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Cerebroplacental ratio at 35–38 weeks gestation and perinatal outcome: A prospective observational study

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Abstract:
The cerebroplacental ratio (CPR) is a non-invasive Doppler parameter used to assess fetal well-being and predict adverse perinatal outcomes in late pregnancy. Therefore, it is of interest to evaluate the CPR at 35–38 weeks and its association with perinatal outcomes among 200 singleton pregnancies at Kamla Raja Hospital, G.R. Medical College, Gwalior. Pre-term births showed significantly lower CPR (0.90 vs. 1.54), lower birth weight (1.68 vs. 2.47 kg), higher cesarean delivery rates and increased neonatal complications compared with term births. Lower CPR was associated with adverse outcomes, including hypoglycemia, respiratory distress syndrome and neonatal sepsis. This study advances knowledge by supporting CPR as a useful antenatal surveillance parameter for early identification of pregnancies at increased risk of adverse perinatal outcomes and timely clinical intervention.

Keywords: Cerebroplacental ratio (CPR), doppler ultrasound, pre-term birth, perinatal outcome, fetal surveillance

Background:
Pregnancy involves dynamic maternal and fetal physiological changes, making third-trimester fetal surveillance essential for favorable perinatal outcomes **[1]**. The cerebroplacental ratio (CPR), derived from cerebral and placental Doppler indices, provides a non-invasive measure of fetal hemodynamic adaptation and placental function **[2]**. Changes in CPR may indicate placental insufficiency, fetal growth restriction and increased risk of adverse perinatal outcomes, particularly during late gestation **[3, 4]**. Although CPR assessment is technically challenging in early pregnancy, Doppler evaluation becomes clinically more relevant in late gestation when fetal and placental circulatory adaptations are pronounced **[5, 6]**. Therefore, it is of interest to evaluate the association of estimated fetal weight and CPR with perinatal hypoxia, APGAR scores and NICU admission exceeding 24 hours in pregnancies at 35–38 weeks of gestation

Materials and Methods:
This prospective observational study was conducted at the Department of Obstetrics and Gynecology, Kamlaraja Hospital, G. R. Medical College, Gwalior, Madhya Pradesh from August 2022 to February 2024. Ethical approval has been obtained from the Ethical Approval Committee of Kamlaraja Hospital, G. R. Medical College, Gwalior, Madhya Pradesh.

Study population:
The study included a total of 200 participants with singleton pregnancies between 35 to 38 weeks of gestation. Cases involving multiple pregnancies, congenital anomalies, or gestational age outside the specified range were excluded. Ethical approval was obtained from the institutional ethics committee of G. R. Medical College and informed consent was secured from all participants. The study adhered to the Declaration of Helsinki, ensuring confidentiality, anonymity and the participants' rights throughout.

Data analysis:
Data were collected using a structured proforma, capturing maternal demographics, ultrasound findings and perinatal outcomes. Routine ultrasounds between 35 to 38 weeks measured UA-PI, MCA-PI and calculated the cerebroplacental ratio (CPR), with values adjusted to multiples of the median. Doppler assessments were done during fetal rest by trained sonographers. Data were analyzed using SPSS version 20, employing descriptive and inferential statistics, with significance set at $p < 0.05$ to identify meaningful associations.

Results:
This prospective observational study was conducted over two years at the Department of Obstetrics and Gynecology, Kamlaraja Hospital, G. R. Medical College, Gwalior, and included 200 pregnant women with singleton pregnancies between 35 and 38 weeks of gestation. Multiple pregnancies, fetal congenital anomalies, and gestational ages outside the specified range were excluded. Maternal characteristics and ultrasound Doppler measurements, including umbilical artery pulsatility index (UA-PI) and middle cerebral artery pulsatility index (MCA-PI), were recorded to calculate the cerebroplacental ratio (CPR), which was adjusted to multiples of the median. Among the 200 pregnancies, 173 (86.5%) resulted in term births and 27 (13.5%) in preterm births, with no statistically significant difference in the distribution ($p = 1.0$). Age-group analysis showed that women aged 21–30 years accounted for the highest proportion of term births (89.3%), whereas the 31–40-year group had the highest proportion of preterm births (25.9%). This association approached statistical significance ($p = 0.0863$). Parity distribution showed that 112 (56%) women were primiparous and 88 (44%) were multiparous. No statistically significant difference in parity distribution was observed between term and preterm births ($p = 1.0$; **Table 1**). Regarding the mode of delivery, lower segment cesarean section (LSCS) was more frequent among preterm births (64.29%) than term births (37.57%), demonstrating a statistically significant association ($p = 0.008$; **Figure 1**). Clear liquor was the most common finding in both groups, occurring more frequently in term births (72.25%) than preterm births (48.15%). Reduced and abnormal liquor findings were more frequent among preterm births, although the difference was not statistically significant ($p = 0.097$; **Figure 2**). Neonatal complications were significantly more common among preterm infants (85.19%) than term infants (17.18%; $p < 0.001$). Hypoglycemia, respiratory distress syndrome (RDS), sepsis, and mortality were observed more frequently among preterm infants, indicating their increased vulnerability and potential need for intensive neonatal care. Specific reported complications, including deaths associated with hypoxic-ischemic encephalopathy (HIE) and sepsis and delayed neonatal adaptation, are presented in **Table 2**. The comparison of maternal age and fetal Doppler parameters revealed significant differences between term and preterm births **(Table 3)**. Mean

