International Journal of Reproduction, Contraception, Obstetrics and Gynecology
Negi P et al. Int J Reprod Contracept Obstet Gynecol. 2024 Aug;13(8):2036-2041
www.ijrcog.org
pISSN 2320-1770 | eISSN 2320-1789

DOI: https://dx.doi.org/10.18203/2320-1770.ijrcog20242066

Original Research Article

Prognostic significance of cerebro-placental ratio in predicting perinatal

Priyanka Negi, Anjali Choudhary, Srishti Kaushik*, Shweta Nimonkar

Department of Obstetrics and Gynaecology, Sri Guru Ram Rai Institute of Medical and Health Services, Dehradun, Uttarakhand, India

Received: 29 April 2024
Revised: 11 July 2024
Accepted: 12 July 2024

***Correspondence:**
Dr. Srishti Kaushik,
E-mail: srishtikaushik1995@gmail.com

ABSTRACT

Background: Cerebro-placental ratio (CPR), measured by Ultrasound Doppler velocimetry in pregnancy, has gained much attention in recent years as an important tool in predicting perinatal outcomes. The study aimed to calculate the cerebro-placental ratio and correlateit with perinatal outcome in terms of intrapartum fetal heart variation, meconium staining of liquor, mode of delivery, Apgar score at birth, and NICU admissions.
Methods: It was hospital-based prospective cross-sectional study on 119 pregnant women with high-risk pregnancies. All women had doppler velocimetry ultrasound, and cerebro-placental ration was calculated. Perinatal outcome was noted in terms of FHR variability in labor, Meconium staining of liquor, Apgar score and need for NICU admission.
Results: Out of the total of 119 women, 88 women had CPR >1.08 and 31 women had CPR of <1.08. Meconium staining of liquor, low Apgar score, and NICU admission was mound in significantly more babies with low CPR.
Conclusions: CPR has a good prognostic value in predicting many adverse perinatal outcomes.

Keywords: Cerebroplacental ratio, High-risk pregnancy, Perinatal outcome, Ultrasound Doppler velocimetry

INTRODUCTION

Cerebro-placental ratio (CPR), measured by ultrasound doppler velocimetry in pregnancy, has gained much attention in recent years as an important tool in predicting perinatal outcomes. Fetal hypoxia during the perinatal period has been recognized as the most common cause of perinatal morbidity and mortality and has long-term consequences in the form of developmental delays, cerebral palsy, and mental retardation. Adequacy of uteroplacental circulation during the antenatal period is necessary to sustain the growing fetus with the transfer of nutrients and gaseous exchange.

Compromised uteroplacental function as the usual result in high-risk pregnancies, is associated with adverse perinatal outcomes.[1] The cerebroplacental ratio is useful for assessing fetal well-being and monitoring uteroplacental circulation in high-risk pregnancies and growth-restricted babies.[2] Over the last three decades, doppler ultrasonography has proven to be an invaluable tool in obstetrics for monitoring high-risk pregnancies.[3] Doppler assessment of impedance to flow in the umbilical artery (UA), fetal middle cerebral artery (MCA), and the ratio of the pulsatility index (PI) in these vessels, or cerebroplacental ratio (CPR), are used for assessment of fetal oxygenation. CPR is calculated as a simple ratio of the middle cerebral artery (MCA) pulsatility index (PI) and umbilical artery (UA) PI. A low CPR indicates a redistribution of the cardiac output to the brain. Cerebral redistribution of blood flow is a proxy for fetal hypoxemia and is associated with poor perinatal performance.[4,5] Although cerebral redistribution is reflected in MCA Doppler, CPR has been shown to improve the accuracy of predicting adverse outcomes compared with MCA or UA Doppler alone and also to have a strong association with intrauterine hypoxia.[6,7]

