CORRELATION OF CEREBROPLACENTAL RATIO IN THIRD TRIMESTER OF PREGNANCY WITH THE PERINATAL OUTCOME

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Abstract

Background: The cerebroplacental ratio is used for assessing fetal well-being and predicting perinatal outcomes in the third trimester of pregnancy. Its integration into antenatal surveillance, along with other Doppler indices and clinical factors, may contribute to improved risk stratification and personalized management strategies to optimize maternal and fetal outcomes.

Aims and Objectives: To study the association of Cerebroplacental ratio in third trimester of pregnancy with the Perinatal Outcome

Methods: This prospective observational study was conducted in the Department of Radio-diagnosis at Faculty of Medicine and Health Sciences, Budhera, Gurugram on pregnant women with gestational age between 28-40weeks referred from Department of Obstetrics and Gynaecology for Doppler USG.

Results: A total 150 participants were included in the study. The study participant`s mean age was 26.1±4.5 years with 79 participants ≤25 years, 41 participants aged 26-30 years, and 30 participants >30 years old. The mean of gestational age at the time of delivery and USG were 35.1±2.4 weeks and 34.1±2.6 week respectively. The mean BPD, HC, AC, and FL were 8.4±0.7 cm, 30.3±2.3 cm, 28.8±3.2 cm, and 6.5±0.6 cm, respectively. The mean pulsatility index for the middle cerebral artery (MCA) and umbilical artery was 1.5±0.39 and 1.03±0.91, respectively. Out of the 150 participants, 123 had CPR >1 and 27 had CPR <1.Among the participants, 33 were delivered by lower segment cesarean section (LSCS), and 117 were delivered by normal vaginal delivery. Additionally, 22 participants experienced antepartum hemorrhage (APH) or postpartum hemorrhage (PPH). The average birth weight of newborns was 2.8±0.5 kg. Among the participants, 105 newborns were normal, 40 were small for gestational age (SGA), and 5 were large for gestational age (LGA). The mean Apgar score at 1 minute and 5 minutes was 7.9±0.96 and 8.2±0.65, respectively. Furthermore, 42 participants had preterm delivery, and 18 newborns required NICU admission. No statistically significant association was found between mothers' age, gestational age at delivery and CPR.

Conclusions: our study demonstrates a significant association between the cerebroplacental ratio (CPR) in the third trimester of pregnancy and various perinatal outcomes, including the Apgar scores, birth weight, mode of delivery, and NICU admission. A lower CPR (<1) was found to be associated with adverse outcomes, suggesting its potential utility as a non-invasive tool for identifying fetuses at risk. The cerebroplacental ratio is used for assessing fetal well-being and predicting perinatal outcomes in the third trimester of pregnancy. Its integration into antenatal surveillance, along with other Doppler indices and clinical factors, may contribute to improved risk stratification and personalized management strategies to optimize maternal and fetal outcomes

Keywords: Cerebroplacental ratio, Pulsatality index, Postpartem haemorrhage, Middle cerebral artery.

INTRODUCTION

A normal pregnancy comprises complex changes in the vasculature of mother and fetus, basically in the uterine blood supply which is critical for a successful pregnancy. After the zygote is implanted in the uterus, arterial system irrigating endometrium and myometrium undergoes a set of changes leading to establishment of uteroplacental circulation. The decidua invading the trophoblast is responsible for such changes in the arterial system. If ever there is an inability to adapt to above changes, abnormal vascular resistance pattern develops, resulting in fetal compromise.[1]

Colour Doppler was initially employed in the study of human pregnancy back in 1977 by Fitzgerald and Drumm[2] Their pioneering work recorded flow velocity waveforms from the umbilical vessels using continuous wave Doppler. Recent advancements in ultrasound technology have led to the development of real-time imaging techniques superimposed with color-coded blood flow, enabling the visualization of flow direction. This breakthrough has facilitated the delineation of smaller vessels such as the umbilical, uterine, foetal middle cerebral arteries, ductus venosus, and foetal aorta with enhanced precision and ease[3]

The application of colour flow doppler has now expanded to evaluate uteroplacental and foetal blood flow patterns, providing insights into the pathophysiology of high-risk pregnancies, including intrauterine growth retardation, pregnancy-induced hypertension and diabetes in pregnancy, among others [4]. Key doppler parameters of interest include absolute flow velocities, resistance index (RI), and pulsatility index (PI).

