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Study On Role of Cerebroplacental Ratio in Predicting Adverse Fetal Outcome from A Tertiary Care Teaching Hospital Of Madhya Pradesh

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Abstract

Background: The following study detects at-risk fetuses susceptible to hypoxia, especially among an ostensibly low-risk group prior to the commencement of labor. The cerebroplacental ratio (CPR) is becoming a significant predictor of adverse pregnancy outcomes. **Aim:** This study aims to evaluate the role of CPR in predicting adverse fetal outcomes during pregnancy by assessing its association with selected perinatal outcomes. **Methods:** The study was a prospective observational investigation conducted in a hospital setting. Following the acquisition of informed consent from the patient, history-taking and examination, prenatal ultrasound with color Doppler for the calculation of CPR was performed. **Results:** The mean age of the participant was 27.4 years. Abnormal cerebroplacental ratio (CPR) was observed in 26.7% (n = 20) of the cases. 70% (n = 14) of women with an abnormal CPR required a cesarean section for fetal distress, compared to 18.2% (n = 10) of those with a normal CPR. CPR had a sensitivity of 55% (n = 11) and a specificity of 100% (n = 55), with a positive predictive value (PPV) of 100% (n = 20) and a negative predictive value (NPV) of 60% (n = 33). **Conclusion:** The high specificity and positive predictive value of CPR suggest that individuals with a normal CPR are at a significantly reduced risk of adverse perinatal outcome. Consequently, deliveries for these individuals may be safely conducted at peripheral centers. In contrast, those with a low CPR should be promptly referred to a higher-level facility equipped for comprehensive fetal monitoring during the intrapartum period, along with access to a neonatal unit.

Key words: cerebroplacental ratio, fetal monitoring, cesarean section, fetal distress, adverse fetal outcome.

INTRODUCTION

Fetal well-being throughout gestation is a paramount concern in obstetric treatment, as the early detection of at risk fetuses can markedly affect postnatal outcomes [1]. Doppler ultrasound has become prominent among prenatal assessment methods due to its non-invasive characteristics and capacity to deliver real-time data on fetal and placental blood flow dynamics [2,3].

The CPR indicates the equilibrium between fetal cerebral perfusion and placental resistance, acting as a sensitive measure of fetal oxygenation and hemodynamic condition [4]. The fetus

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may demonstrate a compensatory redirection of blood flow in response to hypoxic stress, preferring the brain over other organs, a process known as the "brain-sparing effect." This adaptive response is marked by augmented cerebral blood flow (lowered MCA PI) and diminished placental perfusion (elevated UA PI), resulting in a decreased CPR [5,6].

A poor CPR correlates with adverse outcomes, such as preterm birth, low birth weight, stillbirth, and elevated rates of neonatal intensive care unit (NICU) admissions [7,8]. Recent studies have highlighted the efficacy of CPR as a prognostic instrument for unfavorable fetal outcomes, especially in pregnancies affected by FGR, hypertensive diseases, or other placental abnormalities. This study aims to evaluate the role of CPR in predicting adverse fetal outcomes during pregnancy by assessing its association with selected perinatal outcomes.

MATERIAL AND METHODS

This prospective observational study was carried out at the Department of Obstetrics and Gynaecology, Sri Aurobindo Institute of Medical Sciences (SAIMS), Indore, Madhya Pradesh. The research encompassed 75 pregnant women who satisfied the inclusion criteria. Three inclusion criteria were singleton pregnancy, gestational age between 28 to 37 weeks, and absence of any fetal malformations as determined by ultrasonography. Multiple pregnancies, pregnancies complicated by fetal malformations, patients with a gestational period of less than 28 weeks or greater than 37 weeks, and those who did not provide consent for the study were excluded from this research. The consecutive sampling technique was employed.

The comprehensive obstetric history of each participant was documented to collect pertinent baseline information. All participants completed a series of Doppler ultrasonography evaluations to assess fetal blood flow. The subsequent parameters were assessed during the sonographic evaluations: fetal biometry, amniotic fluid index (AFI), mean pulsatility index (PI) of the umbilical artery (UA) and middle cerebral artery (MCA), systolic/diastolic (S/D) ratio of the UA and MCA, and the cerebroplacental (CP) ratio. The main emphasis was on quantifying the pulsatility indices (PI) of the middle cerebral artery (MCA) and the umbilical artery (UA), which are vital indicators of fetal hemodynamics. The cerebroplacental ratio (CPR) was subsequently calculated.