The C-P ratio has a distinct normal and abnormal interpretation which can be used to assign a level of risk to the fetus. It is suitable for assessing the adverse status of fetuses in late pregnancies and provides an excellent method to predict neonatal acidosis.[8] Being a single index, it is simple and easy to calculate, it takes into consideration both umbilical and fetal cerebral circulation, and it correlates well with fetal wellbeing. It has also been known to correlate with the neonatal outcome and can be used to plan timing and mode of delivery to ensure better outcomes for the neonate. It has been highlighted that the value of CPR is superior to the isolated MCA measurements. In the present study, we tried to evaluate the utility of the C-P ratio by USG Doppler in predicting perinatal outcomes in high-risk pregnancies

The study aimed to calculate the cerebro-placental ratio and correlateit with perinatal outcome in terms of intrapartum fetal heart variation, meconium staining of liquor, mode of delivery, Apgar score at birth, and NICU admissions. The secondary objective was to assess the utility of CPR in deciding the timing of the delivery.

METHODS

This was a hospital-based prospective cross-sectional study on 119 pregnant women who attended the Shri Mahant Hospital, Dehradun, Uttarakhand from March 2021 to August 2022.Inclusion criteria were pregnant women with singleton fetuses and high-risk factors between 32 to 42 weeks of gestation. Maternal high-risk factors were defined as, women with Preeclampsia, GDM, FGR, postdated pregnancies, IHCP, oligohydramnios, and BOH. Women with multiple gestation. fetal congenital anomalies and intrauterine fetal death were excluded from the study.

Detailed clinical history along with past personal and family history was noted. dating of the pregnancy was confirmed by the last menstrual period and first-trimester ultrasound. Through general and systemic examination was done, height and weight were noted and BMI was calculated. menstrual history, obstetric history, past medical and surgical history, and family history were taken. Routine and special investigations of patients were noted,

USG for fetal well-being and color Doppler was done. Umbilical and cerebral artery PI value was measured on USG Doppler. Doppler examinations were performed by the sonologist using 4- or 5-MHz sector transducers (USG machine-Phillips Ultrasound Affinity 30) with spatial peak temporal average intensities below 50 mW/cm^2 and the high-pass filter at 50-100 Hz. Measurements were obtained from the umbilical artery at the mid-section of the umbilical cord the distal (straight) portion of the middle cerebral artery and the right and left uterine arteries). The C/P ratio (CPR) was calculated from the PI of MCA divided by the PI of UA. A reference value of 1.08 was used as a cut-off for the prediction of adverse perinatal outcomes. The value C/P ratio below the cut-off was considered abnormal.

After delivery details of mode of delivery, normal instrumental or cesarean was noted in the case of caesarean section indication for cesarean would be noted. Time and date of delivery, gender of neonate, and birth weight were noted. Level of fetal risk was allotted based on values of CPR, no risk-CPR >1.08, mild risk-CPR= 1.08 to1.1, high risk - CPR= <1.08. Neonatal outcomes in terms of (alive and well, stillbirth, neonatal death), NICU admission, meconium staining of liquor**,** intrapartum FHR variation suggestive of fetal distress, and neonatal Birth weight were noted.

Statistical analysis

The data were represented as frequency or percentage. Data were described in terms of range; mean, standard deviation (± SD), median, frequencies (number of cases), and relative frequencies (percentages) as appropriate. A Kolmogorov-Smirnov test was used to determine whether the data were normally distributed. Comparison of quantitative variables between the study groups was done using the student t-test Mann-Whitney U test for independent samples for parametric and non-parametric data respectively. For comparing categorical data, the Chi-square ($\chi 2$) test was performed and the Fisher exact test was used when the expected frequency is less than 5. A probability value (p-value less than 0.05 was considered statistically significant. All statistical calculations were done using (Statistical Package for the Social Science) SPSS version 21 (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

RESULTS

A total of 119 pregnant women with pre-decided high-risk factors were prospectively studied by UDG Doppler with CPR and the pregnancy outcome was noted. The majority of women were in the age group of 26-30 years (42.0%), about 26.1% were in the age group lesser than 25 years of age 26.1 were between 31-35 years old and 5.9 % were more than 35 years old-the mean age was-28.91±4.49. Most women were multigravida (92.4%), 76 women were primigravida. Other demographic parameters like religion, education level, and booking status in women were not statistically significant (Table 1 and 2).