Color doppler ultrasound has now gained importance in surveillance of high risk pregnancy. Doppler use has shown to predict adverse pregnancy outcomes reliably.[5]

CPR, in particular, is a quick, non-invasive test that can be used to diagnose blood flow abnormalities in the placenta-umbilical and feto-cerebral circulations. It also offers information about the hemodynamic condition of the fetus. By splitting the MCA Doppler pulsatility index from the UA, the CPR can be calculated. CPR (MCA PI/UA PI) is becoming a useful tool for managing high-risk pregnancies and is a significant predictor of unfavorable pregnancy outcomes. [6-8]

When assessing a fetus's well-being, CPR is essential in predicting a negative perinatal outcome based on Color Doppler testing[9] It shows alterations in blood flow to the brain as seen by decreased UA diastolic flow as a result of enhanced placental resistance and cerebrovascular dilatation brought on by hypoxia. This change will result in a decrease in the systolic/diastolic ratio, resistance index (RI), and pulsatility index (PI)[10] They are increased in UA as a result of any placental pathology-related increased blood flow resistance. A deranged CPR is associated with various adverse perinatal outcomes including:

- Intrauterine growth restriction (IUGR): A low CPR is often indicative of compromised placental function, which can lead to restricted fetal growth.

- Fetal distress: Abnormalities in the CPR may signify fetal distress, which can lead to complications during labor and delivery.

- Low Apgar scores at birth: A low CPR has been linked to low Apgar scores at birth, indicating potential difficulties in the transition to extrauterine life.

- Admission to the neonatal intensive care unit (NICU): Infants with abnormal CPR values may require specialized care and monitoring in the NICU due to complications related to fetal well-being.

- Stillbirth: Abnormal CPR values could be associated with raised risk of stillbirth, emphasizing monitoring and timely intervention.

Fetal hypoxemia can be detected by the cerebroplacental ratio occurring via two distinct mechanisms: decreased resistance in Middle Cerebral Artery and raised placental resistance. CPR, has been found to be a more accurate predictor of unfavorable outcomes in fetuses with growth restrictions and prolonged pregnancies than the MCA and UA Doppler indices alone.**[11]**

An abnormal CPR leads 3 types of patterns. In the first pattern, UA and MCA PI are in the upper and lower range of the distribution curve. In the second pattern, the MCA PI is reduced while the UA PI is normal, leading to an unusually low CPR. An unusually raised UA PI and an abnormally lowered MCA PI make up the third pattern.[12-13]

The assessment of fetal well-being during pregnancy is a critical aspect of prenatal care, aiding in the identification of potential risks and the implementation of timely interventions. Among the various parameters used to evaluate fetal health, CPR has emerged as a significant tool in examining fetal brain and placental circulation.

This thesis aims to investigate the association between the cerebroplacental ratio measured during the third trimester of pregnancy and the perinatal outcomes of infants. Understanding this association is crucial for enhancing the prenatal monitoring process and improving the management of high-risk pregnancies. This research seeks to shed light on the potential of CPR as a predictive tool for identifying complications during pregnancy and childbirth, thus providing a foundation for enhancing prenatal care practices and improving neonatal outcomes.

AIM AND OBJECTIVES

- To study the association of Cerebroplacental ratio in third trimester of pregnancy with the PerinatalOutcome
- To measure PI (Pulsatility Index) of MCA (Middle Cerebral Artery), PI of UA (Umbilical Artery) and calculate Cerebroplacental Ratio (PI of MCA/PI of UA) in women during third trimester of pregnancy.

