Original Research Article

Cerebroplacental ratio and its relation to poor perinatal outcomes in singleton pregnancies: a cross sectional study in a tertiary care centre of Eastern India

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ABSTRACT

Background: Detection of fetal growth abnormalities by fetal monitoring is a critical component of perinatal care. Cerebroplacental ratio (CPR), as measured by colour Doppler, has recently been demonstrated to be a reliable indicator of foetus health. CPR is calculated as ratio of pulsatility index of middle cerebral artery (MCA) and umbilical artery (UA). When blood is redistributed in the early stages of hypoxia in favour of cerebral circulation, the diastolic flow amplitude increases above normal levels in MCA while umbilical flow in diastole decreases, providing CPR. This study aims to investigate the relationship between CPR and adverse perinatal outcomes.
Methods: After institutional ethical approval, a 2-year study was conducted on 226 pregnant women of age group 18-45 years with singleton pregnancies at 34-38 weeks with informed consent in a tertiary hospital in Eastern part of India. The MCA and UA pulsatility index were calculated using a doppler scan on each patient. When the cerebroplacental ratio is <1 it is deemed abnormal. The perinatal outcomes were observed and their associations were evaluated.
Results: There were 68/226 (30%) women had abnormal CPR (<1). CPR<1 was significantly associated with unfavourable perinatal outcomes (prematurity, low birth weight, NICU admission and perinatal hypoxia) with p value < 0.001.
Conclusions: CPR is important tool in predicting an unfavourable perinatal outcome.

Keywords: Cerebroplacental ratio, Middle cerebral artery, Perinatal outcomes, Umblical artery

INTRODUCTION

The cornerstone of preventive obstetric care aiming at lowering perinatal morbidity and mortality is antepartum foetal surveillance. Early and proper intervention can reduce the bad perinatal outcome in the foetus and is made possible by specific and precise procedures for detecting foetus at risk of mortality or compromise in utero. Neonate with foetal growth restriction (FGR) has four- eight folds elevated perinatal fatality rates and half of the neonates that survive have morbidity.[1] Doppler ultrasound, along with other antepartum foetal surveillance technologies, is an essential part of the antenatal foetal monitoring of

threatening pregnancies. It is a non-invasive method that enables evaluation of the placenta and foetal blood flow, allowing for the early detection of placental insufficiency.[2,3]

Given that a growth-restricted foetus exposed to compromised blood flow is especially at risk for hypoxia, doppler flow velocimetry investigations have advanced as a vital method for distinguishing a highly susceptible smaller foetus from a small foetus that is not likely to experience serious perinatal outcomes.[4] Instruments used in antepartum foetal surveillance include the foetal kick

count, non-stress test, biophysical profile, amniotic fluid index, and arterial and venous doppler.

Different dopplers and their proportions in turn reflect the future foetal growth pace. When a foetus has persistent hypoxia, total blood flow to the foetus is preferentially redistributed to vital organs like brain, heart, kidney.[5] A drop in the middle cerebral artery's pulsatility index (PI) often known as the "brain sparing effect," arises from compensatory vasodilation with an increase in diastolic flow.[6]

We can forecast the perinatal prognosis and adjust the obstetric care as appropriate by performing a doppler assessment of the MCA and UA in the foetus. In this study, the cerebroplacental ratio was investigated in relation to prenatal outcomes, taking into account all the relevant research and conclusions.

METHODS

This was a cross-sectional, observational study done among participants who visited the gynaecology and obstetrics department of a tertiary care hospital (IMS and SUM hospital Bhubaneswar) between December 2020 and November 2022.

Inclusion criteria

Inclusion criteria were the consented subjects between 18-45 year's age, 34-38 week of gestation, cephalic presentation.

Exclusion criteria

Exclusion criteria were patients with multifetal gestation, congenital malformation of foetus, non-consented.

Methods of collection of data

Nonprobability convenient sampling was followed and 226 participants were included in the study. Using a pre-made performa, sociodemographic information, patient characteristics and risk factor (age, health status, DM, hypertension, anemia, hypothyroidism) were noted.