The primary outcomes were birth weight, Apgar score at 1 and 5 minutes, and the need for neonatal intensive care unit (NICU) admission. These outcomes were correlated with the calculated CPR to assess its predictive value.

The study protocol was reviewed and approved by the Institutional Ethics Committee. Informed written consent was obtained from all participants prior to inclusion in the study. The confidentiality of the participants has been maintained.

The data collected was analyzed using Stata version 17.0. Descriptive statistics was applied to present baseline characteristics of the study population. Correlation analysis was employed to determine the strength and direction of the relationship between CPR and each of the perinatal outcome, such as birth weight, Apgar scores at 1 and 5 minutes, and the need for NICU admission. P-value of less than 0.05 was considered the threshold for statistical significance.

RESULTS

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The present study evaluated 75 pregnant women who met the inclusion criteria of a singleton pregnancy between 28 and 37 weeks of gestation with no foetal anomalies. To enroll the 75 participants for this study, a total of 84 pregnant women were approached: 5 women were excluded and remaining 4 women refused to participate in the present study.

Majority (64.0%) of the subjects were less than 35 years of age. The mean age of the participant was 27.4 years. Most individuals had a normal BMI, with 72.0% within a healthy weight range, while 28.0% are overweight with the majority being primigravida (62%, n = 46) and nulliparous (68%, n = 51). The gestational age at delivery ranged from 29 to 37 weeks, with an average of 34.5 weeks. Most of the participants (84%, n = 63) were booked cases who had regular antenatal care. Out of 75 enrolled women, 51 women had normal vaginal delivery and remaining 24 women had C-section (16 emergency and 8 elective C-sections). (Table 1)

Table 1: Demographic characteristics of study subjects

Variables		**Number**	**Percentage (%)**
Age (in years)	<35	48	64.0
	>=35	27	36.0
	Mean age	27.4 years	
BMI (kg/m2)	Normal	54	72.0
	Overweight	21	28.0
Parity	Primi	46	62.0
	Multi	29	38.0
Status of case	Booked case	63	84.0
	Unbooked case	12	16.0
Mode of delivery	Vaginal	51	68.0
	C-section	24	32.0

In terms of Doppler findings, an abnormal cerebroplacental ratio (CPR) was observed in 26.7% (n = 20) of the cases. Additionally, 14.7% (n = 11) of the participants had an abnormal umbilical artery (UA) S/D ratio and 12% (n = 9) had an abnormal middle cerebral artery (MCA) S/D ratio.

Adverse perinatal outcomes were significantly more common among the group with an abnormal CPR. Specifically, 70% (n = 14) of women with an abnormal CPR required a cesarean section for fetal distress, compared to 18.2% (n = 10) of those with a normal CPR ($p < 0.001$). Similarly, 55% (n = 11) of the abnormal CPR group delivered small for gestational age (SGA) infants, while only 7.3% (n = 4) of the normal CPR group did ($p < 0.001$). Additionally, 60% (n = 12) of the abnormal CPR group had newborns with an APGAR score of less than 7 at 1 minute, compared to 14.5% (n = 8) in the normal CPR group ($p < 0.001$). Furthermore, 50% (n = 10) of infants in the abnormal CPR group required NICU admission, compared to 10.9% (n = 6) in the normal CPR group ($p < 0.001$). Notably, there were 2 cases of stillbirth or perinatal death in the abnormal CPR group, with no such cases in the normal CPR group ($p = 0.117$, not statistically significant). (Table 2)

When compared to other Doppler indices, the CPR demonstrated superior predictive accuracy for adverse perinatal outcomes. The CPR had a sensitivity of 55% (n = 11) and a specificity of 100% (n = 55), with a positive predictive value (PPV) of 100% (n = 20) and a negative predictive value (NPV) of 60% (n = 33). In contrast, the UA and MCA S/D ratios had lower sensitivity and predictive values.

