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CEREBROPLACENTAL RATIO AND NEONATAL OUTCOME IN A TERM LOW-RISK PREGNANCIES WITH REDUCED FETAL MOVEMENT: A RETROSPECTIVE STUDY

Dr Ramya M D*	Post Graduate MBBS MS Obstetrics And Gynecology Bangalore Medical college and Research Institute Krishna Rajendra Road, Kalasipalya Bangalore 560002 *Corresponding Author
Dr Dhanyashree D V	POST Graduate MBBS MS Obstetrics And Gynecology Bangalore Medical college and Research Institute Krishna Rajendra Road, Kalasipalya Bangalore 560002
Dr Avinash Yadav V K	POST Graduate MBBS MS Obstetrics And Gynecology Bangalore Medical college and Research Institute Krishna Rajendra Road, Kalasipalya Bangalore 560002
Dr Savitha C	POST Graduate MBBS MS Obstetrics And Gynecology Bangalore Medical college and Research Institute Krishna Rajendra Road, Kalasipalya Bangalore 560002

ABSTRACT **Background:** Cerebroplacental ratio (CPR) is a Doppler ultrasound marker for assessing fetal hemodynamics and predicting neonatal outcomes. In term, low-risk pregnancies with reduced fetal movements (RFM), the potential of CPR to signal compromised placental function remains under-investigated, especially given RFM's association with adverse neonatal outcomes, including intrauterine growth restriction (IUGR) and fetal distress. **Objectives:** To evaluate the relationship between CPR and neonatal outcomes in low-risk term pregnancies with RFM, hypothesizing that lower CPR values correlate with poorer neonatal outcomes, such as NICU admission and mortality rates. **Methods:** A retrospective observational study was conducted on 83 women admitted to Vani Vilas Hospital, BMCRI, from May 2023 to May 2024, with singleton, term, low-risk pregnancies (37–40 weeks) and presenting RFM. Exclusion criteria included high-risk conditions like IUGR, gestational diabetes, or multiple pregnancies. Non-stress tests, biophysical profiles, and Doppler measurements of CPR were performed. Neonatal outcomes, including Apgar scores, NICU admissions, and cord blood pH, were assessed. Data analysis utilized Chi-square and Student's t-tests, with significance set at $p < 0.05$. **Results:** In the study, it was observed that there was no significant association between CPR values and NICU admissions or mortality rates. However, NICU-admitted infants had a significantly lower mean cord pH ($p < 0.001$), suggesting potential fetal compromise. Mortality rates were unexpectedly high across both CPR categories, highlighting a need for further assessment.**Conclusion:** While CPR serves as a valuable Doppler measure, its predictive value for neonatal outcomes in low-risk term pregnancies with RFM was limited in this study. Lower cord pH, however, emerged as a stronger indicator of adverse outcomes. Enhanced antenatal surveillance and prompt intervention are recommended for better outcomes in this cohort.

KEYWORDS : Cerebroplacental ratio, reduced fetal movement, neonatal outcomes, Doppler ultrasound, low-risk pregnancy, NICU admission

INTRODUCTION:

The cerebroplacental ratio (CPR) is an essential Doppler ultrasound parameter, increasingly recognized for its predictive role in neonatal outcomes, particularly in low-risk term pregnancies where reduced fetal movement (RFM) raises concerns. Reduced fetal movement is a frequent clinical presentation associated with potential fetal distress, intrauterine growth restriction (IUGR), and adverse neonatal outcomes, making timely and effective assessment critical (1). While traditional monitoring techniques, such as cardiotocography, offer valuable information, CPR measurement has gained attention as a complementary tool due to its ability to detect subtle alterations in fetal hemodynamics indicative of compromised placental function (2,3).

CPR is calculated as the ratio between the middle cerebral artery and the umbilical artery Doppler indices, serving as a marker for the balance of blood flow between the fetal brain and the placenta (4). A lower CPR suggests a compensatory response to placental insufficiency, where the fetus preferentially redistributes blood to essential organs like the brain, commonly referred to as the "brain-sparing" effect (5). In term pregnancies with otherwise low-risk profiles but presenting with RFM, the value of CPR in predicting neonatal outcomes, including Apgar scores, admission to neonatal intensive care units (NICU), and overall perinatal morbidity, remains under-explored (6). Previous studies have highlighted CPR's association with adverse outcomes in high-risk pregnancies; however, evidence for its efficacy in predicting outcomes among low-risk term pregnancies with RFM is still limited (7,8).

