International Journal of Reproduction, Contraception, Obstetrics and Gynecology
Singh M et al. Int J Reprod Contracept Obstet Gynecol. 2026 Sep;15(9):3609-3614
www.ijrcog.org
pISSN 2320-1770 | eISSN 2320-1789

DOI: https://dx.doi.org/10.18203/2320-1770.ijrcog20263048

Original Research Article

Role of cerebroplacental ratio at 35 to 36 weeks of gestational age in prediction of perinatal out come in asymptomatic pregnant Indian women: a prospective observational study

Mamta Singh*, Shashi Shukla, Amrita Nayak, Sparsh Singh

Department of Obstretics and Gynaecology, Sparsh Hospital, Kannauj, Uttar Pradesh, India

Received: 02 June 2026
Revised: 23 August 2026
Accepted: 25 August 2026

***Correspondence:**
Dr. Mamta Singh,
E-mail: mamtasinghdr@gmail.com

ABSTRACT

Background: Foetal hypoxia and adverse perinatal outcomes remain significant challenges in obstetrics. The cerebroplacental ratio (CPR)-calculated as middle cerebral artery pulsatility index (MCA PI) divided by umbilical artery pulsatility index (UA-PI)-reflects both placental vascular resistance and brain-sparing foetal adaptation. This study evaluated the predictive value of CPR for adverse perinatal outcomes in low-risk pregnancies.
Methods: A prospective cohort study was conducted at Sparsh Hospital, Kannauj, from October 2024 to March 2026, enrolling 100 asymptomatic, low-risk singleton pregnant women at 35 to 36 weeks of gestation. Participants underwent Doppler ultrasonography to measure UA-PI, MCA PI, and CPR. Participants were followed prospectively to evaluate neonatal outcomes, including Apgar scores and Neonatal Intensive Care Unit (NICU) admissions. Spearman's rho correlation was used for statistical analysis.
Results: The mean Apgar score was 9.41±1.61. Mean Doppler values were: UA-PI 1.00±0.334, MCA PI 1.49±0.513, and CPR 1.59±0.601. No statistically significant correlation was observed between Apgar scores and UA PI (rho=-0.058, p=0.568), MCA PI (rho=0.107, p=0.296), or CPR (rho=0.174, p=0.087). However, among 9 patients with CPR <1, 8 babies (88.9%) required NICU admission. Conversely, only 2 of the 91 patients with normal CPR required NICU admission.
Conclusions: Although Doppler indices showed no linear correlation with routine Apgar scores, a threshold of CPR <1 at 35-36 weeks was strongly associated with poor perinatal outcomes and NICU admission in low-risk pregnancies. CPR assessment enables early identification of vulnerable foetuses, supporting closer surveillance and timely delivery.

Keywords: Cerebroplacental ratio, Doppler ultrasonography, Foetal hypoxia, Perinatal outcome, NICU, Brain-sparing effect

INTRODUCTION

Intrauterine hypoxia and unfavorable neonatal sequelae remain principal drivers of perinatal morbidity and mortality globally, particularly within term gestations. Early recognition of vulnerable fetuses is critical to enable timely obstetric management and optimize neonatal trajectories. Antenatal Doppler sonography has become an indispensable, non-invasive standard for evaluating uteroplacental perfusion and fetal cardiovascular dynamics. Among available diagnostic indices, the CPR-computed as the quotient of the middle cerebral artery pulsatility index (MCA-PI) over the umbilical artery pulsatility index (UA-PI), has demonstrated high clinical utility as an indicator of fetal decompensation.[1]

The clinical rationale underlying the CPR centers on the fetal physiological response to oxygen deprivation. Microvascular placental dysfunction increases downstream impedance within the umbilical artery. In

response, arterial chemoreceptor activation triggers a selective redistribution of cardiac output toward vital organ systems (including the brain, myocardium, and adrenal glands), an auto-regulatory mechanism designated as the brain-sparing effect. This compensatory vasodilation reduces cerebrovascular resistance in the middle cerebral artery, resulting in a net decrease in CPR that signals evolving hemodynamic stress.[2]

