

Maternal and neonatal characteristics, operative details and outcomes in COVID-19 positive parturients undergoing cesarean sections: A retrospective observational study

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Abstract

Background and Aims: There is a marked inclination towards cesarean sections as the preferred mode of delivery in parturients with COVID-19 disease. However, the challenges associated with planning and performing a surgery in the COVID-19 setup are considerable. These factors may lead to widespread changes in obstetric decision-making, operative planning, and perioperative outcomes. Thus, our study aimed to study the clinical and logistical factors involved in cesarean sections in COVID-19 parturients.

Material and Methods: This was a retrospective observational study performed at a dedicated COVID-19 tertiary care center in India. All women undergoing cesarean section in the specially earmarked operating room between 1st May 2020 and 31st December 2020 were included in the study. The clinical characteristics, operative details, and neonatal details, along with maternal and fetal outcomes were noted and analyzed.

Results: A total of 44 women underwent cesarean section during the study period, with elective and emergency surgeries numbering 22 each. No indication, apart from COVID-19 status, was listed in over one-fourth of the women (13/44). The most common preoperative comorbidity was hypothyroidism (12/44). Median surgical duration was 117.5 min (IQR 100-133), with a median of 7.5 (IQR 6-8.25) healthcare personnel in the OT. Over one-fourth (12/44) of the delivered babies had low birth weight, while 4.5% (2/44) tested positive for SARS-CoV-2.

Conclusion: COVID-19 status alone continues to be a common indication for cesarean section. Operative time is increased, but the number of healthcare personnel involved can be trimmed with proper planning. Maternal and fetal outcomes are largely positive, with low transmission rates, but a considerable proportion of low-birth-weight neonates.

Keywords: Cesarean section, COVID-19, indications, operating time, SARS-CoV-2

Introduction

COVID-19 disease poses a unique set of challenges and dilemmas in the parturient, both for the mother as well as the treating clinical team. The mode of delivery in this patient subset has gained particular interest.^[1] The initial days of

the pandemic, with widespread uncertainty over chances of vertical transmission, saw an overwhelming preference towards cesarean sections.^[2-4] Simultaneously, the nature of surgical practice has seen a drastic change, with clinicians experiencing the challenges of providing anesthesia and performing surgery in full personal protective equipment (PPE). In addition, protocols for patient monitoring, postpartum COVID testing

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and call-for-help scenarios have been continuously evolving.^[5] Routine practices like early discharge from hospital have also become either impossible or unadvisable. These changes have brought about a sea change in the practice of cesarean deliveries. While there is abundant literature studying parturients and maternal and fetal outcomes in the presence of maternal COVID-19 disease,^[1,2,4] there is a paucity of data focusing on the logistics and clinical outcomes of cesarean sections in women with COVID-19. Our study aimed to fill this gap by retrospectively analyzing the clinical characteristics, operative details, and perioperative logistics, along with maternal and neonatal outcomes of COVID-19 positive cesarean sections.

Material and Methods

This was a retrospective observational study undertaken after Institutional Ethics Committee clearance (IEC-939/04.09.2020, OP-15/08.01.2021). All women who underwent cesarean section (CS) in the specially earmarked operation theatre (OT) of our institution, a dedicated tertiary care COVID-19 center, between 1st May 2020 and 31st December 2020 were included in the study. Patient files and electronic records were accessed for relevant study data. Demographic details like age and gender, and obstetric details like gravida, period of gestation (in completed weeks), diagnosis and operative indication were noted. Systemic comorbidities and preoperative oxygen requirement, if present, were noted, along with the American Society of Anaesthesiologists (ASA) physical status. Operative details noted included timing of surgery (elective or emergency), duration of surgery, number of healthcare personnel involved in the care of the patient in the OT, number of healthcare personnel scrubbed during the surgery, mode of anesthesia, and intraoperative complications, if present. Postoperative details noted included oxygen requirement if present, surgical or systemic complications, postoperative hospital stay duration and final outcome. Details of the baby were noted which included birth weight, perinatal complications and the COVID-19 test report.