All subjects were evaluated with ultrasound for biometry, liquor estimation using the amniotic fluid index (AFI) and cerebroplacental ratio (CPR). To get recordings from the umbilical artery (UA), the sample volume was placed into the artery lumen in a cord loop that is free from placental and foetal insertion sites. The MCA is visible at the base of the skull, overlaying the anterior wing of the sphenoid bone. Recording from MCA is taken using colour or power doppler ultrasound at transverse section of fetal skull at level of thalmi and cavum. CPR is a ratio between the MCA PI and the UA PI. CPR will be given a single cutoff value of 1, with CPRs below 1 regarded as abnormal.

The studied pregnant women were monitored until delivery in order to evaluate the perinatal and obstetric outcomes. Unfavorable perinatal outcomes include stillbirth or neonatal death, low or very low birth weight, an APGAR score at 5 minutes that is below 7, admission to the neonatal intensive care unit (NICU), perinatal hypoxia (umbilical arterial cord blood pH ≤7 and or lactate ≤6 mmol/L) and severe respiratory distress (respiratory support required for >4 hours).

Statistical analysis

Data was entered into MS excel sheet for all study subjects. SPSS v.21 was used to analyse the data that had been gathered. Chi square and independent t test were used for test of significance.

RESULTS

Distribution of study population according to demography

Among the 226 subjects, the mean age was 27.83±3.39. In the study 178 were primigravida and the remaining were multigravida. In majority of the subjects the gestational age was between 36-38 weeks followed by 34-36 weeks. The comorbidities noted was mainly gestational hypertension (17.7%), hypothyroidism (7.5%) and gestational diabetes mellitus (3.5%). Majority (61.1%) of the deliveries was normal and in 38.9% lower segment caesarean section was conducted (Table 1).

Table 1: Socio-demographic distribution.

Socio- demography	Frequency	Percent
Age	27.83±3.39	
Weight	53.89±4.63	
Parity		
Primi	178	78.8
Multi	48	21.2
Gestational age		
34- 36 weeks	61	26.9
36- 38 weeks	165	73.1
Comorbidities		
None	160	70.8
GDM	8	3.5
Gestational HTN	40	17.7
GDM+ HTN	1	0.4
Hypothyroid	17	7.5
Mode of delivery		
LSCS	88	38.9
Normal	138	61.1

Association of abnormal CPR with ultrasound parameters

According to this study, only 8.8% of people with normal CPR had UA PI over the 95th percentile, compared to

91.04% of people with abnormal CPR. As a result, abnormal CPR was significantly ($p<0.01$) associated with $>95^{th}$ percentile UA PI. Similar to those with abnormal CPR, 71.6% of these individuals had MCA PI in the 5th percentile, which was likewise significant ($p<0.01$) as seen in Table 2.

Table 2: Association of abnormal CPR with ultrasound parameters.

Ultrasound parameters	CPR		Total	p-value
UA PI	**Abnormal (<1) (%)**	**Normal (>1) (%)**		
$>95^{th}$ percentile	61 (91.04)	14 (8.8)	75 (33.2)	<0.01
MCA PI				
$<5^{th}$ percentile	48 (71.6)	29 (18.24)	77 (34.07)	<0.01

Distribution according to CPR

The cerebroplacental ratio (Table 3) was abnormal in 30% and normal in the remaining 70% of the subjects.

Table 3: Distribution according to CPR.

CPR	Frequency	Percent
Normal (>1)	158	70
Abnormal (<1)	68	30
Total	226	100

Association between cerebroplacental ratio and perinatal outcomes

A statistically significant association between CPR and perinatal outcomes was found. This indicates that subjects with abnormal CPR were more likely to have underweight babies, APGAR scores of <7 at 5 minutes, NICU admission, and perinatal hypoxia, as shown in Table 4.

Table 4: Association between cerebroplacental ratio and perinatal outcomes.

