19, many patients who have recovered from the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) are coming for elective/emergency surgery. This demands a noteworthy emphasis on the post-COVID-19 obstetric patients. The administration of quality and safe obstetric anesthesia are quite challenging in this mentioned subset due to the overlap of signs and symptoms of COVID-19 with the constitutional signs and symptoms of pregnancy. The physiological changes in normal pregnancy and vascular, metabolic alterations in high-risk pregnancy may affect or exacerbate the pathogenesis or clinical presentation of COVID-19, respectively. This article highlights the specific concerns in recovered COVID-19 pregnant patients with associated comorbidity posted for surgery and their repercussions on anesthesia management.

Keywords: Anesthesia, neonate, obstetric, post-COVID, pregnancy, SARS-CoV-2

Introduction

The severe acute respiratory syndrome coronavirus (SARS-CoV)-2 pandemic has presented unprecedented challenges globally.^[1] The viral infection presents with a constellation of symptoms varying from a mild flu-like illness to life-threatening pneumonia picture. No age group is immune to this deadly infection. Furthermore, as the pandemic is raging on, there is a shift of paradigm from the existing scenario of coronavirus disease (COVID)-19, as more patients are COVID-19 “recovered”. Globally, 210 million women become pregnant every year and give birth to 130 million

babies. Obstetric patients are specifically vulnerable to severe pneumonia due to alteration in the immune and physiological response; increased oxygen consumption, decreased functional residual capacity (FRC), decreased chest compliance, and altered T-lymphocyte immunity, overall contribute to increased maternal mortality and morbidity.^[2] Noteworthy, pregnancy is a state of partial immune response which makes this particular cohort prone to viral infection. Therefore, post-COVID-19 pregnant patients may have a serious post-viral sequel. Nevertheless, it has been reported that age and other underlying medical conditions can increase the severity of the COVID-19 illness both during and for 42 days following delivery.^[3] The post-COVID-19 era has given birth to various

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myths and fallacies regarding medical, surgical, and obstetrical procedures. In the coming time, we may rendezvous with a large number of post-COVID obstetric patients requiring operative interventions. Anesthesia concerns in this vulnerable cohort will be challenging compared to non-COVID obstetric patients. At present, there exist no concrete guidelines for the anesthetic management of this subset although a few suggested guidelines and advisories are available. The current clinical evidence suggests that pregnant patients with COVID-19 infection having associated pneumonia have an increased menace of obstetric complications; cesarean section, premature rupture of membranes, preeclampsia, and preterm labor.^[4,5] The World Health Organization (WHO) has also stated that pregnant patient with pre-existing comorbidities including obesity, diabetes, heart disease, and hypertension may have the additional risk of developing severe COVID-19.^[6] Thus, obstetric anesthesiologists may encounter recovered COVID-positive patients for elective/emergency surgical procedures that may pose unique unaccustomed challenges. The present review aims to increase the insight into peri-intraoperative anesthesia concerns, the effect of post-viral infection on different organs in pregnancy, the associated comorbidities, and postoperative management of post-COVID-19 patients.

Methodology

Keeping this research question in mind, we did a literature search using the keywords COVID-19, SARS-CoV2, SARS-CoV-1, pregnancy, obstetric, neonate, anesthesia management, and related terms in the medical databases including Google Scholar, MedARXiv, PubMed, Cochrane, and Web of Science. In addition to these, references were spotted through a manual search of bibliographies and via the citations in the articles. Specific concerns in recovered COVID-19 pregnant patients and the associated comorbidity posted for surgery, and their repercussions on anesthesia management are discussed extensively in this review.

Pathophysiology of COVID-19 and its implications in pregnancy

COVID-19 is a single-stranded capsulated ribonucleic acid (RNA) virus.^[7] The immunological response to COVID-19 depends on the function of the immune system.^[7] The modulations in immune response to allow growth of the allogeneic fetus during pregnancy may result in an altered immune response to infection.^[8,9] SARS-CoV-2 enters the body and infects the respiratory system mainly via two mechanisms. First, there is a direct attachment of the angiotensin-converting enzyme 2 (ACE2) to spike protein and release of the nucleocapsid protein and viral

genome into the cell cytoplasm of the host.^[10] Second, the alternative avenue is the direct plasma membrane route through transmembrane serine protease 2 (TMPRSS2), causing proteolytic cleavage of the spike protein and fusion with the cell membrane.^[11] During pregnancy, there is upregulation of ACE 2 and renin-angiotensin-aldosterone system (RAAS). Furthermore, this normal hormonal profile in pregnancy favors SARS-CoV-2 entry, and raises the possibility of the increased risk of the pregnant patient acquiring this infection. The viral binding to ACE2 causes its downregulation and un-proportionate increase in angiotensin-2 (Ang) relative to Ang (1-7), thereby, aiding vasoconstriction, preeclampsia, preterm labor, and fetal growth retardation [Figure 1].^[12,13]