IUGR was found in 29 women and women out of them 15 which is 51.7% had a CPR of <1.08. This association was statistically significant as the p-value was 0.001.

The mean MCA PI in CPR >1.08 group was 1.55±0.40 and in CPR <1.08 it was 1.35±0.50. Significant p-value =0.031. The mean umbilical artery PI in CPR >1.08 and CPR <1.08 were 1±0.21and 1.25±0.87respectively which is significant, has p value =0.012 (Table 3).

Table 1: Demographic features.

Demographic parameters	Percentage
Age group (in years)	
<25	26.1
26-30	42
31-35	26.1
>36	5.9
status	
Booked	47.9
Un-booked	52.1
Religion	
Hindu	77.3
Muslim	22.7
Socioeconomic status	
Middle class	92.4
Lower middle class	7.6
Parity	
Multigravida	92.4
Primigravida	7.6
Gestation at diagnosis booking (weeks)	
Minimum	30.6
Maximum	40.2
Mean	37.04±2.35

Table 2: Maternal risk factors.

Risk factors	No. of cases	Percentage
Preeclampsia	30	25.21
Gestational hypertension	8	6.73
Anaemia	27	22.68
FGR	29	24.36
Oligohydramnios	25	21.01
Post-dated	12	10
GDM	18	15.12
Type II DM	3	2.52
IHCP	8	6.7
Others	7	5.88

Table 3: Distribution according to CPR.

CPR group	No. of cases	Percentage
>1.08	88	73.9
<1.08	31	26.1
Total	119	100.0

The relationship of mode of delivery to the low and high CPR groups was not significant. The CPR was >1.08 in 88 women, 41 were women delivered by LSCS, and 47 had vaginal births in this group. Out of 31 women with CPR <1.08, 19 women had a caesarean section and 12 had a vaginal delivery. Meconium staining of the liquor in the low CPR group was statistically significant when compared to the normal CPR group. In the perinatal outcome, the gender distribution in both groups was not significantly different. There were more babies with birth weights less than 1500 grams in low CPR groups. More babies in the low CPR group needed NICU admission as compared to the normal CPR group and also needed a longer NICU stay, a statistically significant correlation. While comparing the sensitivity and specificity of UA PI, MCA PI, and CPR sensitivity in predicting adverse perinatal outcomes, we observed that the CPR was more than other values taken individually (Table 4-7 and Figure 1 and 2).