Perinatal outcome	CPR	Mean	SD	95% Confidence interval		Significance
				Lower levels	**Upper levels**	
Low birth weight	Abnormal	2.03	0.55	1.41	1.15	<0.001*
	Normal	2.93	0.28	1.18	0.97	
APGAR <7 at 5 minutes	Abnormal	1.28	0.45	0.78	0.64	<0.001*
	Normal	2	-	0.82	0.6	
NICU	Abnormal	1.55	0.5	0.51	0.34	<0.001*
	Normal	1.98	0.13	0.55	0.3	
Perinatal hypoxia	Abnormal	1.61	0.49	0.46	0.3	<0.001*
	Normal	1.99	0.07	0.5	0.26	
*Level of significance: p<0.05						

DISCUSSION

Researchers have found that CPR has a good chance of predicting perinatal outcomes like an urgent caesarean due to foetal distress and admission to a new born care unit. Several meta-analyses regarding CPR highlighted the variety of data sources, varying cut-off levels, & the potential for bias.

Some authors found a clear link between CPR and an unfavourable pregnancy outcome until 34 GW, but not beyond. The study by Bethold et al showed that the mean age was 32.42±5.42 years, mean gestational age at delivery was 38.13±1.92 weeks, and most of the deliveries were LSCS.[7] In contrast, our study had mean age of 27.83±3.39 years, with a larger of them being between 36- 38 weeks and majority of them had normal births. According to Anna et al, the majority of the cases were between 37- and 39-weeks' gestation, 60% were primigravidae and 48.6% had normal births.[8] The majority of the findings concur with the current findings. In the Khalil et al study, amongst

patients having low CPR, increased incidence of operative delivery was noted.[9] According to Subha S and Sankari M, the route of birth was LSCS in 64%, and the mean age was 24.9 years whereas in the present study LSCS rate was lower (38.9%).[10] According to Subha et al, 52% were primigravidae (78.8% in the present study) and 70% had gestational hypertension whereas in our study only 17.7% had hypertensive disorders of pregnancy.[10]

Cerebroplacental ratio was not found to be useful in the investigation by Vollgraff et al in predicting any negative perinatal outcome.[11] In the present study 26.9% of women were delivered before 36weeks which concurred with a study by Dall'asta et al {n=562}, in which women with reduced CPR MoM delivered at an early gestational age.[12] There was a significant association between reduced CPR MoM and lower gestational age at delivery. Consistent with a research by Gruttner et al, n=2270, where mean gestational week of birth in the group of patients with pathological CPR was 37 weeks, whereas it was 39 weeks in the group of patients with normal CPR.[13] The

difference of 2 weeks between the various CPR groups was statistically significant. (p<0.001).

According to Bethold et al, patients with aberrant CPR had significantly poorer APGAR scores at 1, 5, and 10 minutes, as well as low birth weight, which is a similar finding observed in the current study.[7] According to Gramellini et al, Apgar below 7 at 5 min was significantly different between abnormal and normal CPR groups.[2] Both the studies have similar finding as the present results. It must be emphasised, as in the present study findings, women with lower CPR gave birth significantly remote from term gestation that may possibly explain the LBW, as evident from Flood et al.[14]

In our study, perinatal hypoxia and NICU admission was significantly associated with abnormal CPR (p<0.01). However, there was no stillbirth. According to the Anna et al study, 2.8% of babies had an APGAR score of 7 at 5 minutes.[8] The study also revealed that 2.2% people had a mild respiratory issue, 0.6% needed new-born critical care, and 0.6% had stillbirths. A link between inadequate CPR and perinatal outcomes like a low APGAR score, LBW and NICU was also reported by Khalil et al in their study.[9] In patients with inadequate CPR, Subha et al observed that admission to the NICU was a significant perinatal outcome which was evident in the present study.[10]

This study has some limitations. In this study, doppler evaluation results were not blinded, which could have created the possibility that this information may have influenced future clinical intervention and treatment outcome, one of the study's shortcomings. Additionally, there was no study of cord blood measurements which may have shown have a greater association with newborn health and lastly long term follow up of neonatal health could not be performed.

CONCLUSION

There is a significant association of CPR with gestational age of delivery, perinatal outcomes like: low APGAR (<7 at 5min), intensive care requirement, perinatal hypoxia. A CPR of >1 excludes unfavourable prenatal outcomes due to its high specificity and negative predictive value. Along with CPR, additional clinical parameters such as association of hypertensive disorder of pregnancy and sonographic parameters such as AC and EFW <10th percentile and oligohydramnios can improve predictions of adverse perinatal outcomes.

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