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Effect of COVID-19 infection during pregnancy on Cerebro-placental circulation (Prospective study)

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Abstract

Background: Most pregnant women who are positive for SARS-COV-2 are asymptomatic and have a low prevalence of perinatal complications. Initially, there was an overreaction concerning the potential complications of SARS-COV-2 in pregnancy, with an increase in rate of indicated preterm birth in order to avoid foetal exposure to the virus. However, now that clinical experience has accumulated, the general consensus is that only minimal or mild foetal side effects are associated with maternal SARS-COV-2 infection during pregnancy.

Aim of the work: The aim of the study is to evaluate the effect of the infection with SARS- COV-2 early in pregnancy on cerebroplacental circulation.

Methods: This prospective study was conducted at tertiary care hospital at ultrasound and foetal medicine unit, Ain Shams University Maternity Hospital from January 2021 till June 2023 and performed on total 283 pregnant women who had infected with SARS-COV-2 during early pregnancy (first trimester or early second trimester), compared to 283 healthy pregnant women as a control group with inclusion and exclusion criteria.

Results: There were no statistically significant differences between the studied groups regarding Middle cerebral artery (MCA) pulsatility index (PI). There were no statistically significant differences between the studied groups regarding Middle cerebral artery (MCA) resistive index (RI). There were no statistically significant differences between the studied groups regarding Umbilical artery (UA) pulsatility index (PI). There were no statistically significant differences between the studied groups regarding Umbilical artery (UA) resistive index (RI). There were no statistically significant differences between the studied groups regarding **c**erebroplacental ratio.

Conclusion: As evident from the current study, this present study reported no significant differences in fetomaternal blood flow parameters in pregnant women who had infected with SARS-COV-2 infection during early pregnancy (first trimester or early second trimester) compared to those who have not had the disease using doppler parameters of umbilical artery, middle cerebral artery and cerebroplacental ratio.

In our opinion, the findings of this specific study may improve our limited knowledge for the application of Doppler ultrasound in pregnant women with COVID-19.

Key words: COVID-19 infection during pregnancy, cerebro-placental circulation during pregnancy

Introduction

The prevalence of severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) infection among pregnant women has been reported to be 14–15%, with most (50–90%) women being asymptomatic[1]. Only a small percentage show severe symptom, mainly during the third trimester of pregnancy; among these women, there is a higher risk of severe complications and death[2].

Most pregnant women who are positive for SARS-COV-2 are asymptomatic and have a low prevalence of perinatal complications. Initially, there was an over-reaction concerning the potential complications of SARS-COV-2 in pregnancy, with an increase in rate of indicated preterm birth in order to avoid foetal exposure to the virus. However, now that clinical experience has accumulated, the general consensus is that only minimal or mild foetal side effects are associated with maternal SARS-COV-2 infection during pregnancy[3].

Since the first case of the 2019 novel coronavirus disease (COVID-19, previously known as 2019-n COV) was reported in Wuhan, China, in December 2019, norovirus infection has spread throughout China and the world. This outbreak has been caused by SARS-COV-2 that is a new coronavirus discovered in humans for the first time. It belongs to the coronavirus-β genus and is similar to Middle East Respiratory Syndrome coronavirus (MERS-COV) and severe acute respiratory syndrome coronavirus (SARS-COV). SARS-COV-2 infection mainly causes interstitial pneumonia, hypoxemia and respiratory distress syndrome but is more infectious than SARS-COV and MERS-COV[4].

Pregnant women, as a special group, can be infected with SARS-COV-2, which often affects the fetuses and new-borns of these women. Since early February 2020,[5] first reported the clinical characteristics of 10 neonates born to mothers with confirmed SARS-COV-2 infection, clinical data of pregnant women infected with SARS-COV-2 are limited, and controversy exists over the prevalence and severity of pregnant women. Although some studies support the opinion that the COVID-19 in pregnant women are similar to those in non-pregnant ones, others show that the severity of infection in pregnant women is more serious. A systematic review on outcomes of SARS, MERS and COVID-19 during pregnancy supported that miscarriage, preeclampsia, cesarean and perinatal death were more common than in the general population[6].