The interplay of post-COVID-19 infection on physiological changes in pregnancy and its effects on different organs

Normal physiological alterations in pregnancy are considered essential for the development of the fetus, to increase the metabolic demand of the body, and for childbirth. These amendments start from the first trimester to labor, peak at term and return to the pre-pregnancy level after delivery in the postpartum period.^[14] Although these changes are well tolerated in a normal healthy pregnant patient, these can be magnified in the presence of COVID-19-related pathophysiological changes. Comprehensive knowledge of the physiological changes concerning post-COVID-19 infection is considered crucial for the successful management of obstetric patients. This conceptual understanding will further assist the anesthesiologists to tailor the anesthetic technique to manage the post-COVID-19 patients and critically ill pregnant patients with comorbidity.

Respiratory system

Recent evidence has revealed that the lung is the most affected organ in COVID-19, and its pathogenesis includes

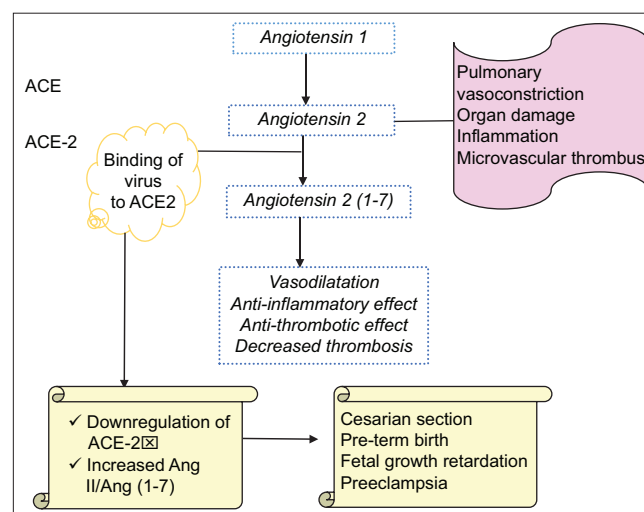


Figure 1: Pathophysiology of COVID-19 and its implication on pregnancy

capillary disruption, hyaline membrane formation, alveolar proliferation (fibrous), alveolar epithelium disruption, and pulmonary consolidation.^[15,16]

Furthermore, pregnancy is a restrictive lung disease and various studies have inferred damaged lung in the post-COVID-19 recovered patient from SARS-CoV-2 pneumonia, leading to a restrictive lung pattern persisting up to 6 weeks post-recovery, thereby, causing an exponentially increased risk of life-threatening comorbidities.^[17,18] The diffusing capacity for carbon monoxide (D_{LCO}) was the most common abnormality followed by impaired total lung capacity (TLC), ranging from 15.5 to 43.6% and 5.2 to 10.9%, respectively, and a decline in the 6-min walk distance (6-MWD), indicating impaired intra-alveolar diffusion capacity.^[19-21] Furthermore, forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1), TLC, increased ratio of FEV1/FVC, and DLCO were significantly lower in the patients after severe/critical COVID-19 [Table 1].^[22]

In conclusion, impaired respiratory muscle strength, decreased diffusion capacity, lung imaging abnormalities, decreased FRC, and decreased ability to clear pulmonary secretions postoperatively can be found in COVID-19 recovered patients.^[23] Despite adequate preoxygenation, increased oxygen consumption and decreased FRC may lead to rapid desaturation during apnea.^[24] Apart from the post-viral residual component, there can be an exacerbation of pre-existing pulmonary complications, thereby, necessitating preoperative optimization and a thorough evaluation. As per a recent recommendation, a 6-week respiratory rehabilitation can improve lung functions effectively.^[25]

Cardiovascular system (CVS)

A high prevalence of cardiovascular disease has been observed in COVID-19 illness.^[26] Takotsubo cardiomyopathy, a stress-induced secondary cardiomyopathy, is common in COVID-19 due to pneumonia.^[27] Perioperative complications may occur due to increased cardiac demand, decreased systemic oxygenation due to pneumonia, and concurrent electrolyte imbalance or immune dysregulation. Factors enhancing the imbalance between the myocardial oxygen demand (hypoxia, hypercarbia, hyperglycemia, and acidosis) should be avoided intraoperatively.