Extensive literature illustrated by Bahado-Singh et al demonstrated that sub-threshold CPR values strongly correlate with adverse peripartum outcomes, including intrapartum distress, emergent operative delivery for fetal indication, meconium-stained amniotic fluid, depressed Apgar scores, neonatal intensive care unit (NICU) admission, and perinatal death.[3] Although single-vessel umbilical artery Doppler has historically served as the benchmark for assessing placental status, contemporary evidence indicates that the CPR delivers superior prognostic precision by simultaneously reflecting placental vascular resistance and the fetal adaptive response.

Late-gestation monitoring is especially vital because subclinical placental insufficiency can present in fetuses that appear clinically unremarkable. Conventional surveillance modalities, such as cardiotocography (CTG) and the biophysical profile (BPP), frequently miss these early subclinical vascular shifts. Consequently, third-trimester CPR screening provides a more sensitive diagnostic tool for identifying fetuses at heightened risk of intrapartum compromise and unfavorable neonatal outcomes.[4,5]

The prognostic utility of CPR is well-established across both low- and high-risk obstetric populations. Pathologically low CPR levels consistently correlate with elevated rates of cesarean delivery for non-reassuring fetal status, intrauterine growth constraint, neonatal acidemia, and extended NICU stays by Odibo et al.[6] Incorporating CPR evaluation into clinical decision-making can guide clinicians regarding the optimal timing and route of delivery to minimize adverse outcomes. However, variations in established normative cutoff thresholds and inconsistent clinical algorithms have prevented universal adoption, emphasizing the necessity of standardized guidelines.

Accordingly, this investigation was designed to evaluate the prognostic accuracy of the cerebroplacental ratio in predicting fetal outcomes at 34 to 35 weeks of gestation and to determine its clinical reliability as an antenatal Doppler metric for stratifying perinatal risk.

METHODS

Study setting

This prospective observational COHORT investigation evaluated the prognostic performance of the CPR for predicting neonatal outcomes in gestations at 35 to 36 weeks. The clinical trial was conducted within the Department of Obstetrics and Gynaecology at Sparsh Hospital, Kannauj, spanning from October 2024 through March 2026. Following formal written informed consent, 100 consecutive pregnant individuals presenting to the outpatient antenatal clinic for routine third-trimester surveillance were prospectively enrolled. The protocol adhered strictly to international ethical standards and institutional guidelines for human subject research.

Inclusion criteria

Patients with singleton gestations; confirmed gestational age of 35^{+0} to 36^{+6} weeks (established via early ultrasound biometry or reliable recall of the last menstrual period); asymptomatic presentation during routine antenatal evaluation; as well as patients with absence of systemic maternal co-morbidities were included.

Exclusion criteria

Patients with multiple pregnancies; foetuses with congenital anomalies; and pregnancies complicated by severe maternal medical disorders such as chronic hypertension, diabetes mellitus, renal disease, or other significant systemic illnesses were excluded.

Ultrasound protocol and Doppler assessment

All enrolled participants underwent detailed baseline clinical assessments, encompassing comprehensive medical histories, physical examinations, and routine laboratory profiles per institutional care standards. Gray-scale sonography and spectral Doppler evaluations were executed by a single certified sonographer with participants positioned in a semi-recumbent state. Diagnostic parameters included biometric assessment of fetal growth parameters like spectral Doppler indices of the UA-PI, spectral Doppler indices of the MCA-PI. The CPR was calculated as follows,

$$\text{CPR}=\frac{MCA-PA}{UA-PI}$$

Waveform acquisition adhered to guidelines established by the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG). Key technical safeguards included maintenance of the angle of insonation below 30°; sampling performed strictly during periods of fetal quiescence (absence of gross somatic or respiratory movements); recording of at least three consecutive, uniform velocity waveforms prior to quantitative Doppler analysis.