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Table 2: Adverse perinatal outcomes with cerebroplacental ratio status among study subjects

Outcome	Normal CPR (n=55)	Abnormal CPR (n=20)	Total (n=75)	p-value
Caesarean section for fetal distress	10 (18.2%)	14 (70%)	24 (32%)	<0.001
Small for gestational age	4 (7.3%)	11 (55%)	15 (20%)	<0.001
APGAR score <7 at 1 minute	8 (14.5%)	12 (60%)	20 (26.7%)	<0.001
NICU admission	6 (10.9%)	10 (50%)	16 (21.3%)	<0.001
Stillbirth/ perinatal death	0 (0%)	2 (10%)	2 (2.7%)	0.117

Discussion

The cerebroplacental ratio (CPR) has emerged as a crucial marker for identifying unfavorable perinatal outcome. FGR babies are widely recognized as being at risk for adverse perinatal outcomes; however, accurately identifying AGA fetuses that are also at risk is notably difficult and contingent upon multiple criteria. The CPR< 1 is recognized for its association with adverse perinatal outcomes in FGR pregnancies; however, a specific cut-off value for AGA fetuses remains undefined [9].

Fetuses with estimated fetal weight above the 10th percentile are assumed to be growing properly and have a lower likelihood of intrauterine fetal compromise. Subclinical placental dysfunction in these appropriately sized fetuses can be identified by a diminished CPR at term, as evidenced by several investigations. Khalil et al. [10] conducted a retrospective cohort research involving 9,772 singleton pregnancies, with CPRs documented within two weeks of delivery. Reduced fetal CPR, irrespective of fetal size, correlated with the necessity for operational delivery due to assumed intrauterine fetal compromise and subsequent admission to the NICU at term. Other investigators have indicated that diminished CPR at term in a low-risk population correlates with increased perinatal problems [11]. Consequently, CPR seems to be a crucial marker in assessing ostensibly normally developed fetuses that are prone to experience intrauterine fetal compromise.

Another observational study which comprised 562 low-risk term pregnancies in early labor, obstetric intervention for suspected fetal distress during labor was three times as prevalent among women with diminished CPR MoM. Unfavorable perinatal outcomes were elevated in fetuses exhibiting CPR MoM below the 10th percentile [12]. Ho et al. [13] examined the correlation between CPR and emergency cesarean delivery for intrauterine fetal compromise, both CPR and EFW below the 10th percentile were suggestive of strong correlations with cesarean birth. SGA babies had substantial odds for both cesarean delivery due to intrauterine fetal compromise and admission to the neonatal intensive care unit, irrespective of cardiotonic profile status.

This study observed that 55% (n = 11) of the abnormal CPR group delivered small for gestational age (SGA) infants, whereas only 7.3% (n = 4) of the regular CPR group did ($p < 0.001$). Moreover, 60% (n = 12) of the aberrant CPR cohort had neonates with an APGAR score below 7 at 1 minute, in contrast to 14.5% (n = 8) in the normal CPR cohort ($p < 0.001$).

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Conversely, AGA fetuses exhibiting a poor CPR were linked to a heightened chance of cesarean delivery for IFC, however not to NICU hospitalization. A prior study demonstrated that both estimated fetal weight (EFW) below the 10th percentile and cerebroplacental ratio (CPR) below the 10th percentile, whether assessed singly or in conjunction, forecasted serious unfavorable outcomes including significant newborn acidosis, Apgar scores below 3 at 5 minutes, NICU hospitalization, and mortality. They determined that the significance of EFW in forecasting unfavorable perinatal outcomes is undeniable [14].

In this study, we observed that 50% (n = 10) of infants in the aberrant CPR group necessitated NICU admission, in contrast to 10.9% (n = 6) in the regular CPR group ($p < 0.001$). Research conducted by Low et al. revealed that diminished or atypical CPR was independently linked to NICU admission, irrespective of fetal size (OR 0.55, 95% CI: 0.33–0.92, $p < 0.021$) [15].

Conclusion

In fetuses with growth restriction, cerebroplacental ratio (CPR) indicates both placental circulatory insufficiency and adaptive changes in the middle cerebral artery, serving as a significant non-invasive method for monitoring. In high-risk AGA fetuses, CPR is beneficial for identifying those at risk of adverse outcomes, facilitating early detection, monitoring, and overall management of these fetuses. Doppler ultrasound, particularly CPR, ought to be incorporated into standard third-trimester ultrasound assessments for high-risk AGA pregnancies. The high specificity and positive predictive value of CPR suggest that individuals with a normal CPR are at a significantly reduced risk of adverse perinatal outcomes. Consequently, deliveries for these individuals may be safely conducted at peripheral centers. Conversely, those with a low CPR should be promptly referred to a higher-level facility equipped for comprehensive fetal monitoring during the intrapartum period, along with access to a neonatal unit.