Consistent conclusion is that the incidence of premature delivery and cesarean section after infection in pregnant women is higher. A systematic review including eighteen articles with 108 pregnancies and 75 neonates reported an extremely high rate of cesarean section (92%) partly due to foetal distress and suspected a response in neonate to maternal SARS-COV-2 infection. Severe maternal morbidity and perinatal death were reported in some studies. Up to now, Zhu et al. reported the highest postnatal morbidity in 10 neonates, included 6 cases of respiratory dyspnea,[7] cases with digestive symptoms and 1 case of death[8].

There is not enough evidence to conclude any definite detrimental effect of COVID-19 infection during pregnancy. Three studies have reported no maternal complication. However, various other studies have reported both maternal and fetal complications including preterm delivery, respiratory distress, fetal distress, and PROM[9].

According to the Royal College of Obstetricians and Gynecologists (RCOG), vertical transmission from a

woman to her baby may be possible, as suggested by new evidence. Taking all the available evidences into consideration, there are only a small number of reported cases to conclude whether there is possible intrauterine vertical transmission of SARS-CoV-2 or not[10].

Pregnant women who were infected with COVID-19 and delivered in the third trimester were more likely to have placentas that showed features of maternal vascular mal-perfusion and intervillous thrombi. No pathognomonic features were however identified[10].

These findings suggest an abnormal maternal circulation reflecting a systemic inflammatory or hypercoagulable state influencing placental physiology and associated with adverse perinatal outcomes. This case report highlights a pregnant woman who was RT-PCR positive for COVID-19. She was asymptomatic and hence home quarantined. After 14 days of her home quarantine, she was tested for SARS-COV-2 IgG antibody and it was found to be positive in high titre. Although the patient did not have any risk factor for IUGR and the normal growth of the fetus was documented up to 34 weeks, IUGR developed around 36 weeks of gestation[11]. Consequently, the aim of the study was to evaluate the effect of the infection with SARS-COV- 2 early in pregnancy on cerebroplacental circulation.

Patients and Methods

After ethical committee approval and written consents from the patients, this prospective study was conducted at tertiary care hospital at ultrasound and foetal medicine unit, Ain Shams University Maternity Hospital from January 2021 till June 2023 and performed on total 283 pregnant women who had been infected with SARS-COV-2 during early pregnancy (first trimester or early second trimester), compared to 283 healthy pregnant women as a control group.

Study population: Pregnant women who had been infected with SARS-COV-2 during early pregnancy (first trimester or early second trimester) with the following inclusion and exclusion criteria:

Inclusion criteria: Pregnant women who had been infected with SARS-COV-2 infection during early pregnancy (first trimester or early second trimester), Maternal Age: - Range between 22-35 years' old and BMI (18-30).

Exclusion criteria: women with previous history of IUGR, Multiple pregnancy fetuses with congenital anomalies, Chronic disorders affecting Doppler indices as: (DM, HTN, Thyroid disease, anemia and thrombophilia with pregnancy).

Study Procedures: All women were subjected to the following: SARS-COV-2 infection was diagnosed by a positive SARS-COV-2 viral RNA PCR or SARS-CoV-2 rapid antigen test carried out on nasopharyngeal samples or patients with two suspicious symptoms (Loss of taste, anosmia, fever) with chest radiological finding. All asymptomatic and Symptomatic cases were included in the study. Symptomatic cases were classified according to their symptoms either mild and severe. Severe cases referred to patients with severe symptoms required oxygen supplementation to maintain pulse oximetry above 95%. Mild cases referred to cases with symptoms such as cough, fever, malaise, diarrhoea and anosmia but didn't require oxygen supplementation.

Ultrasound and Doppler studies: The ultrasound was done for the included cases to evaluate foetal biometry, anatomy of foetus, amniotic fluid volume, placental calcification, and Doppler indices of the umbilical artery (UA), foetal middle cerebral artery (MCA) and cerebro-placental ratio (CPR). Fetal biometry included measurement of biparietal diameter, head circumference, abdominal circumference and femur length, and calculation of estimated fetal weight (EFW). Doppler velocimetry, including UA pulsatility index (PI), Resistance Index (RI) MCA-Pulsatility index (PI), Resistance index (RI) and Cerebro-placental Ratio (CPR) and were recorded according to ISUOG recommendations. UA- RI and

PI were considered abnormal if > 95th percentile for gestational age. MCA-RI and PI were considered abnormal if < 5th percentile for gestational age. CPR ratio was considered abnormal in less than one (reversed ratio)[12]. Ultrasound evaluation was done Twice at first visit and (28- 32) weeks, of pregnancy. by SAMSUNG SW80 machine (Elite) by Convex Probe.