MATERIALS AND METHODS

The study was conducted in the Department of Radio-diagnosis at Faculty of Medicine and Health Sciences, Budhera, Gurugram on pregnant women with gestational age between 28-40weeks referred from Department of Obstetrics and Gynaecology, for Doppler USG, Faculty ofMedicine and Health Sciences, Budhera, Gurugram.

This study was Prospective observational study

Considering the current footfall Of Third Trimester women reporting for obstetrics doppler atthe department of Radiodiagnosis is 2-3 per week. Hence assuming the total data collection period of 1 year i.e. 52 weeks, and the feasibility of carrying the study, Convenient sampling   technique was used where complete enumeration of all the third trimester pregnant females fulfilling the inclusion criteria were taken as final sample size (Sample Size~150 females).

Inclusion Criteria

All pregnant females with singleton pregnancy coming for routine obstetric ultrasound and doppler evaluation with no pre-pregnancy comorbidities.

Exclusion Criteria

- Twin Pregnancy
- Early pregnancy upto 28 weeks
- Congenital anomalies in fetus
- Pregnant females with pre-existing hypertension and diabetes.

EQUIPMENT

2 GE Logic F8 expert Ultrasound machine and Phillips Affinity 50G

METHODOLOGY

All Pregnant women visiting the department of Radio-Diagnosis for routine obstetrics ultrasound willing to participate in study with fulfilling all the PC-PNDT formalities and the inclusion criteria were enrolled in the study. Informed and written consent was taken prior to study.

CLINICAL EVALUATION

This included a detailed clinical history and a complete general physical and systemic examination by the obstetrician. Relevant investigations such as routine antenatal work up available with the patient was taken into account.

SONOGRAPHIC EXAMINATION

All the pregnant women enrolled in the study underwent a comprehensive sonographic evaluation of the fetus. They were subjected to doppler study, including PI of the MCA and PI of the Umbilical Artery. The database collected was recorded in the individual assessment sheets specially structured for the study. Females participating in the study were followed up until term and managed as per protocol. These women were then followed up until delivery, and perinatal outcomes were studied as follows:

o Gestation: Period of birth

o Mode of Delivery

o Live Birth/Still Birth /Neonatal Deaths

o Birth Weight

o APGAR score (at 1 min and 5min)

o NICU admission rate for fetal distress

The hospital's Institutional Ethical Committee gave its approval before proceeding with the study.

OBSERVATIONS AND RESULTS:

This study showed that out of the 150 participants, 79 were ≤25 years, 41 were in age of 26-30 years and 30 were > 30 years of age.

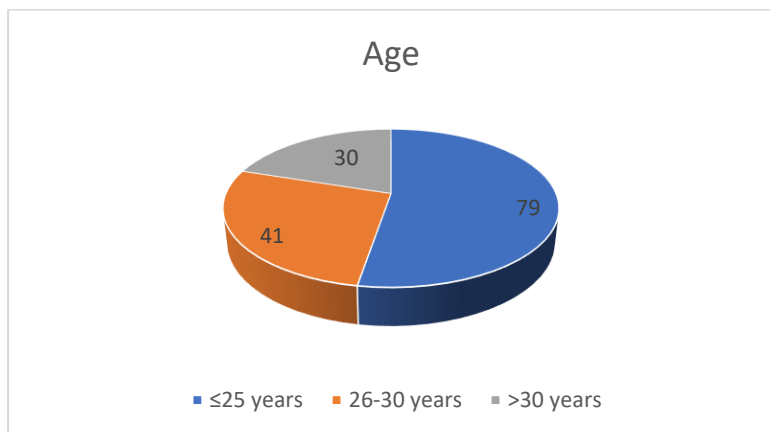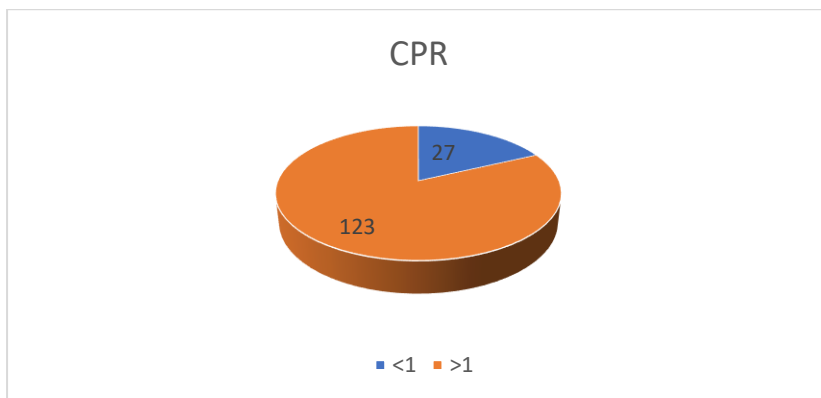Pie chart showing age distribution