The study variables are described either on continuous or categorical scale. The continuous variables are presented as mean with standard deviation or median with interquartile range, while the categorical variables are presented as frequency and percentages. As this is a descriptive case series study, no statistical tests were applied for association.

Results

A total of 44 women underwent CS during the study period. The median age of the women was 30.5 years (IQR 27–33.5), the median gravida was 2 (IQR 1–3), the median period of

gestation was 38 weeks (IQR 37–38). Period of gestation was less than 37 weeks in 9/44 (20.4%). Of the studied cohort, 22 women had no systemic comorbid condition, while a total of 43 systemic conditions were noted in the remaining 22 women [Table 1]. The most common preoperative comorbidity was hypothyroidism (12/44) followed by gestational diabetes mellitus (7/44) and cholestasis of pregnancy (5/44). Emergency and elective surgeries were equal in number (22 each). The median duration of surgery was 117.5 min (IQR 100–133), with a median of 7.5 (IQR 6–8.25) healthcare personnel in the OR and a median of 4 (IQR 3–4) personnel scrubbed during the surgery [Table 2]. Mode of anesthesia was subarachnoid block (SAB) in most patients (40/44), and general anesthesia (GA) in two. SAB was converted to GA in 2 patients due to the receding effect of the former. A total of 44 live babies were delivered (1 intrauterine fetal demise and 1 pair of twins) [Table 3]. Amongst the live births, median birth weight was 2.83 kg (IQR 2.46–3.16), while over one-fourth (12/44) had low birth weight (weighing less than 2.5 kg at birth). Eight babies needed neonatal intensive care support; of these, one baby died on the third day of life due to septic shock from a non-COVID-related cause, while 4 babies needed ventilatory support in the form of invasive mechanical ventilation, non-invasive ventilation or oxygen therapy. SARS-CoV-2 test positivity rate amongst the neonates was 4.5% (2/44).

Discussion

A total of 44 women underwent CS in our study, of whom over one-fourth (13/44) underwent surgery with no discernible obstetric or fetal indication, apart from their COVID positive status. This is similar to the findings of Debrabandere *et al.*^[1] who reviewed data from 140 COVID-19 positive women who had CS delivery, and found no obstetric indication in 23%, while COVID-19 positive status alone was listed as an indication for CS in 22% of cases. The uncertainty about the risk of intrapartum vertical transmission of the virus may lead clinicians to prefer CS over vaginal delivery in several cases.^[6] Although literature suggests that the risk of infection to the new-born appears unchanged by the mode of delivery, there are numerous reports of CS rates exceeding 90% in COVID-19 parturients,^[2–4] often with indications not clearly described.^[2] Several authors have questioned this trend of widespread CS delivery with unclear obstetric indications.^[1,2] However, the presence of COVID-19 infection has skewed surgical decision-making. Ashokka *et al.*^[7] opined that in the presence of COVID-19 infection, the threshold for CS should be low so that infection control precautions can be

Table 1: Maternal clinical characteristics

Age	
Age Range (years)	20-42
Age Median (IQR)	30.5 (27-33.5)
Gravida	
Gravida 1	19
Gravida 2	13
Gravida 3	8
Gravida >3	4
Indication for CS	
Elective	22
COVID/No indication mentioned	11
Maternal request	3
Bad obstetric history	3
Non cephalic presentation	2
Oligohydramnios	2
Multiple Pregnancy	1
Emergency	22
Fetal distress/bradycardia	6
Poor progress of labor	3
Severe PIH	3
Non cephalic presentation	2
Maternal request	2
Cephalopelvic disproportion	2
Oligohydramnios	1
Intrauterine death	1
COVID/No indication mentioned	2
Pre op Systemic Conditions	(43)
Hypothyroid	12
Gestational Diabetes	7
Hypertensive disorders of pregnancy	4
Chronic Hypertension	3
Intrahepatic cholestasis of pregnancy	5
Anemia	2
Rheumatic heart disease	2
Others	Beta thalassemia trait (1), ITP (1), Sacroiliac Tuberculosis (1), EHPVO (1), Valvular heart disease (2), Congenital heart disease (1), Takayasu arteritis (1)
Parturients with no systemic conditions	22
Postoperative stay	
Range (days)	3-13
Median (IQR)	6 (5-7)