This retrospective study aims to evaluate the relationship between CPR and neonatal outcomes in low-risk term pregnancies presenting with RFM, hypothesizing that lower CPR values may correlate with poorer neonatal outcomes. By providing insights into the prognostic value of CPR in this specific cohort, the study seeks to enhance clinical assessment protocols for pregnancies characterized by RFM, ultimately contributing to improved neonatal care and intervention strategies (9). Objectives of the study was to study the Relation between Cerebroplacental Ratio and Neonatal Outcome in Term Low Risk Pregnancies with Reduced Foetal Movements

MATERIAL AND METHODS:

The study was conducted on inpatients admitted to the Department of Obstetrics and Gynecology at Vani Vilas Hospital, BMCRI. This retrospective observational study was carried out from May 2023 to May 2024. Sample size of 83 subjects were collected based on a pre-defined formula. The sample size was estimated from the mean cerebroplacental ratio (CPR) among subjects with reduced fetal movements reported in a prior study by Binder et al.(10) (mean 0.99 ± 0.22). Sample size (N) = $Z1-\alpha/22$ SD2 / d2. With a 5% alpha error, 95% confidence level, and accounting for a 10% non-response rate. All consecutive cases of reduced fetal movements meeting inclusion criteria were included retrospectively. Convenient sampling was used to collect data. 83 women with singleton, low-risk pregnancies, and a gestational age of 37–40 weeks were considered. Gestational age was confirmed using the last menstrual period and ultrasound measurements taken in the first trimester. Excluded were those with multiple pregnancies, fetal anomalies, intrauterine growth restriction (IUGR), oligohydramnios, polyhydramnios, gestational diabetes, or hypertension.

Non-stress tests (NST) and biophysical profiles (BPP) were performed, with participants classified into categories 1, 2, or 3. Estimated fetal weight was assessed using the Hadlock 4 formula,(11) and Doppler parameters, such as the CPR, were recorded. Doppler waveform recordings of the umbilical artery (UA) and middle cerebral artery (MCA) were conducted, and eligible women were monitored until labor or delivery. CPR values were blinded from both patients and health care providers.

Poor neonatal outcomes were defined as cases with Apgar scores <7 at 5 minutes, cord blood pH <7.16, category three monitoring during labor, meconium presence, NICU admission, or fetal death. In terms of assessment tools, the study used Apgar scoring, Neonatal Resuscitation Program (NRP) algorithms, umbilical cord blood gas analysis, NICU admission data, and metrics assessing neonatal CPR quality.

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics (version 22, Somers, NY, USA).(12) Categorical data were expressed as frequencies and proportions, while continuous data were presented as means and standard deviations. For visual representation, pie charts and bar diagrams were created. Statistical significance for categorical data was evaluated using the Chi-square test or Fisher's exact test. Quantitative data significance was assessed with Student's t-test; when the independent t-test was invalid, or the distribution skewed, the Mann-Whitney U test was applied. A p-value <0.05 was considered statistically significant.

RESULTS:

In this study, the majority of subjects (74.7%) were housewives, while the remaining 25.3% were workers. With regard to parity, 54.2% of the subjects were multiparous, while 45.8% were nulliparous. For fetal movements, decreased fetal movement (DFM) was noted in 75.9% of cases, compared to 24.1% with active fetal movement (AFM). The placental location was predominantly anterior in 72.3% of cases, with the remaining 27.7% located posteriorly. Meconium was present in 15.7% of cases, while the majority (84.3%) showed no meconium. NICU admissions occurred in 26.5% of cases, whereas 73.5% did not require NICU care. Notably, mortality was observed in 97.6% of cases, with only 2.4% showing no mortality [Table 1].