Post-Doppler evaluation, clinical management followed an expectant protocol, permitting spontaneous labor onset unless secondary obstetric indications necessitated intervention. Patients were monitored prospectively through delivery and the immediate postpartum period.

Evaluated outcome metrics

Perinatal outcomes evaluated post-delivery comprised mode of delivery (spontaneous vaginal vs. operative/ cesarean); intrapartum meconium-stained amniotic fluid (MSAF); non-reassuring fetal status during labor; 1-minute and 5-minute Apgar scores; rate of admission to the NICU; birth weight and small-for-gestational-age status; composite perinatal morbidity and mortality.

RESULTS

Overall, the COHORT demonstrated favorable immediate postnatal outcomes, with a mean Apgar score of 9.41±1.61 (median: 10.0). Hemodynamic evaluation yielded a mean UA-PI of 1.00±0.334, a mean MCA-PI of 1.49±0.513, and a mean CPR of 1.59±0.601 (Table 1).

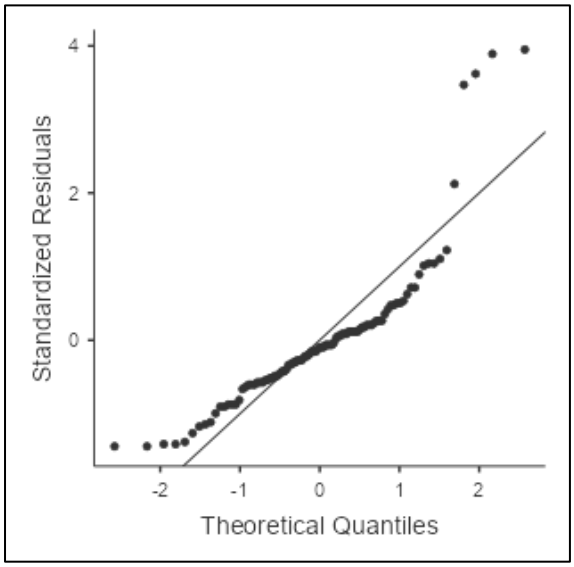

Figure 1: Plot of UA-PI.

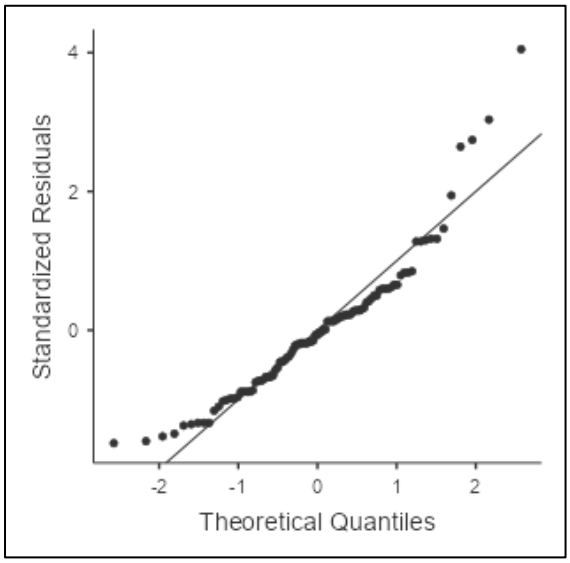

Figure 2: Plot of MCA MPI.

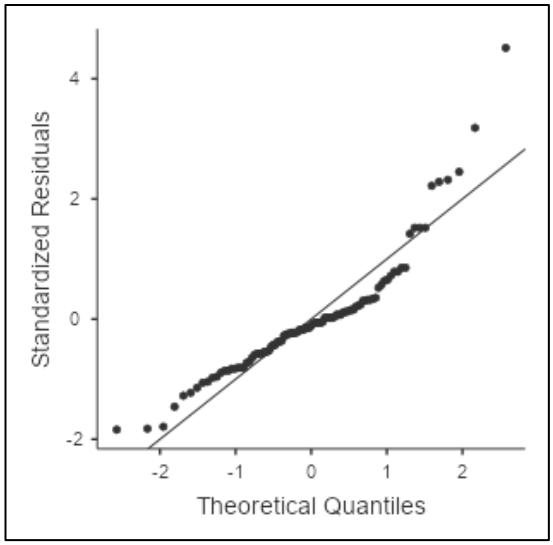

Figure 3: Plot of CPR.