Outcome measures: the effect of the infection with SARS-COV-2 early in pregnancy on cerebroplacental circulation.

Ethical Considerations: The patient data were anonymous. Data presentation was not be by the patient's name but by diagnosis and patient confidentiality was protected. An informed consent was taken from all participants, it was in Arabic language and confirmed by date and time. confidentiality was preserved by assigning a number to patients initials and only the investigator knew it

Conflict of interest: the candidate declared that there is no conflict of interest and the cost of the study was paid by the candidate.

Statistical analysis: Analysis is to be performed using SPSS for windows v20.0, Data to be presented in terms of range, mean and standard deviation (for numeric parametric variables); range, median and inter-quartile range (for numeric non-parametric variables); or number and percentage (for categorical variables). Difference between two independent groups is to be analyzed using independent student's t-test as well as the mean difference and its 95% CI (for numeric parametric variables); or chi-squared test as well as the risk ratio and its 95% CI (for categorical variables). Binary logistic regression analysis is to be performed for estimating the association between good/poor response and the measured variables ROC curves are to be constructed for estimating the validity of measured variables as predictors of good or poor response validity is to be presented in terms of sensitivity, specificity, positive and negative predictive values and their corresponding 95% Cis significance level is set at 0.05.

Results

During this study, 600 patients were assessed for eligibility and 566 patients were included in the study (283 in each group). Of all eligible patients, 22 patients were excluded from the study based on the inclusion criteria and 12 patients refused to participate in of the study. Ultimately, the analysis was based on the data of 283 pregnant women who had been infected with SARS-COV-2 during early pregnancy (first trimester or early second trimester), compared to 283 healthy pregnant women as a control group.

Table 1 shows that no statistically significant differences between the studied groups regarding demographic characteristics; age, body mass index and parity as well as gestational age at the study time points. All COVID-19 cases were of mild severity.

Table 2 shows that that no statistically significant differences between the studied groups regarding Middle cerebral artery (MCA) pulsatility index (PI).

Table 3 shows that that no statistically significant differences between the studied groups regarding Middle cerebral artery (MCA) resistive index (RI).

Table 4 shows that There were no statistically significant differences between the studied groups regarding Umbilical artery (UA), Pulsatility index (PI).

Table 5 shows that There were no statistically significant differences between the studied groups regarding Umbilical artery (UA) resistive index (RI).

Table 6 shows There were no statistically significant differences between the studied groups regarding Cerebroplacental ratio

Discussion

COVID-19 is a new, multisystem infectious disease that may also affect fetuses by vertical transmission. Acute inflammation and increased peri villous fibrin and decidual arteriopathy in the placentas

of pregnant women infected with COVID-19 were detected[10] with identified coronavirus virons in the placental villi by using electron microscopy. Pathological processes that interact with placental vascular structures and maternal hypoxia were reported to cause impaired fetal Doppler findings[13]. Therefore,

Table 1. Demographic characteristics between the study groups.

VARIABLES		COVID-19 GROUP (TOTAL=283)	CONTROL GROUP (TOTAL=283)	P-VALUE
Age (years)	***Mean±SD***	27.7±3.0	27.5±2.9	^0.572
	Range	22.0–35.0	22.0–35.0	
BMI (kg/m2)	***Mean±SD***	24.5±2.1	24.3±2.2	^0.342
	Range	18.8–29.8	18.9–29.9	
Parity (n, %)	***Nulli***	107 (37.8%)	101 (35.7%)	#0.601
	Multi	176 (62.2%)	182 (64.3%)	
Gestational age (20-24 weeks)	***Mean±SD***	22.2±0.8	22.2±0.8	^0.167
	Range	20.0–24.0	20.0–24.0	
Gestational age (28-32 weeks)	***Mean±SD***	30.1±0.8	30.2±0.8	^0.266
	Range	28.0–32.0	28.0–32.0	
Severity (n, %)	***Mild***	283 (100.0%)	Not applicable	

BMI: Body mass index. ^Independent t-test. #Chi square test

Table 2. Middle cerebral artery (MCA) pulsatility index (PI) between the study groups.

TIME		COVID-19 GROUP (TOTAL=283)	CONTROL GROUP (TOTAL=283)	P-VALUE
Week 20-24	Mean±SD	1.77±0.11	1.77±0.10	0.473
	Range	1.48–2.22	1.47–2.05	
Week 28-32	Mean±SD	2.11±0.08	2.11±0.09	0.471
	Range	1.89–2.41	1.79–2.39	

Independent t-test.