Table: 1 Distribution of fetal parameters

Parameters	Mean	Median	SD	Minimum	Maximum
BPD	8.3660	8.3500	.71581	4.42	9.50
HC	30.3097	30.5950	2.31941	17.50	34.60
AC	28.8298	29.0100	3.17469	13.75	34.00
FL	6.5445	6.6350	.63628	2.94	7.44

PI MCA	1.4520	1.4500	.39111	.70	2.66
PI UMBLICAL	1.0292	.9050	.49383	.54	3.15

In the present study, out of the 150 participants, 123 had > 1 CPR and 27 had <1 CPR.

Pie chart showing distribution according to CPR

In present study, 33 participants were delivered by LSCS and 117 were delivered by normal vaginal delivery.

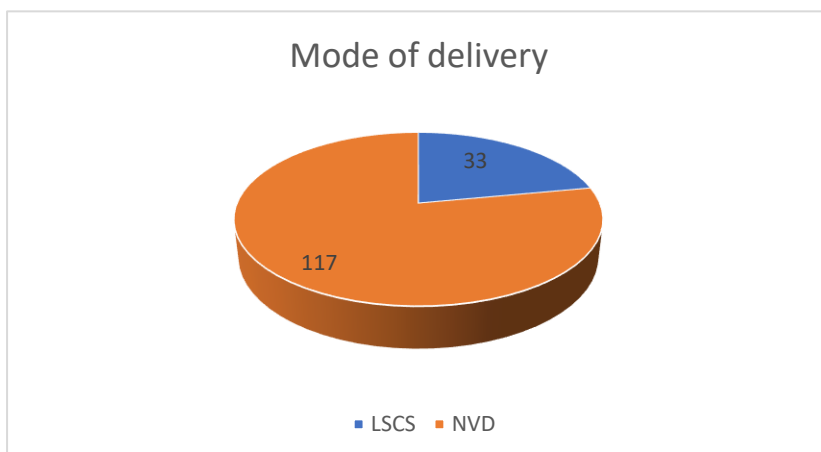Pie chart showing distribution according to Mode of delivery

Table: 2 Birth weight (kg) distribution of newborns:

Mean	2.815
Median	2.800
Std. Deviation	.5334
Minimum	2.0
Maximum	3.8

In the present study, average birth weight of newborn was 2.8±0.5 kg.

Table: 3 Distribution of study participants according to fetal outcome

Outcome	Frequency	Percent
SGA	40	26.7
LGA	5	3.3
Normal	105	70.0
Total	150	100.0

This study showed that out of the 150 participants, 105 newborn were normal, 40 were SGA(less than 10th percentile for gestational age) and 5 were LGA(greater than 95th percentile for gestational age).

Table: 4 APGAR score distribution newborns

	APGAR at 1 min	APGAR at 5 min
Mean	7.89	8.23
Median	8.00	8.00
SD	.963	.649
Minimum	6	7
Maximum	10	10

In this study, average APGAR score at 1 min and 5 min was 7.9±0.96 and 8.2±0.65 respectively.

Table: 5 Distribution of study participants according to Preterm delivery

Preterm delivery	Frequency	Percent
No	108	72.0
Yes	42	28.0
Total	150	100.0

In present study, out of the 150 participants, 42 had preterm delivery.