Alteration in the aortocaval compression compensatory mechanism may be observed in post-SARS-CoV-2 infection due to variation in the renin-angiotensin system to maintain blood pressure in the supine position, which may result in supine hypotension syndrome characterized by pallor, transient tachycardia followed by bradycardia, sweating, hypotension, and malaise.^[28,29] Therefore, the pregnant patient should

be preferably placed laterally with a wedge under the right buttock.

There is shortness of breath in 18% of the COVID-19 recovered patients.^[30] Moreover, there also exists physiological dyspnea due to increased maternal oxygen requirement, fetal oxygen consumption, and gestational anemia. Therefore, it should be distinguished from pathological breathlessness.^[31] There can be other related changes in the CVS in post-COVID-19 pregnant patients [Table 2].

Immune response

- The modulations in maternal immune response favor T-helper 2 (Th-2; anti-inflammatory, interleukin (IL)-4,10,13, and transforming growth factor- β (TGF- β) than Th-1 (proinflammatory,

Table 1: Alteration of physiological changes in normal pregnancy in the post-COVID-19 pregnant patient

Parameter	Change in normal Pregnancy	Alteration in post-COVID Pregnant patient
ERV	Decreased	Decreased
FRC	Decreased	Decreased
VC	No change	Decreased
TLC	Decreased	Decreased
FEV ₁	No change	Decreased
FEV ₁ /FVC	No change	Increased
IRV	Increased	Decreased
IC	Increased	Decreased
DLCO	Increased	Decreased

ERV: Expiratory reserve volume, FEV1: Forced expiratory volume in 1 s; FVC: Forced vital capacity; TLC: Total lung capacity, FRC: Functional residual capacity, VC: Vital capacity, IRV: Inspiratory reserve volume, IC: Inspiratory capacity, DLCO: Diffusing capacity of the lung for carbon monoxide

Table 2: Cardiovascular post-COVID-19 manifestations

Post-COVID-19 Cardiovascular manifestations	Normal Physiological Cardiovascular manifestations in an obstetric patient
Asymptomatic cardiac arrhythmias	Sinus tachycardia
Increased risk of left ventricular diastolic/systolic dysfunction	Non-sustained arrhythmia, palpitations, and missed beats
Pulmonary arterial hypertension, heart failure, fresh myocardial infarction	Increased stroke volume (20-30%)
Arrhythmias, including premature ventricular complexes, ventricular tachyarrhythmias, and atrial fibrillation due to healing myocarditis and myocardial fibrosis	Increased cardiac output and heart rate (15-25%)
Inappropriate sinus tachycardia or bradycardia	Increased blood volume (20%)
Elevated serum cardiac troponin levels	Wide pulse pressure
Abnormalities in cardiac imaging	Reduced mean arterial pressure, leading to sodium and water retention and increased plasma volume (40-50%)
	Increased left ventricular end-diastolic volume
	Increased ejection fraction
	Elevated serum cardiac troponin levels in hypertension and preeclampsia
	The cardiac silhouette may appear more "horizontal"

microbicidal, interferon- γ (IFN- γ), IL-1 α , IL-1 β , IL-6, and IL-12).^[32]

- The COVID-19 patients have both Th-1 and Th-2 activation; IFN- γ , IL- β , IL-4,10, and predominantly IL-6, and overall contribute to high mortality.^[33,34]
- Although there is a dearth of data on the immune response of SARS-CoV-2 in pregnant patients, the available evidence suggests that overall, pregnancy increases the risk of infection and mortality compared to non-pregnant patients.^[35]
- It is imperative to know the timing of acquiring the COVID-19 infection. The first and third trimesters are considered proinflammatory. Noteworthy, the SARS-CoV-2 infection acquired during this time has an exaggerated response to the virus, and thus, the patient may land up in a cytokine storm, thus, increasing the morbidity and mortality in the parturient.^[36]
- Clinical evidence has suggested that post-COVID-19 parturients with mild residual symptoms may need intensive care unit admission for respiratory symptoms.^[37,38]
- Lastly, there is a high level of stress and inflammation at the level of labor, further enhancing the poor outcome in post-COVID-19 recovered patients.^[39]