Table 3. Middle cerebral artery (MCA) resistive index (RI) between the study groups.

TIME		COVID-19 GROUP (TOTAL=283)	CONTROL GROUP (TOTAL=283)	P-VALUE
Week 20-24	***Mean±SD***	0.78±0.03	0.78±0.03	0.888
	Range	0.69–0.87	0.69–0.87	
Week 28-32	***Mean±SD***	0.83±0.03	0.83±0.03	0.247
	Range	0.74–0.92	0.74–0.92	

Independent t-test.

Table 4. Umbilical artery (UA) pulsatility index (PI) between the study groups.

TIME		COVID-19 GROUP (TOTAL=283)	CONTROL GROUP (TOTAL=283)	P-VALUE
Week 20-24	***Mean±SD***	1.15±0.11	1.15±0.10	0.822
	Range	0.88–1.60	0.88–1.47	
Week 28-32	***Mean±SD***	1.00±0.05	1.00±0.05	0.861
	Range	0.88–1.14	0.90–1.16	

Independent t-test.

Table 5. Umbilical artery (UA) resistive index (RI) between the study groups.

TIME		COVID-19 GROUP (TOTAL=283)	CONTROL GROUP (TOTAL=283)	P-VALUE
Week 20-24	***Mean±SD***	0.80±0.05	0.79±0.06	0.428
	Range	0.64–0.90	0.63–0.90	
Week 28-32	***Mean±SD***	0.66±0.04	0.66±0.04	0.880
	Range	0.55–0.79	0.54–0.81	

Independent t-test.

Table 6. Cerebro-placental ratio between the study groups.

TIME		COVID-19 GROUP (TOTAL=283)	CONTROL GROUP (TOTAL=283)	P-VALUE
Week 20-24	***Mean±SD***	1.55±0.13	1.54±0.13	0.415
	Range	1.21–1.93	1.26–1.94	
Week 28-32	***Mean±SD***	2.12±0.11	2.12±0.10	0.467
	Range	1.81–2.41	1.83–2.42	

we thought that COVID-19 infection might have an adverse effect on fetal Doppler parameters.

Researchers suggested that maternal COVID-19 may affect the oxygen supply of the fetus, leading to placental insufficiency, IUGR, fetal distress, and fetal death[14].

Fetal Doppler parameters ultrasonography have been used for the assessment of fetal well-being in high-risk pregnancies for years. Various vascular structures like uterine artery, umbilical artery, middle cerebral artery and ductus venosus have been evaluated via ultrasonographic Doppler measurements to help physicians for decision-making processes. However, our knowledge regarding the application of Doppler ultrasound in pregnant women with COVID-19 is limited[12].

Since Covid-19 infection during pregnancy represents major conflict due to the physical and physiological changes that occur during pregnancy and often associated with obstetric complications, evaluating the effect of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) on fetal Doppler parameters was highlighted as a main point of interest[14].

Consequently, this study was conducted and aimed to evaluate the effect of the infection with SARS-COV-2 early in pregnancy on cerebroplacental circulation.

This prospective study was conducted at tertiary care hospital at ultrasound and fetal medicine unit, Ain Shams University Maternity Hospital from January 2021 till June 2023 and performed on total 283 pregnant women who had been infected with SARS-COV-2 during early pregnancy (first trimester or early second trimester), compared to 283 healthy pregnant women as a control group.

During this study, 600 patients were assessed for eligibility and 566 patients were included in the study (283 in each group). Of all eligible patients, 22 patients were excluded from the study based on the inclusion criteria and 12 patients refused to participate in of the study.

Ultimately, the analysis was based on the data of 566 pregnant women who had been infected with SARS-COV-2 during early pregnancy (first trimester or early second trimester).

The current study revealed that there were no statistically significant differences between the studied groups regarding demographic characteristics; age, body mass index and parity as well as gestational age at the study time points. All COVID-19 cases were of mild severity (p values = 0.603, 0.703, 0.999, 0.485) respectively.

As regards Middle cerebral artery doppler, the current research study revealed that there were no statistically significant differences regarding Middle cerebral artery (MCA) pulsatility index (PI) and resistive index (RI) at different gestational ages (20-24 and 28-32 weeks).