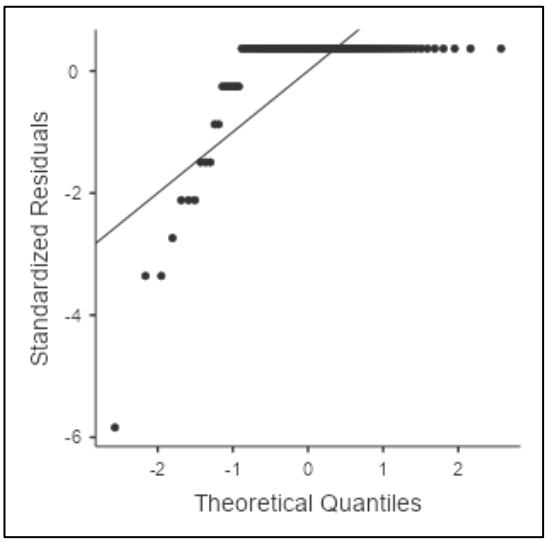

Figure 4: Plot of Apgar score.

Assessment of data distribution using the Shapiro-Wilk test demonstrated significant departure from normality across all continuous variables ($p<0.001$). Consequently, non-parametric analysis via Spearman's rank correlation coefficient (ρ) was employed to assess linear relationships between Doppler parameters and neonatal Apgar scores (Figure 1-3).

In this cohort of 100 mother-neonate dyads (98 evaluable), the mean maternal age was 25.69±3.07 years with a mean gestational age of ~35-36 weeks. The majority of neonates were male (54.08%, n=53) with a mean birth weight of 2.59±0.33 kg, and 71.43% (n=70) were delivered via vaginal delivery. Overall neonatal outcomes were predominantly favorable, with 85.71% (n=84) classified within normal limits and a mean Apgar score of 9.41±1.61, while fetal Doppler parameters showed a mean UMA PI of 1.00±0.33, MCA MPI of 1.49±0.51, and CPR of 1.59±0.60 (Table 2).

Table 1: Descriptive statistics and normality testing.

Doppler parameters	Mean±SD	Spearman's Rho (ρ)	P value	Statistical significance
UA-PI	1.00±0.334	-0.058	0.568	Non-significant
MCA-PI	1.49±0.513	0.107	0.296	Non-significant
CPR	1.59±0.601	0.174	0.087	Non-significant (trend observed)

Table 2: Demographic characteristics.

Parameters	Category	Values
Maternal age (years)	Mean±SD	25.69±3.07
	Range (min-max)	20-35
Neonatal gender	Male, N (%)	53 (54.08)
	Female N (%)	45 (45.92)
	Missing/deceased data, (N)	2
Gestational age (GA)	Mean/range	~35-36 weeks
Birth weight	Mean±SD	2.59±0.33
	Range (min-max)	1.70-4.00
	Missing/deceased data, (N)	2
Mode of delivery	Vaginal delivery, N (%)	70 (71.43)
	Caesarean delivery, N (%)	28 (25.57)
	Missing/deceased data, (N)	2
Apgar score	Mean±SD	9.41±1.61
	Median	10.0
	Missing/deceased data, (N)	2

Table 3: Subgroup analysis of CPR threshold and perinatal morbidity.