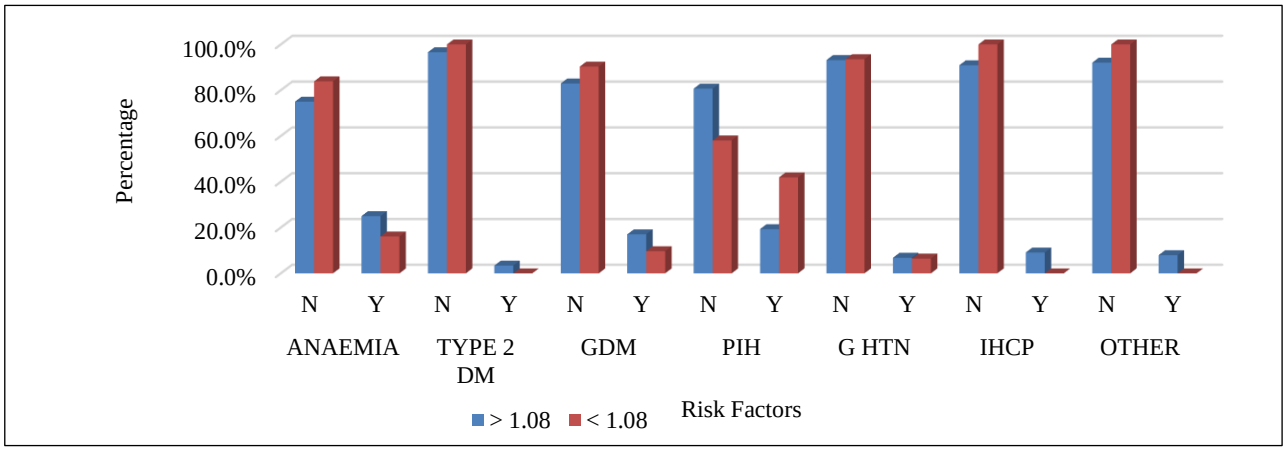

Figure 1: Relation of maternal risk factors to CPR values.

Table 4: Correlation of CPR to ultrasonographic features.

USG parameters	CPR > 1.08		CPR < 1.08		Z	P value
	Mean	SD	Mean	SD		
MCA PI	1.55	0.40	1.35	0.50	2.190	0.031
UA PI	1.00	0.21	1.25	0.87	2.553	0.012
MCA RI	0.77	0.10	0.74	0.17	1.187	0.238
UA RI	0.62	0.11	0.66	0.44	0.770	0.443
MCA SD	4.41	1.40	3.73	1.38	2.307	0.023
UA SD	2.75	0.74	3.85	5.33	1.895	0.061

Table 5: Relationship of CPR to perinatal outcome.

		No. of cases	CPR group				Chi-square	P value
			>1.08		<1.08			
			Percent	Number	Percent	Number		
FGR	N	74	84.1	16	51.6	90	13.12	0.001
	Y	14	15.9	15	48.4	29		
Total		80	100.0	24	100.0	104		

Table 6: Relation of birth weight <1.5 kg and CPR.

		CPR group				Total	Chi-square value	P value
		> 1.08		< 1.08				
		Number	Percent	Number	Percent			
Weight 1.5	N	84	95.5	25	80.6	109	6.532	0.019
	Y	4	4.5	6	19.4	10		
Total		88	100.0	31	100.0	119		

Table 7: Correlation of CPR NICU admission and duration of NICU stay.

		CPR Group				Total	Chi-square value	P value
		>1.08		<1.08				
		Number	Percent	Number	Percent			
NICU admission Y/N	N	69	78.4	9	29.0	78	24.749	0.001
	Y	19	21.6	22	71.0	41		
Total		88	100.0	31	100.0	119		
		>1.08		<1.08		Z		P value
Duration of NICU stay		Mean	SD	Mean	SD			
Duration		4.16	4.48	12.12	12.85	-2.865		0.007

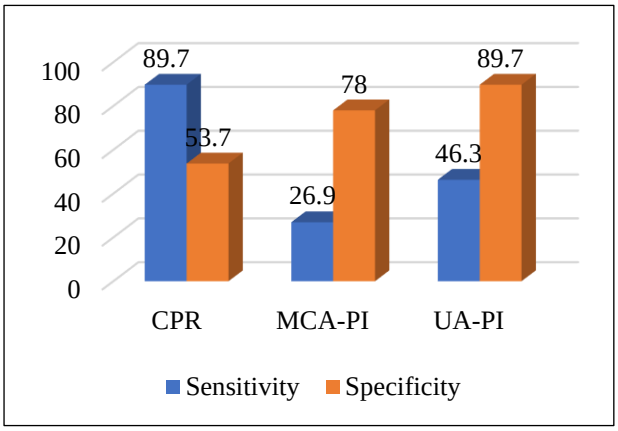

Figure 2: Comparative sensitivity/specificity of CPR vs UA-PI vs MCA-PI in predicting the neonatal outcome.