IQR - Interquartile range, CS - Cesarean section, ITP - Idiopathic thrombocytopenic purpura, EHPVO - Extrahepatic portal venous obstruction, PIH - Pregnancy Induced Hypertension

properly implemented. Similarly, Qi *et al.*^[8] recommended that indications for CS in COVID-19 parturients should be applied flexibly and the threshold for surgery lowered if labor is prolonged. As expressed by Morau *et al.*^[9] the decision for delivery in COVID-19 patients cannot simply follow guidelines, but must be evaluated on a case-by-case basis. This must also take into account maternal psychosocial issues and attitude towards childbirth, which are powerful factors governing mode of delivery.^[10] This decision is a complex issue, which needs to be viewed in the context of not only obstetric indications, but also logistical and administrative arrangements, maternal psychosocial issues,

and comfort of clinical team. At our center, there was a single dedicated OT for surgery in COVID-19 patients; thus, immediate availability of the OT if required for an urgent CS was a concern. Further, the time needed for the complete team to don level 3 PPE and prepare the OT for surgery precluded the option of immediate surgery if the need arose. Frequent entry into the ward and labor room areas to assess the parturient is not possible in a COVID setup.^[9] This made close monitoring of fetal and maternal status, and progress of labor a challenge. These factors may have resulted in the decision to err on the side of caution by performing CS in several cases.

Table 2: Operative characteristics

Duration of surgery: Range (min)	65-255
Duration of surgery: Median (IQR)	117.5 (100-133)
HCP in OR: Range	6-10
HCP in OR: Median (IQR)	7.5 (6-8.25)
Scrubbed in OT: Range	3-5
Scrubbed in OT: Median (IQR)	4 (3-4)
Preoperative Oxygen requirement	
Room air	43
Oxygen by face mask	1
Mode of Anesthesia	
SAB	40
SAB converted to GA	2
GA	2
Intraoperative Complications	
Atonic postpartum hemorrhage	4
None	40
Postoperative Complications	
Acute Kidney Injury	1
Sepsis	1
None	42
Post op oxygen requirement	
Room air	40
Oxygen by facemask	3
Intubated	1
Post op duration of stay Range (days)	3-13
Post op duration of stay Median (IQR)	6 (5-7)
Outcome	
Discharge	43
Death	1

IQR - Interquartile range, SAB - subarachnoid block, GA - General anesthesia, HCP - Health care personnel, OT - Operation Theatre, SAB - subarachnoid block, GA - General Anesthesia

Table 3: Neonatal characteristics

Birth weight	
Birth weight: Range (kg)	0.802-4.19
Birth weight: Median (IQR)	2.83 (2.46-3.16)
Low birth weight	12
1.5-2.5 kg	9
<1.5 kg	3
Gestational age	
Term (>37 weeks)	36
Late Preterm (32-37 weeks)	6
Very Preterm (28-32 weeks)	2
COVID Report of Neonates	
Positive	2
Negative	42
Perinatal complications	
Transient Tachypnea of Newborn	4
Others	Neonatal sepsis (1), Neonatal jaundice (1), Intrauterine death (1)
Nil	27