Middle cerebral arterial (MCA) Doppler is affected by various factors, such as fetal anemia, IUGR, and fetal distress[15]. In IUGR, blood flow tends toward the fetal brain and MCA flow resistance is reduced, maximizing oxygen and nutrient supply to the brain (the brain-sparing effect). Thus, it has been used widely and for years by clinicians for monitoring high-risk pregnancies. However, the role of MCA Doppler in pregnant women with COVID-19 infection has not yet been clarified. We hypothesized that fetal brain circulation may be affected by COVID-19 infection-related events. Impaired fetal perfusion may be caused by cytokine storms, maternal hypoxia, and impaired coagulation cascades[16]. Furthermore, vertical transmission of viral particles may result in an excessive inflammatory fetal response. Despite our expectations, we did not find differences in MCA Doppler PI between the groups in this study.

As regards umbilical artery doppler, the current research study revealed that there were no statistically significant differences regarding umbilical artery (UA) pulsatility index (PI) and resistive index (RI) at different gestational ages (20-24 and 28-32 weeks).

The umbilical artery (UA) has been used for years to assess fetal wellbeing. Abnormal UA Doppler values are closely related to placental diseases. Increased resistance shows uteroplacental insufficiency, which can occur in stressed fetuses, similar to IUGR fetuses[17]. Maternal vascular malperfusion due to hypoxemia and thrombosis may affect UA Doppler values in fetuses infected with COVID-19. However, we did not find differences in UA Doppler parameters between the two groups in this study.

As regards Cerebro-placental ratio, the current research study revealed that cerebroplacental ratio at 20-24 weeks was 1.55±0.13 and 1.54±0.13 and at 28-32 weeks, it was 2.12±0.11 and 2.12±0.10 in covid-19 group and control group respectively (p value= 0.415, 0.467) with no statistically significant differences between the studied groups.

Recent data shows that CPR is an independent predictor of adverse perinatal outcomes[18,19]. However, our study did not detect differences in CPR values between patients with COVID-19 and patients in the control group. A latest study reported that fetal brain and heart tissues do not express ACE2 receptors and that these organs will not be a target for the virus[20]. This might be one explanation for the findings of the present study.

Many findings in the previous literatures are similar to our research results which strengthens and augments these findings and results reliability.

These findings are in agreement with previous studies. Ayhan, S. G et al.,[14] conducted a prospective case-control study that enrolled 54 COVID-19 confirmed pregnant women and 97 age-matched pregnant women as a control group between 28 and 39 weeks to investigate the effect of SARS-CoV-2 on fetal Doppler parameters and revealed that when the Doppler parameters were compared, there were no statistically significant differences regarding UA PI (0.88± 0.29 vs 0.87± 0.22; p value=0.81), MCA PI (2.16± 0.85 vs 2.19± 1; p value=0.80), Ductus venosus (0.77± 0.61 vs 0.86± 0.54; p value=0.27), Cerebro-placental ratio (2.6± 1.2 vs 2.65± 1.6; p value=0.83) in covid19 group and control group respectively.

In support of our findings, Asir, B et al.,[21] conducted a prospective case-control study that enrolled 100 pregnant women (50 in each group) to evaluate maternal and fetal blood flow parameters of term pregnant women who had recovered from COVID-19 during pregnancy and revealed that no significant differences were found in terms of PI and RI values of MCA (1.67± 1.47 vs 1.61± 1.30 and 0.69± 0.16 vs 0.75± 0.17; p value=0.830, 0.104) and UA (1.19± 1.33 vs 1.19± 1.93 and 0.59± 0.28 vs 0.61± 0.30; p value=0.985, 0.666) between term pregnant women who had COVID-19 during pregnancy and those who did not.

Consistent with our results, Soto- Torres et al.,[22] found no significant differences in fetal ultrasound and Doppler findings between pregnant women who were positive for SARS-CoV-2 and those who were negative.

Moreover, Mehmet, Ö et al.,[23] conducted a prospective case-control study that enrolled 81 pregnant women who had mild to moderate COVID-19 infections during their pregnancy and 70 patients who had no RT-PCR positivity or symptoms during their pregnancy to evaluate the effects of COVID-19 infection on neonatal outcomes in the late preterm period, fetal biometry, and fetal Doppler measurements and revealed that Uterine A, Umbilical A, MCA Doppler measurement (pulsatility index [PI], systolic/ diastolic ratio [S/D]), cerebroplacental ratio (CPR), amnion fluid index, head circumference, abdominal circumference, and femur length measurements performed in the late preterm period between 34 and 37 weeks, and there was no difference significantly between COVID-19 and control groups.