Thrombo-embolic phenomenon

The net result of the post-COVID-19 changes and physiological changes in pregnancy is a hypercoagulable state [Table 3].^[23]

Endocrine system

SARS-CoV-2 enters the pancreas through the ACE2 receptors expressed in the endocrine pancreas. About 51% of the post-COVID-19 recovered patients may develop new-onset diabetes with no history of diabetes or receiving any steroid treatment during the illness.^[40] Overall, metabolic and hormonal perturbations caused by the involvement of the pancreas, thyroid, and adrenal gland have been noted. The post-COVID-19 trajectory consists of mainly primary hypothyroidism, hypothalamic-pituitary-adrenal axis damage, hypocortisolism, and secondary hypothyroidism.^[23]

Table 3: Comparison of coagulation changes between the post-COVID pregnant patient and normal pregnancy

Changes in post-COVID pregnant patient	Changes in normal pregnancy
Hypercoagulable state	Hypercoagulable state
Thrombotic events	Increased risk of the thrombo-embolic phenomenon
Mild thrombocytopenia	Mild thrombocytopenia
Prolongation of prothrombin time (PT), International normalized ratio (INR), and Thrombin time (TT)	Shortened PT INR normal or slight decrease Shortened TT
Decreased activated partial thromboplastin time (aPTT).	No change or slight decrease aPTT
Increased D-dimer	Increased D-dimer (up to 400%)

Neurological system

Cerebrovascular accidents are common neurological sequelae in post-COVID-19 patients. There can be a residual neuromuscular weakness, or headache (2–3% post-COVID), that may lead to an excruciating spinal headache. Critical illness myopathy, fatigue, and muscle weakness can be observed in the recovering parturient and should be considered before employing regional anesthesia and perioperative risk stratification.

Renal system

Acute kidney injury (AKI) after SARS-CoV-2 infection has proved to be an important risk factor for predicting mortality in critically ill patients. Due to AKI, approximately 35% of the patients recovered from SARS-CoV-2 may have a decreased glomerular filtration rate (GFR) for up to 6 months.^[41] Also, in the perioperative period, further insults like hypovolemia due to blood loss, improper fluid management, hypotension, and use of nephrotoxic drugs can exacerbate kidney injury.^[23] The aforementioned causes may increase the risk of intraoperative AKI and due precautions should be taken to prevent further injury.

Gastrointestinal (GI) system

The most cardinal gastrointestinal symptoms in the post-COVID-19 state are lack of appetite, nausea, and vomiting.^[42] All this can lead to Mendelson's syndrome; a well-recognized cause of lung injury and pulmonary edema, secondary to aspiration of gastric contents in the tracheobronchial tree.^[43]

Preoperative considerations

- Anesthesia implications will be profound in the indexed subset, as the normal physiology of such patients will be impacted both by changes due to pregnancy and COVID-19 post-infection. Therefore, a thorough detailed preoperative evaluation is paramount.
- The preoperative evaluation, history taking, functional status before surgery, and consent particularly to COVID-19 status should be given utmost importance.
- Risk stratification should be done in the preoperative assessment; a.) Mild: stable vital signs with mild residual symptoms, b.) Severe: respiration rate ≥ 30 /min, resting arterial oxygen saturation ($\text{SaO}_2 \leq 93\%$), Critical: shock with organ failure, respiratory failure requiring mechanical ventilation, or refractory hypoxemia.^[43] Based on the clinical evaluation, a multidisciplinary approach, along with an assessment of appropriate postoperative respiratory care is to be adopted.
- History of duration and severity of COVID-19, along with associated comorbidities should be noted along with their residual effects.^[44]