DISCUSSION

Compromised intrauterine existence of the fetus due to maternal, fetal, or placental factors often is the cause of poor intrapartum performance and adverse perinatal outcomes. The cerebroplacental ratio calculated by ultrasound Doppler velocimetry is recently being hailed as a good indicator of the intra-uterine status of the fetus and is believed to correlate well with neonatal outcome. A cut-off ratio of 1.08 is suggestive of adequate placental perfusion and fetal well-being. According to many researchers' ratios lower than 1.08 are believed to be due to reduced flow in the umbilical artery (UA-PI) and a compensatory increase in the middle cerebral artery (MCA-PI) flow indicating a "brain-sparing effect". We recruited 110 women with high-risk pregnancies between 32 to 42 weeks gestation to study the value of CPR and found it to be a useful tool in the prediction of neonatal outcomes.

The majority of the participants were multigravidas and the mean age at diagnosis -was 28.71±4.0), out of which 47.9% were booked patients Mean gestation was, and 52.1% were un-booked. However, in a similar study by Aiob et al, where they studied the performance of CPR in low-risk pregnancies in women with SGA babies who complained of reduced fetal movement, the number of nulligravidae was more than multigravidas.[8]

We divided the study group by CPR values, out of 119 women 31 women (26.1%) with abnormal CPR, and 88 women (73.9%) with normal CPR, based on a pre-decided cut-off value for CPR of 1.08. We compared women in these two CPR groups for fetal and maternal risk factors and found that except preeclampsia (statistically significant correlation p-value =0.017) and IUGR (significant relationship, p-value of 0.001) other risk factors like anaemia, GDM, post-dates, oligohydramnios, and IHCP had no statistical correlation to the abnormal CPR values. In a study by Gunay and co-workers, where 145 pregnant women, scheduled for induction of labor for various indications, were studied for the role of CPR on adverse perinatal outcomes, they found 28 women out of 145 to have abnormal CPR and 117 had normal CPR. They had taken a cut-off value of CPR at 1 and less than 1 was considered abnormal. This study found a lack of intrauterine growth restriction (IUGR) (OR 13.21, P = 0.001), fetal distress (OR 8.14, P = 0.003) or meconium aspiration (OR 159.91, P = 0.001), and umbilical artery pH values greater than 7.31 (OR 17.51, P = 0.015) in the group with normal CPR (≥1) as compared with the group with abnormal CPR.[9]

The intrapartum events like meconium staining of liquor (MSL) and non-reassuring FHR patterns in labor when co-related to the CPR values, were statistically significant (p-value 0.001and 0.007 respectively), in women with low CPR (i.e. CPR <1.08). Other neonatal parameters that showed a statistically significant relation to low CPR were low birth weight low (p value 0.001) and low 5-minute Apgar score at birth (p value of 0.012).

More babies from the low CPR groups required NICU admissions than the group with normal CPR group, out of 31 babies born to mothers with CPR <1.08, 22 (71%) required NICU admission. This observation was statistically significant (p value= 0.001). The newborns with low CPR were growth-restricted or preterm babies and required longer NICU stays. There was one neonatal death in the NICU due to complications of extreme prematurity, the rest of the babies were discharged in good condition.

In a systematic review of the utility of the fetal cerebroplacental ratio measured at term for the prediction of adverse perinatal outcome, Dunn and colleagues analysed 13 prospective and eight retrospective studies and noticed that low CPR was associated with abnormal foetal heart rate pattern, meconium stained liquor, low Apgar score, acidosis at birth and composite adverse perinatal outcome scores. They also found a relationship between low CPR and the need for caesarean section for intrapartum fetal compromise, SGA, foetal growth restriction, and NICU admission across the studies.[10]