REFERENCES

1. Anand S, Mehrotra S, Singh U, Solanki V, Agarwal S. Study of association of fetal cerebroplacental ratio with adverse perinatal outcome in uncomplicated term AGA pregnancies. The Journal of Obstetrics and Gynecology of India. 2020 Dec;70:485-9.
2. Giri A, Shrestha A, Joshi A. Role of Cerebro-Placental Ratio in prediction of adverse perinatal outcome in hypertensive disorder of pregnancy. Nepal Medical College Journal. 2022 Apr 4;24(1):56-61.
3. Gupta A, Maheshwari B, Gupta N, Malhotra N. Cerebroplacental Ratio: Can It Be Taken as a Single Predictor of Adverse Perinatal Outcome in Singleton Uncomplicated Pregnancy at Term. Journal of South Asian Federation of Obstetrics and Gynaecology. 2024 Feb 23;16(2):116-20.
4. Meena S, Dadhwal V, Sharma KA, Perumal V. Cerebroplacental ratio as a predictor of intrapartum fetal compromise in term pregnancy. International Journal of Gynecology & Obstetrics. 2021 Jul;154(1):31-8.
5. Bharatnur S, Rani CK, Hebbar S. Study of cerebro-placental ratio in pregnancies with abnormal umbilical artery doppler in predicting adverse perinatal outcome: Are we here yet. J Preg Child Health. 2021;4:118.
6. Maitra N, Prajapati P, Sheth TM, Vaishnav P, Patel PK. Third-trimester Cerebroplacental Ratio as a Predictor of Neonatal Outcome in a Low-risk Pregnancy. Journal of South Asian Federation of Obstetrics and Gynaecology. 2020 May;12(3):151.

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 11, 2024

7. Gupta N, Agarwal M, Kapoor A. The role of cerebro placental ratio as a predictor of adverse perinatal outcome in uncomplicated term pregnancies. International Journal of Reproduction, Contraception, Obstetrics and Gynecology. 2023 Dec 1;12(12):3592-8.
8. Jain A, Sharma KA, Dadhwal V, Perumal V. Role of myocardial performance index (MPI) and cerebro-placental ratio (CPR) in predicting adverse perinatal outcome. Echocardiography. 2022 Dec;39(12):1563-70.
9. Sengodan SS, Mathiyalagan S. Doppler study (cerebroplacental ratio) as a predictor of adverse perinatal outcome. International Journal of Reproduction, Contraception, Obstetrics and Gynecology. 2020 Dec 1;9(12):5068-75.
10. Khalil AA, Morales-Rosello J, Morlando M, Hannan H, Bhide A, Papageorghiou A, et al. Is fetal cerebroplacental ratio an independent predictor of intrapartum fetal compromise and neonatal unit admission? Am J Obstet Gynecol. 2015 Jul;213(1):54.e1-54.e10.
11. Morales-Rosello J, Khalil A, Fornes-Ferrer V, Perales-Marin A, Accuracy of the fetal cerebroplacental ratio for the detection of intrapartum compromise in nonsmall fetuses. J Matern Fetal Neonatal Med. 2018;21:1-11.
12. Dall'Asta A, Figueras F, Rizzo G, Ramirez Zegarra R, Morganelli G, Giannone M, Cancemi A, Mappa I, Lees C, Frusca T, Ghi T. Uterine artery Doppler in early labor and perinatal outcome in low-risk term pregnancy: prospective multicenter study. Ultrasound in Obstetrics & Gynecology. 2023 Aug;62(2):219-25.
13. Ho C, Flatley CJ, Kumar S. Emergency caesarean for intrapartum fetal compromise and admission to the neonatal intensive care unit at term is more influenced by fetal weight than the cerebroplacental ratio. J Matern Fetal Neonatal Med. 2018 Oct 29;1–6.
14. DeVore GR. The importance of the cerebroplacental ratio in the evaluation of fetal well-being in SGA and AGA foetuses. Am J Obstet Gynecol 2015;213(1):5–15.
15. Low JA, Pickersgill H, Killen H, et al. The prediction and prevention of intrapartum fetal asphyxia in term pregnancies. Am J Obstet Gynecol 2001;184(4):724-730.