- Based on the indication of cesarean section, the severity of symptoms, presence of comorbidities (preeclampsia, cardiac, respiratory disease), obstetric history, and fetal condition, the timing of delivery can be individualized. In the absence of fetal distress and mild symptoms, pregnancy can be continued.^[45]
- **Post-COVID syndrome:** The Center for Disease Control (CDC) has coined the term post-acute COVID-19 syndrome for the patients who recovered from SARS-CoV-2 infection characterized by the persistence of clinical symptoms beyond 4 weeks from the onset of acute symptoms. It consists of a myriad of symptoms including tiredness, dyspnea, fatigue, brain fogging, autonomic dysfunction, headache, persistent loss of smell or taste, cough, depression, low-grade fevers, palpitations, dizziness, muscle pain, and joint pains. These further mandate the evaluation of the multiorgan effect of post-COVID infection on various organ systems.^[46]
- **Cardiovascular system:** Cardiomyopathies, myocardial infarction, arrhythmias, and myocarditis are commonly associated complications with the recovered COVID-19 patients, warranting cardiac evaluation in SARS-CoV-2-recovered parturients.^[47] Furthermore, cardiac and normal pregnancy symptoms including dyspnea on exertion, palpitations, tachycardia, and syncope are two sides of the same coin, thus, necessitating prompt differentiation between the two entities.
- **Respiratory system:** The evaluation of pulmonary sequelae after SARS-CoV-2 infection is cardinal. Effort tolerance after post-COVID-19 infection is subjective, albeit a 6-min walk test and breath-holding time are fairly objective. This aforementioned, non-invasive test can be conducted at the time of a pre-anesthesia checkup (PAC), if feasible.^[48]
- **Neurological system:** Post-viral symptoms are compiled under the parasol term of “post-COVID-19 syndrome.”^[49] Symptoms including headache, neuromuscular weakness, depression, or any cerebrovascular accidents need to be properly evaluated at the time of PAC and properly documented, as they may have important implications during the intraoperative and postoperative period.^[49]
- **Anticoagulants:** Obstetric patients who recovered from SARS-CoV-2 infection can be on antiplatelet or antithrombotic agents. A detailed history of the drug and clear instructions regarding the timing of stoppage and continuation should be given during the pre-anesthetic checkup. Low dose aspirin (75–150 mg/day) can be continued safely, clopidogrel should be stopped 5 days before surgery and resumed 24 h postoperatively in high-risk cardiac event patients.^[23] Dual-antiplatelet therapy can be discontinued 7–10 days before surgery and resumed 23 h postoperatively in the low-risk of cardiac events parturients. Prophylactic and therapeutic doses of low molecular weight heparin (LMWH) should be stopped at 12 and 24 h, respectively, after the last dose.
- **Comorbidity:** The history of comorbidity and preoperative optimization as far as possible is cardinal in these subsets as there can be worsening of comorbidities in the recovered COVID-19 patients
- **Psychological counseling:** Post-COVID-19 recovered patients are in a state of post-trauma stress with anxiety and depression. Nonetheless, they generally have increased anxiety and are worried about the neonatal outcome. Hence, they may require immediate psychological counseling from an expert.
- **Vaccination history:** The history of COVID-19 vaccination should be elicited.
- **Venous access:** The propensity for venous thrombosis in the post-COVID-19 recovered patient may lead to difficulties in venous access. Therefore, veins need to be checked preoperatively and central venous cannulation can be considered, depending upon the overall assessment of the patient.
- **Requirement of oxygenation:** The shift of the diaphragm due to the growing uterus, reduction in FRC, and increased oxygen consumption result in the increased requirement of oxygen in pregnancy. Indeed, post-COVID-19 pulmonary fibrosis or other respiratory sequelae can further increase the oxygen requirement, and hence, functional assessment of oxygen requirement intra- and postoperatively is imperative. Also, the need for postoperative ventilation needs to be duly addressed preoperatively.
- **Drug allergy:** History of old drug allergy or newly developed drug allergy due to anti-COVID-19 drugs or COVID-19 vaccine should be asked, as ignorance may lead to anaphylaxis or any other catastrophic event intraoperatively.

Investigations

The goal of the investigations should be based on the evaluation of post-COVID-19 illness sequelae, functional evaluation of various organs, and associated comorbidities. Special investigations in a post-COVID-19 obstetric patient may vary from patient to patient and should be individualized depending upon the clinical scenario, presence of comorbidities, and institutional protocol. Any of the abnormal values in this battery of special investigations suggest that the disease sequelae are persisting and are not completely resolved, thereby, indicating a higher risk of intra-/perioperative complications [Table 4].