CPR group	Total patients (n=100)	NICU admission N (%)	Normal outcome N (%)	Primary clinical indication/notes	Relative risk/ association
Pathological CPR (CPR <1.0)	9	8 (88.9)	1 (11.1)	Hemodynamic distress/fetal compromise	High Risk (p<0.001)
Normal CPR (CPR ≥1.0)	91	2 (2.2)	89 (97.8)	Prolonged labor with low Apgar (n=2)	Baseline/ Reference
Total COHORT	100	10 (10.0)	90 (90.0)	—	—

*Statistically significant difference evaluated via Fisher's exact test (p<0.001).

Despite the absence of a statistically significant continuous correlation with Apgar scores, binary threshold analysis of CPR (CPR<1.0) revealed a strong association with adverse neonatal outcomes.

Pathological CPR group (CPR<1.0, n=9), eight neonates (88.9%) required NICU admission, whereas only one neonate (11.1%) experienced an uncomplicated course.

Normal CPR group (CPR≥1.0, n=91), only two neonates (2.2%) required NICU admission, both secondary to prolonged labor complicated by depressed Apgar scores.

These findings demonstrate that an abnormal cerebroplacental ratio (CPR<1.0) at 35-36 weeks of gestation serves as a critical indicator of perinatal compromise in otherwise asymptomatic pregnancies, supporting intensifying fetal surveillance and considering expedited delivery based on serial clinical observations (Table 3).

DISCUSSION

The CPR has gained widespread clinical validation as a sensitive sonographic metric for stratifying fetal risk and predicting adverse perinatal sequelae. While fetuses demonstrating overt fetal growth restriction (FGR) are universally recognized as high-risk candidates for intrapartum compromise, isolating subclinical hemodynamic stress within appropriate-for-gestational-age (AGA) fetuses presents a substantial diagnostic challenge. Although a pathological threshold of CPR<1.0 is robustly established for predicting adverse outcomes in FGR gestations, universally accepted gestational-age-specific cutoff values for AGA populations remain a subject of ongoing clinical investigation. In the present study, a statistically significant divergence in mean CPR values was observed between COHORTs (1.55 in AGA fetuses vs. 0.98 in FGR fetuses; p=0.0001), reinforcing the cerebroplacental ratio as a superior predictive marker for adverse perinatal outcomes relative to single-vessel

Doppler indices. Optimal timing of delivery remains a cornerstone of preventive obstetric management. Robust trial evidence and clinical consensus support labor induction at 41 weeks of gestation in low-risk, normally growing pregnancies to mitigate perinatal morbidity and mortality.[7-10] Conversely, in gestations complicated by FGR, expedited delivery at 37 weeks is widely recommended to lower the incidence of severe perinatal complications, particularly intrauterine stillbirth, with earlier intervention warranted in cases exhibiting advanced fetal hemodynamic decompensation.[11-15] Unlike protocols targeting known high-risk COHORTs, this investigation specifically evaluated an asymptomatic pregnant population entering spontaneous labor to examine the prognostic accuracy of CPR. Our findings demonstrate that routine late-third-trimester CPR assessment can successfully identify a sub-population of clinically unremarkable, asymptomatic gravidas harboring subclinical fetal hemodynamic compromise (CPR<1.0). Identifying this latent high-risk subset enables clinicians to recommend timely obstetric interventions and planned early delivery, thereby preventing intrapartum hypoxia and improving overall neonatal trajectories.

Limitations

The limitation of the study was that this was a single centre study with limited participants. Multicentre study is required to strengthen the result of this study.

CONCLUSION

The study found that Apgar score was not significantly associated with UMA-PI, MCA PI, or CPR. Although CPR demonstrated a trend toward a positive correlation with Apgar score, the relationship was weak and statistically non-significant. These findings suggest that the Doppler parameters evaluated may have limited predictive value for immediate neonatal outcome as measured by Apgar score in this study population. Patient who has CPR less than 1 have poor out come at the time of delivery so that we can advise these patients' early delivery according to their monitoring finding.