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maternal age was slightly higher in the preterm group than in the term group (25.04 ± 5.10 vs. 24.29 ± 3.86 years; p = 0.0465). The mean UA-PI was significantly higher among preterm births (1.19 ± 0.24) than term births (1.01 ± 0.26; p = 0.0004). Conversely, mean MCA-PI was lower among preterm births (1.03 ± 0.27) than term births (1.47 ± 0.49; p < 0.001). The CPR and birth weight were also lower among preterm infants, with highly significant differences (p < 0.001).

Table 1: Distribution of cases based on parity between term and pre

Parity	Term N (%)	Preterm N (%)	Total N (%)	P- value
Primipara	97(56.07%)	15(53.57%)	112(56%)	1
Multipara	76(43.93%)	12(42.8%6)	88(44%)	
Total	173(100)	27(100)	200(100)	

Table 2: Comparison between term and pre term of complications

Complication	Preterm (N)	Preterm (%)	Term (N)	Term (%)
Death-HIE-2	1	3.70%	0	0.00%
Death-sepsis	1	3.70%	0	0.00%
Delayed adaptation	1	3.70%	0	0.00%

Table 3: Comparison between term and preterm for age, ua- pi, mca- pi, cerebroplacental placental ratio, birth weight

	Term Mean ±SD	Preterm Mean ±SD	z-test	p-value
Age	24.29 ± 3.86	25.04 ± 5.10	-0.7299	0.0465
UA-PI	1.01 ± 0.26	1.19 ± 0.24	-3.53	0.0004
MCA- PI	1.47 ± 0.49	1.03 ± 0.27	6.8414	< 0.001

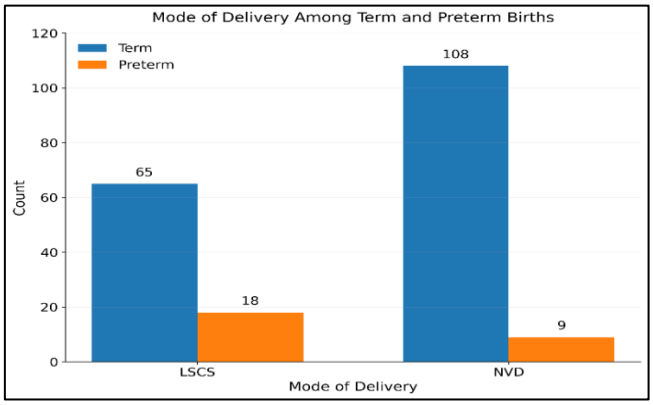


Figure 1: Comparison between term and pre term of mode of delivery

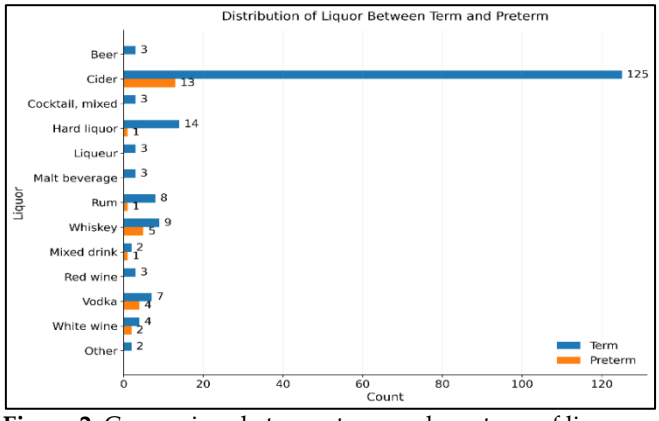


Figure 2: Comparison between term and pre-term of liquor

Discussion:

Pregnancy is a remarkable journey marked by significant physiological adaptations in both the mother and the fetus. These changes are essential for supporting fetal growth and preparing the maternal body for labor. As pregnancy advances, especially between 35 to 38 weeks of gestation, ensuring fetal well-being becomes increasingly important. This is a time when vital fetal organs such as the lungs and brain undergo final stages of development, making close monitoring crucial to identify any complications. Among the parameters used to assess fetal health, the cerebroplacental ratio (CPR) has gained prominence. It is measured through Doppler ultrasound by dividing the pulsatility index of the middle cerebral artery by that of the umbilical artery. This ratio reflects the balance between placental resistance and fetal brain perfusion, serving as an important indicator of fetal condition, particularly in the later stages of pregnancy **[7].** In this context, our study explored multiple factors influencing pregnancy outcomes, beginning with maternal age. We found that the average maternal age for term births was 24.29 years, while it was slightly higher at 25.04 years for preterm births. Though the age difference is minimal, it suggests a subtle trend where increasing maternal age may correlate with a higher likelihood of preterm delivery. This pattern resonates with broader studies showing advanced parental age, especially paternal, is associated with higher risks of preterm births and variations in birth weight, underscoring the complex influence of both maternal and paternal age on perinatal outcomes **[8].** Parity was another aspect studied, categorizing women as primipara or multipara. Among the total participants, 56% were first-time mothers, while 44% had previous deliveries. The distribution was similar for both term and preterm births, with no statistically significant difference. These findings indicate that in our study population, parity did not significantly influence the incidence of preterm birth. However, this observation contrasts with other regional studies that found higher rates of preterm birth among multiparous women. Such discrepancies highlight the need for context-specific analysis and healthcare strategies that account for local demographic variations **[9, 10].** Regarding gestational age, 86.5% of the deliveries in our study were term and 13.5% were preterm. This preterm rate is slightly higher than the global average of approximately 11%, indicating potential region-specific risk factors. This aligns with national data showing that preterm births in India can range from 5.5% to nearly 15%, depending on the region. Recognizing such patterns is essential for tailoring health interventions aimed at reducing the incidence of early deliveries and improving neonatal health outcomes **[11].** The mode of delivery also varied significantly between term and preterm births. Among preterm deliveries, cesarean sections (LSCS) were far more common, accounting for 64.29% of births, whereas normal vaginal deliveries (NVD) accounted for 32.14%. In contrast, most term births occurred through vaginal delivery (62.43%). This statistically significant difference reflects the higher likelihood of complications in preterm labor necessitating surgical intervention. Understanding these trends can inform clinical decisions and the development

of protocols to ensure safer delivery outcomes, particularly in high-risk pregnancies **[12].** Amniotic fluid characteristics, or liquor status, showed notable differences between term and preterm births. Clear amniotic fluid was more frequently seen in term births, while reduced and altered types were more common in preterm births. Though the difference was of borderline statistical significance, the trends suggest that abnormal amniotic fluid characteristics could signal higher risk for complications and influence the mode of delivery. Monitoring such indicators can provide valuable insights into fetal health and guide timely medical responses **[13].** Birth weight also showed a significant disparity, with term infants weighing an average of 2.47 kg compared to just 1.68 kg in preterm infants. This statistically significant difference emphasizes the impact of gestational age on fetal growth, with preterm infants being far more susceptible to low birth weight and the associated health risks. Reducing preterm births through improved prenatal care could play a key role in decreasing the prevalence of low birth weight and its consequences **[14].** Lastly, CPR values in our study were significantly higher in term births (average 1.54) than in preterm births (average 0.90). This highlights CPR's potential as a predictive marker for preterm deliveries, indicating compromised placental function and fetal blood flow in cases of low CPR. Incorporating CPR into routine prenatal assessments may help identify at-risk pregnancies earlier and enable interventions to prolong gestation or prepare for early delivery, ultimately improving outcomes for both mothers and infants **[15].**

Conclusion:

We show the association between cerebroplacental ratio (CPR) and perinatal outcomes, emphasizing CPR as a vital indicator of fetal well-being, especially in the late third trimester. The observed differences in key parameters between term and pre-term births underscore the importance of routine Doppler ultrasound evaluations. Early identification of at-risk pregnancies through CPR monitoring can improve clinical decision-making and optimize perinatal care, highlighting its potential as a crucial tool in prenatal assessment and fetal surveillance.

Conflict of interest: None declared

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