Perioperative concerns

1. Monitoring: Standard American Society of Anesthesiologists (ASA) monitoring including a pulse oximeter, electrocardiography (ECG), non-invasive blood pressure, end-tidal carbon dioxide (ETCO₂), and temperature monitoring are to be done in all pregnant patients requiring surgical intervention.^[50]
2. The goal of oxygen therapy is to maintain oxygen saturation above 95–96% in a post-COVID-19 recovered obstetric patient.^[50] It is noteworthy that recovered patients may have decreased saturation and anesthesia drugs may further cause desaturation, hence, warranting supplementary oxygenation. Pregnancy is a state of increased oxygen consumption and decreased oxygen levels are not only detrimental to the mother but may cause fetal distress and enhance mortality and morbidity. Tools including modified early obstetric warning systems (MEOWS) can be helpful.^[51] Also, an increased need for oxygen is a sign of deterioration.^[52]
3. Anti-aspiration prophylaxis, H₂ blocker, and/or metoclopramide for aspiration prophylaxis can be used to decrease the risk of aspiration due to reduced lower esophageal sphincter tone, particularly after 16 weeks of pregnancy.^[53,54]
4. There is compression of inferior vena cava (IVC) due to the gravid uterus causing supine hypotension syndrome. Keeping a wedge under the right lower back or 10–15° left lateral table tilt can be useful for the same.^[18]
5. The choice of anesthesia depends upon the emergency/urgency of the cesarean section and should be tailored based on the fetal, obstetric, and anesthesia risks involved.^[23] Neuraxial anesthesia is recommended as first-line in post-COVID-19 recovered patients both for elective and emergency cesarean section.^[38]
6. If the patient is on anticoagulants, she should not receive regional anesthesia.^[23] An early epidural to prevent the chance of an emergency cesarean section under general anesthesia, recent platelet count, keeping in mind the possibility of thrombocytopenia and other coagulation abnormalities due to antiplatelet or antithrombotic drugs are recommended for neuraxial blockade.^[55] In the post-COVID-19 state. The American Society of Regional Anesthesia (ASRA) institutional guidelines should be followed before administration of regional anesthesia, and there exists no strong evidence on any particular neuraxial technique more advantageous than others; hence, the decision depends on the discretion of the anesthesiologist.
7. Labor analgesia: Early labor analgesia is recommended to avoid general anesthesia in case of emergency and can also be used for postoperative pain relief. Patient-controlled epidural analgesia (PCEA) can be used for giving labor analgesia.
8. Goal-directed fluid therapy can be instituted. Overzealous fluid overloading should be avoided. The COVID-19 recovered parturient may become hypotensive (18%) during regional anesthesia or induction of anesthesia. Prophylactic vasopressors, namely phenylephrine/ephedrine are preferred over fluid overloading. In a multicenter, retrospective, propensity score-matched cohort study, the incidence of neuraxial anesthesia-related hypotension was 57.4% in the COVID-19 parturients and 41.9% in control parturients.^[56] Another retrospective review of the patients with a history of COVID-19 infection revealed abnormal cardiovascular function in 275 cases, orthostatic symptoms including postural orthostatic syndrome in 22% of the cases, and orthostatic intolerance in 11% of the cases between 0 and 122 days post-infection. Post-COVID-19 autonomic and small fiber neuropathy can occur.^[57] Nevertheless, low cortisol levels and adrenal insufficiency have also been reported as post-COVID-19 sequelae.^[58]
9. Cross-matching of blood and an adequate arrangement of blood and blood products should be ensured, depending on the requirement of the case.

Table 4: Battery of routine and special investigations

Routine Investigations	Special Investigations for post-COVID recovery status
Coagulation profile: BT, CT, PT, INR, APTT, platelet	D-dimer
Serum Electrolytes: Sodium, Potassium, and calcium	LDH/Ferritin/prealbumin
RFTs: BUN, Serum Creatinine	Fibrinogen
LFT	Serum lactate
TLC	2 D Echo who had moderate/severe hypoxia or significant cardiac symptoms during COVID19
COVID Antibody IgM/IgG	ECG
Tests	PFT; If feasible
Blood culture, if the count is very high	ABG
	Troponin
	HRCT (High-resolution computed tomography) needs to be done in patients who had mild hypoxia (53.9%)
	MRI can be done in hospitalized and recovered patients to find out any abnormalities
	CT/MRI brain in case of neurological involvement or patient on anticoagulants to rule out any intracranial hemorrhage
	POCUS