Table: 6 Distribution of study participants according to NICU admission

NICU admission	Frequency	Percent
No	132	88.0
Yes	18	12.0
Total	150	100.0

In present study, out of the 150 participants, 18 new born required NICU admission.

Table: 7 Association of CPR with age of mothers:

Age	CPR	p-value

	<1		>1		
	Count	%	Count	%	
≤25 years	17	63.0%	62	50.4%	0.492
26-30 years	6	22.2%	35	28.5%	
>30 years	4	14.8%	26	21.1%	
Total	27	100.0%	123	100.0%	

In the current study, mothers age and CPR showed no substantial association.

Table: 8 Association of CPR with gestational age:

Gestational age	CPR				p-value
	<1		>1		
	Mean	SD	Mean	SD	
Gestational age at the time of USG	32.96	2.968	33.34	2.268	0.108
Gestational age at delivery time	34.07	2.895	35.35	2.240	0.112

In the present study, no statistically significant association of gestational age at the time of delivery and USG was found with CPR.

Table: 9 Association of CPR with fetal outcome:

Gestational age	CPR				p-value
	<1		>1		
	Mean	SD	Mean	SD	
Birth weight (kg)	2.363	.5197	2.826	.5377	0.001
APGAR AT 1 min	6.15	.818	7.84	.987	0.001
APGAR AT 5 min	7.59	.501	8.15	.653	0.148

The current study discovered a statistically significant correlation between CPR and birth weight as well as APGAR scores at one and five minutes. When compared to participants who had more than one CPR, newborns whose CPR was less than one CPR had statistically significant lower birth weights and APGAR scores at one and five minutes.

Table: 10 Association of CPR with mode of delivery:

MOD	CPR				p-value
	<1		>1		
	Count	%	Count	%	
LSCS	16	59.3%	17	13.8%	0.0001

| NVD | 11 | 40.7% | 106 | 86.2% | |
| Total | 27 | 100.0% | 123 | 100.0% | |

In this table, statistically significant association between CPR and mode of delivery was found. Participants < 1CPR had statistically significant high rate of LSCS compare to participants had > 1CPR.

Table: 11 Association of CPR with Preterm delivery:

Preterm delivery	CPR				p-value
	<1		>1		
	Count	%	Count	%	
No	16	59.3%	92	74.8%	0.103
Yes	11	40.7%	31	25.2%	
Total	27	100.0%	123	100.0%	

In this study, no statistically significant correlation of CPR was noted pertaining to preterm delivery.

Table: 12 Association of CPR with NICU admission:

NICU admission	CPR				p-value
	<1		>1		
	Count	%	Count	%	
No	17	62.9%	115	93.5%	0.021
Yes	10	37.1%	8	6.5%	
Total	27	100.0%	123	100.0%	

In our study, a statistically significant association between CPR with NICU admission was seen. Participants < 1CPR had statistically significant high rate of NICU admission compare to participants had > 1CPR
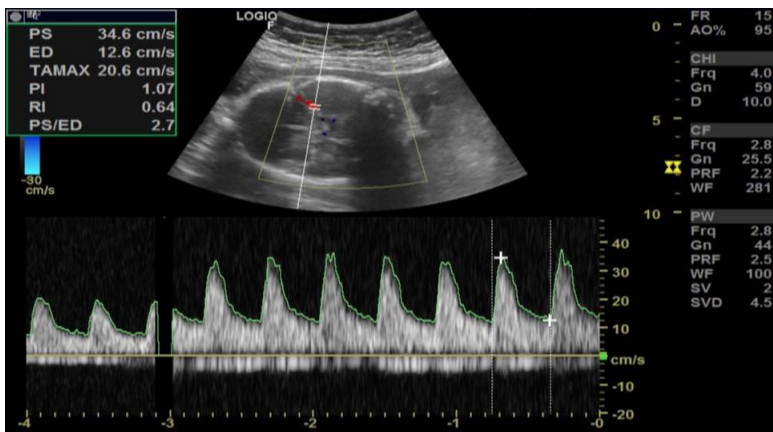
Table: 13 Association of CPR with SGA and LGA:

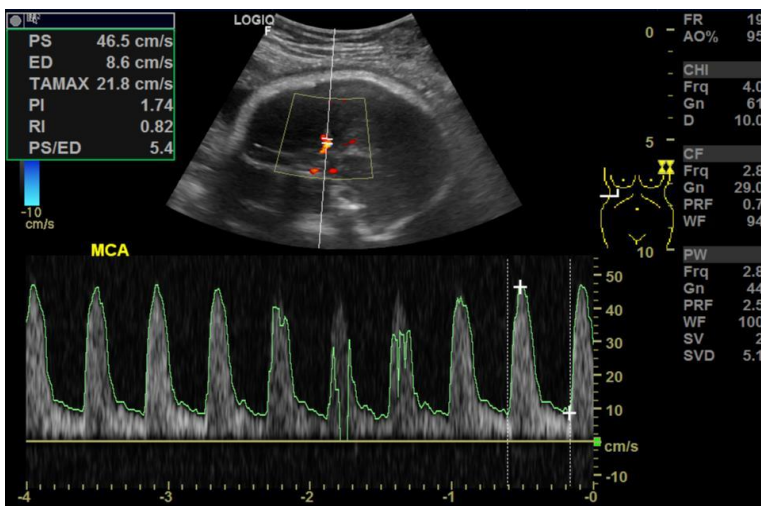| Parameter | CPR | | | | p-value |
	<1		>1		
	Count	%	Count	%	
SGA	9	33.3%	31	25.2%	0.387
LGA	2	7.4%	3	2.4%	0.678

There was no statistically significant correlation between CPR and SGA or LGA in this study.
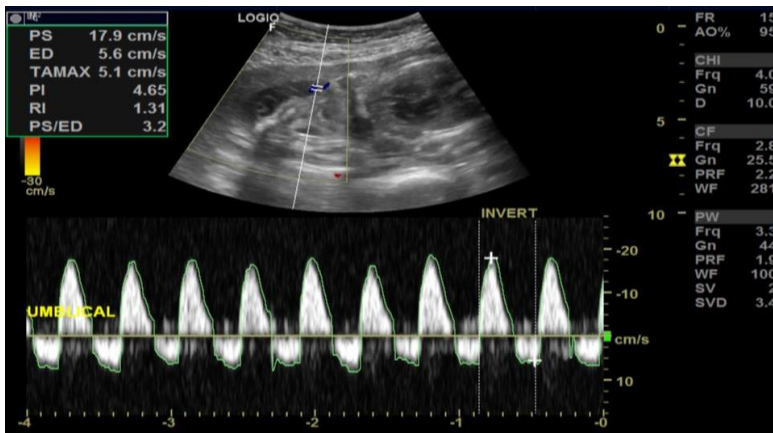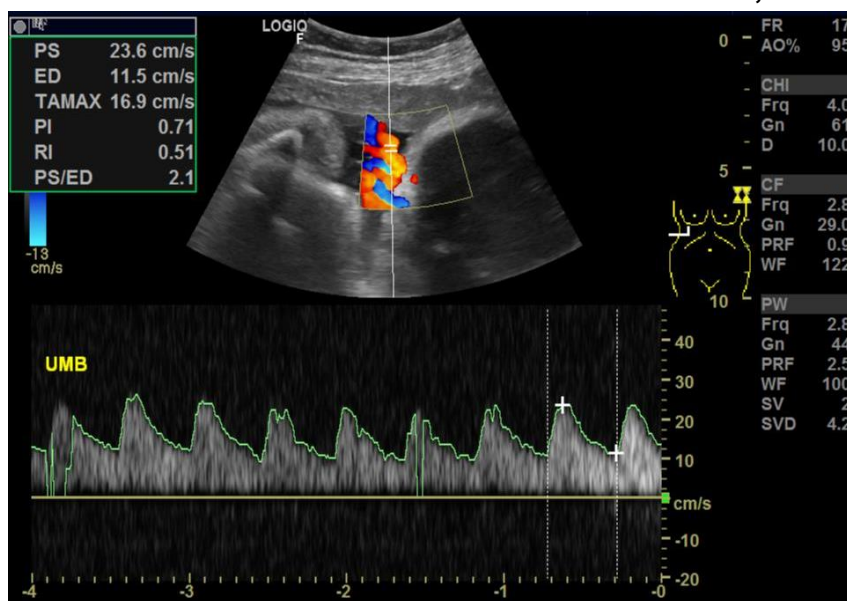