Table 1: Profile of subjects

Profile		N	%
Occupation	House Wife	62	74.7%
	Worker	21	25.3%
Parity	Nulliparous	38	45.8%
	Multipara	45	54.2%
DFM	AFM	20	24.1%
	DFM	63	75.9%
Placental Location	Anterior	60	72.3%
	Posterior	23	27.7%
Meconium	No	70	84.3%
	Yes	13	15.7%
NICU Admission	No	61	73.5%
	Yes	22	26.5%
Mortality	No	2	2.4%
	Yes	81	97.6%

Table 2: Factors associated with NICU admission

		NICU Admission				P value
		Yes		No		
		N	%	N	%	
Age	Mean ± SD	29 ± 5.8		26.4 ± 5.6		0.067
POG	Mean ± SD	38.5 ± 1.1		38.6 ± 0.9		0.907
Occupation	House Wife	16	72.7%	46	75.4%	0.782
	Worker	6	27.3%	15	24.6%	
Parity	Nulliparous	12	54.5%	33	54.1%	1.00
	Multipara	10	45.5%	28	45.9%	
DFM	AFM	8	36.4%	12	19.7%	0.148
	DFM	14	63.6%	49	80.3%	
NST CAT	Mean ± SD	1.5 ± 0.6		1.7 ± 0.7		0.208
AFI	Mean ± SD	8.1 ± 3.8		9.9 ± 5.5		0.175
BPP	Mean ± SD	7.6 ± 0.8		7.4 ± 1.0		0.336
EFW	Mean ± SD	2.9 ± 0.4		2.9 ± 0.4		0.742
Gestational age at delivery	Mean ± SD	38.5 ± 1.1		38.6 ± 0.9		0.907
Cord PH	Mean ± SD	7.0 ± 0.2		7.3 ± 0.1		<0.001*
CPR	>1	20	90.9%	48	78.7%	0.333
	<1	2	9.1%	13	21.3%	
Placental Location	Anterior	16	72.7%	44	72.1%	1.000
	Posterior	6	27.3%	17	27.9%	
Meconium	No	19	86.4%	51	83.6%	1.000
	Yes	3	13.6%	10	16.4%	

The mean age of subjects admitted to the NICU was 29 ± 5.8 years, compared to 26.4 ± 5.6 years for those not admitted, though this difference was not statistically significant (p = 0.067). The mean period of gestation (POG) was similar across groups, with 38.5 ± 1.1 weeks in the NICU group and 38.6 ± 0.9 weeks in the non-NICU group (p = 0.907). Occupation, parity, and placental location showed no significant differences between groups. Decreased fetal movement (DFM) was more common in the NICU group (63.6%) than in the non-NICU group (80.3%), though this was not statistically significant (p = 0.148). The cord pH was significantly lower in the NICU group (7.0 ± 0.2) compared to the non-NICU group (7.3 ± 0.1), with a p-value of <0.001, indicating a statistically significant difference. Other parameters such as NST CAT, AFI, BPP, EFW, gestational age at delivery, CPR, meconium presence, and placental location did not show statistically significant differences between groups [Table 2].

Table 3: Outcome among subjects with respect to CPR

		CPR				P value
		>1		<1		
		N	%	N	%	
DFM	AFM	17	25.0%	3	20.0%	0.148
	DFM	51	75.0%	12	80.0%	
NICU Admission	No	48	70.6%	13	86.7%	1.000
	Yes	20	29.4%	2	13.3%	
Mortality	No	1	1.5%	1	6.7%	1.000
	Yes	67	98.5%	14	93.3%	

When analyzing outcomes based on the CPR ratio, 75.0% of subjects with a CPR >1 had DFM, compared to 80.0% with a CPR <1, though this difference was not significant (p = 0.148). NICU admission rates were higher in the group with a CPR >1 (29.4%) than those with a CPR <1 (13.3%), but this was not statistically significant (p = 1.000). Mortality rates were very high across both groups, with 98.5% in the CPR >1 group and 93.3% in the CPR <1 group, showing no significant difference between groups (p = 1.000) [Table 3].

DISCUSSION:

This study determines the association between cerebroplacental ratio (CPR) and neonatal outcomes in term, low-risk pregnancies presenting with decreased fetal movement (DFM). This retrospective analysis provides valuable insights, particularly regarding NICU admissions and mortality rates. Interestingly, while CPR was initially hypothesized to correlate with adverse neonatal outcomes, the data here suggest that CPR variations did not significantly affect NICU admission or mortality rates. This outcome aligns with some previous studies, while conflicting with others that noted CPR as a predictive marker for adverse neonatal outcomes, specifically in high-risk pregnancies.

A recent study by Figueras and Gratacos (2018) found that low CPR is associated with an increased risk of adverse outcomes, including NICU admissions and stillbirths, especially in high-risk pregnancies, such as those with intrauterine growth restriction (IUGR) or preeclampsia (13). However, the current study focuses on a low-risk population, which may explain the lack of significant findings between CPR and neonatal outcomes. Studies, such as those by Khalil et al. (2015) and Morales-Rosello et al. (2017), have indicated that while CPR is a useful predictor in high-risk groups, its predictive value diminishes in low-risk pregnancies, a finding consistent with the present results (14,15).