BT: Bleeding time; CT: Clotting time; PT: Prothrombin time; INR: International normalized ratio; APTT: Activated partial thromboplastin time; LDH: Lactate dehydrogenase; LFT: Liver function tests; TLC: Total leucocyte count; ABG: Arterial blood gas; PFT: Pulmonary function tests; ECG: Electrocardiogram; MRI: Magnetic resonance imaging; CT: Computed tomography; POCUS: Point of care ultrasound; Ig: Immunoglobulin

10. General anesthesia (GA) can be administered depending upon maternal emergency (severe pre-eclampsia/eclampsia/HELLP (hemolysis, elevated liver enzymes, low platelet count)), contraindication to regional anesthesia (severe thrombocytopenia, failed RA, coagulopathy), or fetal emergency (cord prolapse, severe fetal distress). GA should be preferred in patients with decreased cardio-pulmonary reserve. Rapid sequence induction is employed and a higher fraction of inspired oxygen (FiO₂) has to be maintained till fetal delivery to ensure adequate fetal oxygenation.^[23]
 11. Patients receiving magnesium sulphate (MgSO₄) should be carefully observed for any respiratory muscle weakness. This mandates its judicious use in patients with respiratory distress.
 12. Preoxygenation is recommended in COVID-19 recovered parturients because of decreased FRC and an increased vulnerability to desaturation. Video laryngoscope-aided intubation should be preferred due to the high chance of first-pass success rate. A difficult airway cart has to be kept ready because of altered airway anatomy in a pregnant patient. According to the difficult airway algorithm, second-generation supraglottic airway devices can be used as a part of the rescue plan in cannot intubate/ventilate situation.
 13. The post-COVID-19 recovered obstetric patients are prone to AKI intraoperatively, and hence, reno-toxic drugs should be avoided and urine output should be maintained above 0.5–1 mL/h.
 14. In a diabetic parturient, perioperative perturbations in blood sugar levels should be avoided. Tight glycemic control is now being perceived as a perioperative goal in patients undergoing surgery.^[59,60] Although there exist no robust guidelines for the target glycemic control intraoperatively, albeit blood glucose can be titrated to 80–120 mg/dL, and an institutional insulin infusion protocol can be followed.^[61]
 15. Although, there is a lack of evidence supporting the vertical transmission of the SARS-CoV-2 infection in the neonate from the mother, standard neonatal resuscitation guidelines are to be followed and an emergency cart including resuscitation drugs, suction, oxygen, and intubation trolley should be kept ready. Neonatologists are to be kept informed and available to assess the neonate's well-being.
3. The following criteria denote intensive care unit (ICU) admission: Respiratory rate >30/min, desaturation (<92-93%) at rest, FiO₂ <300 mmHg. The Quick Sequential Organ Failure Assessment Score (qSOFA) can also be used as an adjunct for making the final decision.
 4. Post-COVID-19 recovered patients are prone to post-dural puncture headache (PDPH) and should be managed promptly with adequate rest, judicious fluids, NSAIDs, and caffeine. Epidural saline is preferred over an autologous blood patch.
 5. Antiplatelet, anticoagulant, LMWH, and other drugs can be continued as per the recommended guidelines.
 6. Early mobilization should be encouraged, as both pregnancy and post-COVID recovered states are considered hypercoagulable states, thereby, necessitating deep vein thrombosis (DVT) prophylaxis.
 7. Psychological well-being is very important in the COVID-19 recovered patients, and the literature has reported severe post-partum depression in SARS-CoV-2 -recovered patients. Prompt recognition and identification of depression and anxiety symptoms in a parturient along with proper psychological counseling and treatment are pivotal.
 8. Breastfeeding can be encouraged.

Conclusion

Successful management of the post-COVID-19 recovered obstetric patient requires multidisciplinary teamwork and anesthesiologists form an integral part of the team. Neuraxial anesthesia and analgesia seem to be effective and safe in the recovered COVID-19 obstetric patients. It is of utmost importance to establish standard care definitions in this important subset. The goal of anesthesia management should focus on the recognition of the sequelae of the COVID-19 infection in the parturient with the aim of preoperative optimization, goal-directed fluid therapy, protective intraoperative ventilatory strategies, adequate analgesia, and early ambulation.

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Conflicts of interest

There are no conflicts of interest.

Postoperative concerns

1. Standard postoperative monitoring with a focus on continuous oxygen monitoring via pulse oximetry is mandatory.
2. Multimodal analgesia can be used for enhanced recovery after cesarean section (postoperative pain

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