ACKNOWLEDGEMENTS

The author would like to thank Dr. Saket Shekhar, Assistant Professor, Department of Community Medicine, ESIC Medical College and Hospital, Bihar, Patna, for his contribution to the statistics work.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A. Cerebral-umbilical Doppler ratio as a predictor of adverse perinatal outcome. Obstet Gynecol. 1992;79(3):416-20.
2. Baschat AA, Gembruch U. The cerebroplacental Doppler ratio revisited. Ultrasound Obstet Gynecol. 2003;21(2):124-7.
3. Bahado-Singh RO, Kovanci E, Jeffres A, Oz U, Deren O, Copel J, et al. The Doppler cerebroplacental ratio and perinatal outcome in intrauterine growth restriction. Am J Obstet Gynecol. 1999;180(3 Pt 1):750-6.
4. Figueras F, Gratacos E. Stage-based approach to the management of fetal growth restriction. Prenat Diagn. 2014;34(7):655-9.
5. Khalil A, Morales-Rosello J, Morlando M, Hannan H, Bhide A, Papageorghiou A, Thilaganathan B. Is fetal cerebroplacental ratio an independent predictor of intrapartum fetal compromise and neonatal unit admission? Am J Obstet Gynecol. 2015;213(1):54.
6. Odibo AO, Riddick C, Pare E, Stamilio DM, Macones GA. Cerebroplacental Doppler ratio and adverse perinatal outcomes in intrauterine growth restriction: evaluating the impact of using gestational age-specific reference values. J Ultrasound Med. 2005;24(9):1223-8.
7. Bonnevier A, Maršál K, Brodszki J, Thuring A, Källén K. Cerebroplacental ratio as predictor of adverse perinatal outcome in the third trimester. Acta Obstet Gynecol Scand. 2020;100(3):497-503.
8. Ozeren M, Dinç H, Ekmen U, Senekayli C, Aydemir V. Umbilical and middle cerebral artery Doppler indices in patients with preeclampsia. Eur J Obstet Gynecol Reprod Biol. 1999;82(1):11-6.
9. Alkmark M, Wennerholm U, Saltvedt S, Bergh C, Carlsson Y, Elden H, et al. Induction of labour at 41 weeks of gestation versus expectant management and induction of labour at 42 weeks of gestation: A cost-effectiveness analysis. BJOG. 2022;129(13):2157-65.
10. Keulen JK, Bruinsma A, Kortekaas JC, Dillen JV, Bossuyt PM, Oudijk MA, et al. Induction of labour at 41 weeks versus expectant management until 42 weeks (INDEX): multicentre, randomised non-inferiority trial. BMJ. 2019:364:l344.
11. Hussain AA, Yakoob MY, Imdad A, Bhutta ZA. Elective induction for pregnancies at or beyond 41 weeks of gestation and its impact on stillbirths: a systematic review with meta-analysis. BMC Public Health. 2011;11(3):5.
12. Kaimal AJ, Little SE, Odibo AO, Stamilio DM, Grobman WA, Long EF, et al. Cost-effectiveness of elective induction of labor at 41 weeks in nulliparous women. Am J Obstet Gynecol. 2011;204(2):137.
13. Lausman A, Kingdom J. How and when to recommend delivery of a growth-restricted fetus: A review. Best Pract Res Clin Obstet Gynaecol. 2021;77:119-28.
14. Figueras F, Gratacós E. Update on the diagnosis and classification of fetal growth restriction and proposal of a stage-based management protocol. Fetal Diagn Ther. 2014;36(2):86-98.

15. Rabinovich A, Tsemach T, Novack L, Mazor M, Rafaeli-Yehudai T, Staretz-Chacham O, et al. Late preterm and early term: when to induce a growth restricted fetus? A population-based study. J Matern Fetal Neonatal Med. 2018;31(7):926-32.

Cite this article as: Singh M, Shukla S, Nayak A, Singh S. Role of cerebroplacental ratio at 35 to 36 weeks of gestational age in prediction of perinatal out come in asymptomatic pregnant Indian women: a prospective observational study. Int J Reprod Contracept Obstet Gynecol 2026;15:3609-14.