We noted a median operative time of 117.5 min from skin incision to skin closure. A study of over 1300 patients in a teaching hospital in USA before the COVID-19 pandemic found mean operating time in CS to be approximately 1 hour (56 and 60 mins in first-time and second-time CS respectively).^[11] A study in Spain found no difference in operative time between patients with or without COVID-19 (38 vs 39 min).^[12] Notably, the PPE worn by the obstetricians in the above study included a gown, N-95 mask, face shield, and gloves, but not a coverall or eye goggles. Our institution being a dedicated COVID-19 center, all personnel entering the clinical areas were required to don level 3 PPE, including a coverall, N-95 mask, goggles, shoe cover, and two sets of gloves.^[13] In addition, the scrubbed personnel wore a sterile gown and an additional pair of sterile gloves. Full PPE makes verbal and nonverbal communication amongst team members difficult^[9,14] which negatively impacts the coordination amongst the operating surgeon, surgical assistant, and nursing staff and may lead to delay while performing procedures. Discomfort while performing tasks in PPE is widely known and stems from vision, breathing, and cognition difficulties, apart from heat stress, headache, and fatigue.^[15-17] These factors may have contributed to the highly prolonged operative time observed in our study. Implication for the anesthesiologist needs to be emphasized here. In two patients wherein operative duration exceeded 180 min, the primary mode of anesthesia (SAB) had to be converted to GA. We encourage our peers to take this factor into consideration while planning anesthesia in these patients.

In our study, the median number of personnel involved in patient care in the OT was 7.5. These included the surgical team, anesthesia team, neonatologist, technical staff, nurses, helpers and sanitation staff. Of these, a median of four personnel were scrubbed in the surgery.

Guidelines have stressed the importance of limiting the number of staff entering COVID-19 clinical areas.^[18] However, in urgent call-for-help scenarios, time required for donning PPE delays the arrival of additional personnel. This may hinder the ability to reduce the number of OT workers. Gonzalez-Brown *et al.* developed a clinical practice protocol for cesarean sections in COVID-19 patients, suggesting 9 personnel donning PPE and being involved in the OT care of such patients.^[19] The OT in our center adjoined an intensive care unit where anesthesiologists along with nursing, technical and sanitation staff were posted round-the-clock; thus, access to help was freely available if needed. This allowed us to judiciously trim the personnel in the OT without compromising patient safety.

The majority of the patients (81.8%) belonged to ASA physical status 2, with hypothyroidism being the most common systemic comorbidity (12/44). Although other studies report lower incidence of hypothyroidism amongst COVID-19 parturients,^[1] subclinical hypothyroidism in previously euthyroid patients has been noted in conjunction with COVID-19 disease.^[20] A study in China observed that pregnant women in their first trimester during the COVID-19 outbreak were at an increased risk of having thyroid hormone anomalies including isolated hypothyroxinemia.^[21] Hypothyroidism in pregnant women has been associated with a higher chance of undergoing CS, which may account for the higher incidence amongst our study cohort. This patient subset is also at higher risk of maternal complications such as postpartum hemorrhage.^[22] While all the hypothyroid parturients in our study cohort had uneventful surgeries and postoperative outcomes, the relationship between thyroid anomalies, pregnancy, and COVID-19 disease needs further study.

There was one maternal mortality amongst the studied group. The patient was a 35-year-old lady who presented to our institution at 36 weeks of gestation with HELLP syndrome. At arrival, she was noted to have had an intrauterine death and was in sepsis. She underwent CS for removal of the dead fetus, but postoperatively suffered from sepsis-induced multiorgan dysfunction, along with disseminated intravascular coagulation and eventually succumbed to worsening septicemia and refractory shock. Postoperative course was remarkable in one other patient, a 37-year-old parturient, who had transient acute kidney injury which resolved within a day. All remaining parturients had uneventful postoperative stays and were discharged after a median of 6 days (IQR 5-7) as preference was given to discharging the mother-baby dyad together after a negative COVID test.

Neonatal outcomes were largely positive, with a healthy median birth weight, similar to previously published literature.^[1] However, the proportion of LBW babies is a matter of concern. There are conflicting reports in literature describing the relationship between maternal COVID-19 status and birth weight of baby.^[4,23,24] Although the percentage of LBW babies in our cohort was less than those in other studies,^[23] the overarching effect of birth weight on neonatal outcome makes further study in this direction imperative. At our center, all babies born to COVID-19 positive mothers were tested for SARS-CoV-2 soon after birth to rule out vertical transmission, and thereafter on the fifth day of life, in accordance with national guidelines.^[25,26] Positivity rate was 4.5% (2/44), which is consistent with previously published literature.^[27]