VARIATIONS IN MORTALITY AND NICU ADMISSIONS

The high mortality rate observed (97.6%) is unexpected and significantly higher than what is typically reported in low-risk pregnancies. While DFM has been associated with increased perinatal morbidity and mortality, studies such as that by Winje et al. (2015) found that prompt clinical intervention upon presentation of DFM can significantly reduce adverse outcomes (16). The unexpectedly high mortality rate in this cohort suggests potential delays in intervention or underlying factors not accounted for, such as undiagnosed fetal compromise or sociodemographic factors. Additionally, the predominance of anterior placental location (72.3%) contrasts with reports by Smith et al. (2018) that suggest posterior placental locations are more often associated with adverse outcomes (17).

CPR AS A PREDICTIVE MARKER

In exploring CPR's efficacy, Morales-Rosello et al. (2015) demonstrated that a CPR below 1 was predictive of adverse perinatal outcomes, including low Apgar scores and NICU admissions, particularly in fetuses with IUGR (15). Yet, in this study, the presence of CPR values below did not correlate with statistically significant increases in adverse outcomes, such as NICU admission rates or mortality. This discrepancy could be attributed to the absence of high-risk criteria within the sample or possibly to the differences in healthcare protocols between study settings. Furthermore, the mean gestational age at delivery and cord pH levels, which were significantly lower in the NICU-admitted group (p < 0.001), also point to other physiological markers that may hold more prognostic value

than CPR alone in predicting adverse outcomes in term pregnancies.

INFLUENCE OF MATERNAL CHARACTERISTICS AND SOCIOECONOMIC FACTORS

Maternal demographics in this study, such as the high percentage of housewives and the mean age of 29 in the NICU group, underscore the importance of socioeconomic factors in pregnancy outcomes. Research has shown that socioeconomic status can influence access to healthcare, health literacy, and adherence to antenatal care recommendations, ultimately impacting neonatal outcomes (Blondel et al., 2019) (18). The current study's cohort might benefit from further exploration of social and healthcare access factors to better understand how these influence the management of DFM and subsequent outcomes.

CLINICAL IMPLICATIONS AND RECOMMENDATIONS

Given these findings, the clinical value of CPR in low-risk pregnancies appears limited, suggesting that reliance on CPR as a sole predictor for adverse outcomes in DFM cases might not be warranted. Instead, integrating additional assessments, such as cord pH and biophysical profiles, may improve outcome predictions. Further, the unexpectedly high mortality in this cohort emphasizes the need for a standardized protocol for managing DFM, including consistent monitoring and timely intervention, as suggested by Unterscheider et al. (2013) in the management of high-risk pregnancies (19).

The study highlights the need for close monitoring of term, low-risk pregnancies with reduced fetal movement (DFM), especially given the high NICU admission and mortality rates observed. Recommendations include enhanced antenatal surveillance for cases with low cerebroplacental ratio (CPR) and reduced cord pH to potentially lower adverse neonatal outcomes. However, limitations exist due to the retrospective design, small sample size, and lack of diversity in socioeconomic factors. Additionally, the high mortality rate limits the generalizability of findings, suggesting that future research should involve larger, multi-center studies with a longitudinal design to better understand the relationship between CPR, DFM, and neonatal outcomes.

CONCLUSION:

From the study Placental location, parity, occupation, and other biometric measures, including amniotic fluid index (AFI) and estimated fetal weight (EFW), showed no significant impact on NICU admission rates. The only parameter that presented a notable difference between NICU and non-NICU cases was cord blood pH, which was significantly lower in NICU admissions, potentially indicating compromised fetal health in these cases. When outcomes were analyzed according to CPR values, NICU admission rates were higher for CPR >1, but this was not statistically significant. Mortality rates were overwhelmingly high across both CPR categories, underscoring the critical need for more targeted monitoring and interventions in term pregnancies with reduced fetal movement.

Overall, while CPR is a valuable tool in assessing fetal well-being, this study indicates that its utility in predicting NICU admissions and mortality in low-risk, term pregnancies with reduced fetal movement is limited. Further research could help clarify additional factors influencing neonatal outcomes in similar populations, providing better prognostic tools.

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