Reversal of diastolic flow of umbilical artery with raised PI and RI

Decreased PI , RI , PS/ED of MCA and reversed CPR.

Normal Middle Cerebral Artery and Umbilical Artery waveform

DISCUSSION:

The correlation of the Cerebroplacental Ratio (CPR) in 3rd trimester of pregnancy with perinatal outcomes is a critical area of investigation in maternal-fetal medicine. This parameter, calculated by dividing MCA PI by UA PI, serves as a valuable indicator of fetal well-being and oxygenation.

Understanding the correlation between CPR and perinatal outcomes provides crucial insights into the potential risks and complications that may arise during pregnancy and childbirth. Factors such as birth weight, Apgar scores, mode of delivery, and the need for neonatal intensive care unit (NICU) admission are often influenced by the CPR, offering clinicians valuable information to guide management decisions.

The study aimed to determine the association of CPR in third trimester of pregnancy with perinatal outcomes. We will discuss the results in comparison with similar studies to provide a comprehensive understanding of the implications value of CPR in assessing maternal and fetal well-being.

The mean age of the study participants was 26.1±4.5 years, with a diverse distribution across different age groups. This aligns with previous research indicating that age is not a significant factor influencing CPR. Dall'Asta et al[14]. and Bakalis et al[15]. similarly reported on the demographics of their study populations, providing a basis for comparison.

The mean gestational age at the time of USG and delivery in our study was 34.1±2.6 weeks and 35.1±2.4 weeks, respectively. Comparable findings were noted by Khalil et al.[16] and Adiga et al.[17], emphasizing the relevance of assessing CPR in the later stages of pregnancy for its predictive value.

The study observed variations in birth weight, Apgar scores, and delivery modes. Newborns with <1 CPR exhibited significantly lower birth weights and Apgar scores at 1 and 5 minutes, consistent with findings from Dall'Asta et al[14]. and Bakalis et al[15]. However, the study did not find a significant association with preterm delivery, in contrast to Khalil et al[19]. This discrepancy may arise from differences in study populations and methodologies.

In our study, 123 participants had a CPR >1, while 27 had a CPR <1. This finding is important, as a lower CPR has been associated with adverse perinatal outcomes in various studies.

Maternal and Neonatal Outcomes

In our study, 33 participants (22%) underwent cesarean section (LSCS), while 117 (78%) had a normal vaginal delivery. We found a statistically significant association between CPR and the mode of delivery, with participants having a CPR <1 experiencing a higher rate of LSCS in comparison to those with a CPR >1. This conclusion is in line with that of Khalil et al.[16], who found that pregnancies with

lower CPR rates had a higher rate of operative delivery for suspected fetal compromise.

Additionally, 22 participants (14.7%) in our study experienced antepartum hemorrhage (APH) or postpartum hemorrhage (PPH). However, no significant association between CPR and the occurrence of APH/PPH was found. This aspect was not specifically addressed in the compared studies.

The mean birth weight of the newborns in our study was 2.8±0.5 kg. Out of the 150 participants, 105 newborns were considered normal, 40 were small SGA, and 5 were large for gestational age LGA. We found a statistically significant association between CPR and birth weight, with newborns having a CPR <1 exhibiting a lower birth weight compared to those with a CPR >1. This finding is consistent with the concept that a lower CPR may indicate fetal adaptation to placental insufficiency, resulting in reduced fetal growth.