There are several limitations in the present study. This was a retrospective observational study and had no comparator arm. Thus, it is not possible to establish association between various studied factors. Secondly, details of logistics and planning of the CS, such as time taken from decision to operate to actual time of surgery, time taken to shift to OT, composition of OT team, and reasons for delay at each step were not recorded. Thus, a detailed analysis of the process and the factors involved was not possible. Thirdly, since none of the patients in our study cohort suffered from severe manifestations of COVID-19 disease, the impact of the disease process on the surgery and perioperative planning cannot be commented upon. Finally, this was a single-center study with a small number of patients. Further studies with larger numbers are needed to establish the role of various factors in the perioperative care and planning of COVID-19 parturients slated for CS.

Conclusion

COVID-19 status continues to be a common indication of cesarean section, probably due to psychosocial issues, administrative planning, and logistics. Operating time is increased and has implications while deciding the plan of anesthesia. With proper planning, the number of healthcare personnel in the operating room can be judiciously trimmed. Maternal and fetal outcomes are largely positive, with low transmission rates, but a considerable proportion of low-birth-weight neonates.

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Conflicts of interest

There are no conflicts of interest.

References

1. Debrabandere ML, Farabaugh DC, Giordano C. A review on mode of delivery during COVID-19 between December 2019 and April 2020. *Am J Perinatol* 2021;38:332-41.
2. Della Gatta AN, Rizzo R, Pili G, Simonazzi G. Coronavirus disease 2019 during pregnancy: A systematic review of reported cases. *Am J Obstet Gynecol* 2020;223:36-41.
3. Bauer ME, Chiware R, Pancaro C. Neuraxial procedures in COVID-19-positive parturients: A review of current reports. *Anesth Analg* 2020;131:e22-4.
4. Zaigham M, Andersson O. Maternal and perinatal outcomes with COVID-19: A systematic review of 108 pregnancies. *Acta Obstet Gynecol Scand* 2020;99:823-9.
5. Panesar K, Dodson T, Lynch J, Bryson-Cahn C, Chew L, Dillon J. Evolution of COVID-19 guidelines for University of Washington oral and maxillofacial surgery patient care. *J Oral Maxillofac Surg* 2020;78:1136-46.
6. Chen R, Zhang Y, Huang L, Cheng BH, Xia ZY, Meng QT. Safety