In contrast to our results, Anuk et al.,[24] compared maternal-fetal Doppler patterns in pregnant women who were diagnosed with COVID-19 and completed the quarantine period with healthy pregnant women and reported higher pulsatility and resistance indices of Umbilical A and Uterine A in pregnant women who recovered from COVID-19 compared to the control group.

Furthermore, Kaplan, E et al.,[25] observed that the UA-PI, MCA-PI, MCA-RI, UA-RI, MCA S/D and UA-S/D values increased and the CPR value decreased in pregnant women recovered from asymptomatic COVID-19 compared to healthy pregnancies. In addition, studies on the placentas of pregnant women who gave birth at term have shown the presence of fetal vascular malformation with multiple thrombosis[26]. The increase in Doppler U/S resistance parameters obtained, suggests that pregnant women who had COVID-19, even if asymptomatically, may have shown variability due to vascular malformations caused by placental vertical transmission of COVID-19.

The reason for these different results may be related to the methodological differences in the studies. Anuk et al.,[24] performed Doppler measurements during the week of pregnancy who had COVID-19 disease and completed the quarantine period and Kaplan, E et al.,[25] conducted a retrospective study which may cause bias in the evaluation of these data.

Whereas, we prospectively performed all Doppler ultrasound evaluations for pregnant women who had been infected with Covid-19 infection during early pregnancy (first trimester or early second trimester). We recorded the pregnant women who were diagnosed with COVID-19, followed up, and performed Doppler ultrasound and fetal biometry measurements when they reached 20 and above gestational weeks to 32 weeks.

As regards fetal weight and parameters, our study results revealed that the mean fetal weight at 20-24 weeks was 470.4±56.2 gm and 477.3±54.4 in covid-19 group and control group respectively (p value= 0.140), and 1504.3±128.3 gm and 1512.5±140.4 gm at 28-32 weeks in covid-19 group and control group respectively (p value= 0.470). None of the studied cases showed Small for gestational age nor Large for gestational age with no statistically significant differences between the studied groups.

Moreover, there were no statistically significant differences between the studied groups regarding fetal Biparietal diameter, fetal Head circumference, fetal Femur length and fetal Abdominal circumference. Amniotic fluid volume was non-significantly lower in COID-19 group. Oligohydramnios was non-significantly more frequent in COID-19 group, while Polyhydramnios was non-significantly less frequent in COID-19 group and Placental calcification was non-significantly more frequent in COID-19 group.

In concordance with our results, Ayhan, S. G et al.,[14] revealed that the fetal weight was 2377±850 gm and 2398±646 gm in covid-19 group and control group respectively which was statistically non-significant (p value= 0.87).

In agreement with our results, Asir, B et al.,[21] revealed that the fetal weight was 2632±552 gm and 2735±600 gm in covid-19 group and control group respectively which was statistically non-significant (p value= 0.87) with no statistically significant difference as regards amniotic fluid index (p value= 0.310).

The strength points of this study

The strength points of this study are that it is prospective study design, its setting at a single tertiary care center, having no patients lost to follow-up during the study period and relatively larger sample size related to the previous literatures. To the best of our knowledge, this is the first study with the largest population to evaluate adverse perinatal outcomes, Doppler ultrasound parameters and biometric measurements together in pregnant women who had been infected with COVID-19 infection during early pregnancy (first trimester or early second trimester). The ultrasound parameters were performed by single sonographer which decreased the detection bias and interobserver variability.

The limitations of the study

The findings of this study should be interpreted in light of its limitations. Firstly, including the lack of information about the long-term fetal and maternal follow-up of the participants such as mode of delivery, and APGAR scores of the baby. Secondly, since it is a single-center study, there is a homogeneous patient population.

Conclusion

This present study reported no significant differences in fetomaternal blood flow parameters in pregnant women who had been infected with SARS COVID 2 infection during early pregnancy (first trimester or early second trimester) compared to those who have not had the disease using doppler parameters of umbilical artery, middle cerebral artery and cerebroplacental ratio.

In our opinion, the findings of this specific study may improve our limited knowledge for the application of Doppler ultrasound in pregnant women with COVID-19.

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