In a small study of 66 women Shaheen et al found that CPR had a higher predictive value for foetal distress (FD), operative delivery, and LBW and concluded that CPR was modestly predictive of adverse perinatal outcomes. They compared sensitivities and specificities of the S/D ratio, S/D ratio of umbilical artery, S/D ratio of MCA and CPR, and observed that the CPR was more sensitive than the S/D ratio of the umbilical artery for the presence of meconium, FD, operative interference, low Apgar score (A/S), NICU admission and low birth weight (LBW).[11]

When we compared the sensitivity and specificity of CPR with the sensitivity and specificity of UA-PI and MCA-PI, the CPR showed the highest sensitivity among the Doppler indices. This suggests the ratio, rather than the individual components of CPR are better predictors of poor neonatal

outcomes. These findings agree with the observations of D Gramellini, who also found that the cerebroplacental ratio is a better predictor of SGA and adverse perinatal outcome than MCA-PI and UA-PI alone.[12] The USG Doppler studies have always been valuable in providing the status of intrauterine foetal well-being and have been used for deciding the judicious timing and mode of deliveries in high-risk pregnancies and calculation of CPR can add value in identifying foetuses at risk.

CONCLUSION

CPR has a good prognostic value in predicting many adverse perinatal outcomes. It is also an excellent tool for risk stratification of high-risk foetuses and can be used in justified timing of deliveries.

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

REFERENCES

1. Blencowe H, Cousens S, Jassir FB, Say L, Chou D, Mathers C, et al. National, regional, and worldwide estimates of stillbirth rates in 2015, with trends from 2000: a systematic analysis. Lancet Glob Heal. 2016;4(2):e98-108.
2. DeVore GR. The importance of the cerebroplacental ratio in the evaluation of fetal well-being in SGA and AGA fetuses. Ame J Obstetr Gynecol. 2015;213(1):5-15.
3. Fitzgerald DE, Drumm JE. Non-invasive measurement of human fetal circulation using ultrasound: a new method. Br Med J. 1977;2(6100):1450-1.
4. American College of Obstetricians and Gynecologists. ACOG134: fetal growth restriction. Obstet Gynecol. 2013;121(5):1122-33.
5. Zelop CM, Javitt MC, Glanc P, et al. ACR Appropriateness Criteria® growth disturbances: risk of intrauterine growth restriction. Ultrasound Q 2013;29(3):147-51.
6. Turan OM, Turan S, Gungor S, Berg C, Moyano D, Gembruch U, et al. Progression of Doppler abnormalities in intrauterine growth restriction. Ultrasound Obstet Gynecol 2008;32(2):160-7.
7. Guo LN, Chai YQ, Guo S, Zhang ZK. Prediction of neonatal acidosis using the cerebroplacental ratio at different gestational weeks: A case-control study. Medicine (Baltimore). 2019;98(29):e16458.
8. Aiob A, Toma R, Wolf M, Haddad Y, Odeh M. Cerebroplacental ratio and neonatal outcome in low-risk pregnancies with reduced fetal movement: A prospective study. Eur J Obstet Gynecol Reprod Biol X. 2022;14:100146.
9. Günay T, Bilir RA, Hocaoğlu M, Bör ED, Özdamar Ö, Turgut A. The role of abnormal cerebroplacental ratio in predicting adverse fetal outcome in pregnancies with scheduled induction of labor. Int J Gynaecol Obstet. 2021;153(2):287-93.
10. Dunn L, Sherrell H, Kumar S. Systematic review of the utility of the fetal cerebroplacental ratio measured at term for the prediction of adverse perinatal outcome. Placenta. 2017;54:68-75.
11. Bano I, Ahmad I. Doppler cerebroplacental ratio and adverse perinatal outcome. J South Asian Federat Obstetr Gynaecol. 2015;6(1):25-7.
12. 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.

Cite this article as: Negi P, Choudhary A, Kaushik S, Nimonkar S. Prognostic significance of cerebro-placental ratio in predicting perinatal. Int J Reprod Contracept Obstet Gynecol 2024;13:2036-41.