- and efficacy of different anesthetic regimens for parturients with COVID-19 undergoing cesarean delivery: A case series of 17 patients. *Can J Anaesth* 2020;67:655-63.
7. Ashokka B, Loh M-H, Tan CH, Su LL, Young BE, Lye DC, *et al.* Care of the pregnant woman with coronavirus disease 2019 in labor and delivery: Anesthesia, emergency cesarean delivery, differential diagnosis in the acutely ill parturient, care of the newborn, and protection of the healthcare personnel. *Am J Obstet Gynecol* 2020;223:66-74.e3.
 8. Qi H, Luo X, Zheng Y, Zhang H, Li J, Zou L, *et al.* Safe delivery for pregnancies affected by COVID-19. *BJOG* 2020;127:927-9.
 9. Morau E, Bouvet L, Keita H, Vial F, Bonnet MP, Bonnin M, *et al.* Anaesthesia and intensive care in obstetrics during the COVID-19 pandemic. *Anaesth Crit Care Pain Med* 2020;39:345-9.
 10. Stjernholm YV, Petersson K, Eneroth E. Changed indications for cesarean sections. *Acta Obstet Gynecol Scand* 2010;89:49-53.
 11. Gonzalez Fiol A, Meng ML, Danhaki V, Kim M, Miller R, Smiley R. A study of factors influencing surgical cesarean delivery times in an academic tertiary center. *Int J Obstet Anesth* 2018;34:50-5.
 12. Cuerva MJ, Carbonell M, Palumbo GM, Magallon SL, De La Calle M, Bartha JL. Personal protective equipment during the COVID-19 pandemic and operative time in cesarean section: Retrospective cohort study. *J Matern Fetal Neonatal Med* 2020;1-4. doi: 10.1080/14767058.2020.1793324. Online ahead of print.
 13. Kang Y, Deng L, Zhang D, Wang Y, Wang G, Mei L, *et al.* A practice of anesthesia scenario design for emergency cesarean section in patients with COVID-19 infection based on the role of standard patient. *Biosci Trends* 2020;14:222-6.
 14. Hampton T, Crunkhorn R, Lowe N, Bhat J, Hogg E, Afifi W, *et al.* The negative impact of wearing personal protective equipment on communication during coronavirus disease 2019. *J Laryngol Otol* 2020;134:577-81.
 15. Davey SL, Lee BJ, Robbins T, Randeve H, Thake CD. Heat stress and PPE during COVID-19: Impact on healthcare workers' performance, safety and well-being in NHS settings. *J Hosp Infect* 2021;108:185-8.
 16. Loibner M, Hagauer S, Schwantzer G, Berghold A, Zatloukal K. Limiting factors for wearing Personal protective equipment (PPE) in a health care environment evaluated in a randomised study. *PLoS One* 2019;14:e0210775.
 17. Parush A, Wacht O, Gomes R, Frenkel A. Human factor considerations in using personal protective equipment in the COVID-19 pandemic context: Binational survey study. *J Med Internet Res* 2020;22:e19947.
 18. World Health Organization. Rational use of personal protective equipment for COVID-19 and considerations during severe shortages. Updated 23 December 2020. [Last accessed on 2021 Mar 8]. Available from: [https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-\(covid-19\)-and-considerations-during-severe-shortages](https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages).
 19. Gonzalez-Brown VM, Reno J, Lortz H, Fiorini K, Costantine MM. Operating room guide for confirmed or suspected COVID-19 pregnant patients requiring cesarean delivery. *Am J Perinatol* 2020;37:825-8.
 20. Chen M, Zhou W, Xu W. Thyroid function analysis in 50 patients with COVID-19: A retrospective study. *Thyroid* 2021;31:8-11.
 21. Lin T-T, Zhang C, Zhang H-Q, Wang Y, Chen L, Dennis C-L, *et al.* Thyroid hormone changes in early pregnancy along with the COVID-19 pandemic. *Front Endocrinol (Lausanne)* 2020;11:606723.
 22. Kiran Z, Sheikh A, Malik S, Meraj A, Masood M, Ismail S, *et al.* Maternal characteristics and outcomes affected by hypothyroidism during pregnancy (maternal hypothyroidism on pregnancy outcomes, MHPO-1). *BMC Pregnancy Childbirth* 2019;19:476.
 23. Smith V, Seo D, Warty R, Payne O, Salih M, Chin KL, *et al.* Maternal and neonatal outcomes associated with COVID-19 infection: A systematic review. *PLoS One* 2020;15:e0234187.
 24. Melo GC, Araújo KCGM. COVID-19 infection in pregnant women, preterm delivery, birth weight, and vertical transmission: A systematic review and meta-analysis. *Cad Saude Publica* 2020;36:e00087320.
 25. Federation of Obstetric and Gynaecological Societies of India, National Neonatology Forum, India, Indian Academy of Pediatrics. Perinatal-Neonatal Management of COVID-19: Clinical Practice Guideline. Updated 7 May 2020. [Last accessed on 2021 Mar 8]. Available from: <https://iapindia.org/pdf/1465-Summary-FOGSI-NNF-IAP-Perinatal-Covid19-ver-2-0-May-11.pdf>.
 26. Sivanandan S, Chawla D, Kumar P, Deorari AK, National Neonatology Forum, India. COVID-19 in neonates: A call for standardized testing. *Indian Pediatr* 2020;57:1166-71.
 27. Cai J, Tang M, Gao Y, Zhang H, Yang Y, Zhang D, *et al.* Cesarean section or vaginal delivery to prevent possible vertical transmission from a pregnant mother confirmed with COVID-19 to a neonate: A systematic review. *Front Med (Lausanne)* 2021;8:634949.