The mean Apgar scores at 1 and 5 minutes were 7.9±0.96 and 8.2±0.65, respectively. We found a significant association between CPR and Apgar scores, with newborns having a CPR <1 showing lower Apgar scores at both time points. This finding suggests that that a higher risk of fetal distress and newborn morbidity may be linked to a lower CPR.

Preterm delivery occurred in 42 participants (28%) in our study. However, no significant association between CPR and the occurrence of preterm delivery was found . This aspect was not specifically addressed in the compared studies.

No still births or neonatal deaths were noted in the study.

Neonatal intensive care unit (NICU) admission was required for 18 newborns (12%) in our study. We found a statistically significant association between CPR and NICU admission, with newborns having a CPR <1 experiencing a higher rate of NICU admission compared to those with a CPR >1. This finding is in line with the results of Khalil et al.[16], who reported a higher rate of neonatal unit admission in pregnancies with a lower CPR.

Adiga et al.[17]conducted a study comparing the cerebrouterine (CU) ratio (MCA/uterine artery PI) with the CPR in predicting adverse perinatal outcomes among pregnancies complicated by hypertensive disorders. They discovered that in terms of forecasting unfavorable outcomes, both ratios exhibited superior negative predictive values. Nevertheless, when combined, the CU and CP ratios were more effective than either ratio alone at predicting unfavorable outcomes.

This finding suggests that incorporating uterine artery Doppler along with the CPR may enhance the predictive value for adverse perinatal outcomes.

Our study findings suggest that the CPR in the third trimester of pregnancy is associated with various perinatal outcomes, including the mode of delivery, birth weight, Apgar scores, and NICU admission. A lower CPR (<1) was found to be significantly associated with adverse outcomes, such as a higher rate of LSCS, lower birth weight, lower Apgar scores, and higher NICU admission rates.

These results highlight the potential utility of the CPR as a non-invasive tool for identifying fetuses at risk of adverse perinatal outcomes. Incorporating the CPR into routine antenatal surveillance, particularly in the third trimester may aid in risk stratification and guide clinical decision-making regarding the timing and mode of delivery.

However, it is essential to interpret the CPR in the context of other clinical factors and Doppler indices. As demonstrated by some of the compared studies, the CPR alone may have limited predictive value, and its performance may vary depending on the specific outcome and the time interval between assessment and delivery.

Therefore, a comprehensive approach integrating the CPR with other Doppler indices, such as uterine artery and umbilical artery Doppler, along with clinical risk factors, may provide a more accurate assessment of fetal well-being and guide appropriate interventions.

The predictive value of the CPR varies across studies, and its performance may be influenced by factors such as the specific outcome assessed and the time interval between assessment and delivery. Therefore, the CPR should be interpreted in conjunction with other clinical factors and Doppler indices to provide a comprehensive assessment of fetal well-being.[18-19]

Our findings contribute to the growing evidence on the potential role of the CPR in antenatal surveillance and highlight the need for further research to validate its utility in different populations and to establish standardized cut-off values.

Incorporating the CPR into clinical practice, along with other Doppler indices and clinical risk factors, may aid in risk stratification and guide appropriate interventions to optimize perinatal outcomes. However, the CPR should be used as an adjunct to clinical judgment and not as a sole determinant of management decisions.

Future research should focus on refining the clinical application of the CPR, investigating its utility in specific high-risk populations, and evaluating the impact of incorporating the CPR into management protocols on perinatal outcomes and resource utilization.

CONCLUSION:

In conclusion, our study demonstrates a significant association between the cerebroplacental ratio (CPR) in the third trimester of pregnancy and various perinatal outcomes, including the Apgar scores, birth weight, mode of delivery, and NICU admission. A lower CPR (<1) was found to be associated with adverse outcomes, suggesting its potential utility as a non-invasive tool for identifying fetuses at risk. The cerebroplacental ratio is used for assessing fetal well-being and predicting perinatal outcomes in the third trimester of pregnancy. Its integration into antenatal surveillance, along with other Doppler indices and clinical factors, may contribute to improved risk stratification and personalized management strategies to optimize maternal and fetal outcomes.

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