

Cerebroplacental Ratio as a Diagnostic Factor of Adverse Perinatal Outcome in 35-38 Weeks in Appropriate for Gestational Age Fetuses

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Abstract

Objective: The objectives of this study were to evaluate the diagnostic abilities of the cerebroplacental ratio (CPR) for the prediction of adverse perinatal outcome (APO)

Methods: This was a study of 200 high-risk fetuses attending the day hospital unit of a tertiary referral hospital that underwent an ultrasound examination at 34–38 weeks . APO was defined as a composite of abnormal intrapartum fetal heart rate or intrapartum fetal scalp pH <7.20 requiring urgent cesarean section, neonatal umbilical cord pH <7.10, 5-min Apgar score <7, and postpartum admission to neonatal or pediatric intensive care units.

Results: It was observed that only 16 (43.2%) patients were delivered by cesarean section and 123 (75.5%) underwent vaginal delivery with CPR>1. On the other hand 21 (56.8%) women had cesarean delivery while vaginal delivery was performed for 16 (43.2%) women with CPR <1. The correlation was statistically significant ($p =0.00$).the sensitivity, specificity, Positive predictive value (PPV) and negative predictive value (NPV) were 34%, 90%, 60% and 76% respectively. The intrapartum fetal distress was the major cause for increased cesarean rate.

Conclusion: CPR is an independent indicator in an obstetrician's armamentarium to detect patients at risk (CPR <1) in primary stage, triage them, monitor their labor strictly and deliver them early in order to procure healthy fetus.

Keywords: Fetal growth restriction, Surveillance, Doppler ultrasound, Biophysical profile

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Introduction

Vigilant antepartum fetal surveillance is the key to a healthy fetus. Globally around 45% of stillbirths i.e. 1.3 million per year occur during intrauterine period [1]. Intrapartum hypoxia can cause spectrum of

neurodevelopment disabilities, vision or hearing impairment, cerebral palsy and even intrauterine death[2]. Early identification and intervention can aid to curb this rising figure of in utero fetal

demise. Based on estimated fetal weight in ultrasonography (USG) fetus is classified as small for gestational age (estimated fetal weight <90 th percentile) and appropriate for gestational age (estimated fetal weight >10th percentile). Though unfavorable obstetric results are more common in SGA fetus but around 63% of fetal asphyxia have occurred in pregnancies with nil antenatal risk factors [3,4].

Since early 1990s cerebroplacental ratio (CPR) has been identified as the best doppler parameter to diagnose fetal hypoxia [5]. It is the ratio of pulsatility index (PI) of the middle cerebral artery (MCA) and umbilical artery (UA) [6]. In normal circumstances cerebrovascular resistance is higher than placental resistance at any gestational period which results in CPR >1. During initial intrapartum insult there is increase in placental blood flow resistance which ultimately accentuates PI of UA [7]. Further deterioration in placental blood flow leads to centralization of blood from periphery to fetal brain (brain sparing effect). Earlier it was thought to be a compensatory mechanism but recently it has been associated with fetal growth restriction [8]. This decreases PI of MCA resulting in CPR <1.

Hence CPR has been proposed as ideal Doppler index to identify fetal vascular redistribution pattern [9,10]. Numerous studies have elicited the high predictive capacity of CPR for SGA at birth [11] but through this study we intended to emphasize role of CPR as a prognostic marker of adverse perinatal outcome in AGA fetus.

Materials and Methods

Our study was a prospective observational study conducted in the department of Obstetrics and Gynaecology in Sultania Zanana hospital, Gandhi Medical College during 1st February 2020 to 30th January 2021.

Methodology

Total 200 admitted women with singleton pregnancy were included. Patients with AGA fetus as per first USG and within 34+6 – 37+6 period of gestation were recruited. Exclusion criteria were multiple pregnancies, congenital anomalies, gestational age <34 or >38 weeks and associated comorbidities like hypertensive disorders, gestational diabetes mellitus, oligohydramnios etc.

After receiving written consent from the participants, detailed history and clinical examination was performed. Patients underwent routine biometric scan to tally gestational age calculated by last menstrual period.

As recommended by International Society for Ultrasound in Obstetrics and Gynecology (ISUOG) Doppler measurements of UA were taken from free loop of cord for the sake of simplicity [12]. The angle of insonation was restricted to less than 60. PI was calculated by subtracting end diastolic velocity from peak systolic velocity divided by the mean velocity. While in MCA Doppler axial plane of fetal head was magnified at the base of skull at the level of thalami and wings of sphenoid bone. The angle of insonation was 0 as the vessel was parallel to the insonating beam which enhanced the accuracy for deriving PI for MCA. CPR was calculated just prior to their delivery.

CPR was calculated as follows

$$\text{CPR} = \text{MCA PI}/\text{UA PI}$$

CPR <1 was taken abnormal. Patients were followed for labor and delivery in the institute but labor was avoided in women with CPR <1 and were taken for cesarean delivery to prevent unfavorable results. Post-delivery adverse neonatal outcomes were indicated by APGAR score <7 at 5 minutes after delivery, Neonatal intensive care unit (NICU) admission due to seizures or hypoxic ischemic encephalopathy and stillbirth

Consent: Written consent was obtained from the relatives of patients after explaining them the nature and purpose of the study. They were assured that confidentiality would be strictly maintained.

The option to withdraw from the study was always open.

Observation chart

Table 1: Frequency of cpr among participants

CP ratio	Frequency	Percent
>1	139	69.5
<1	61	30.5
Total	200	100

Table 2- Correlation between cpr and gestational age of participants

Gestational Age	CP ratio		Total
	>1	<1	
>= 37 weeks	75	30	105
	71.4%	28.6%	100.0%
< 37 weeks	64	31	95
	67.4%	32.6%	100.0%
Total	139	61	200
	69.5%	30.5%	100.0%

Chi-Square = 0.388, p = 0.5333

Table 3: Correlation between cpr and mode of delivery

Mode of Delivery	CP ratio		Total
	<1	>1	
LSCS	21	16	37
	56.8%	43.2%	100.0%
Normal	40	123	163
	24.5%	75.5%	100.0%
Total	61	139	200
	30.5%	69.5%	100.0%

Chi-Square = 14.75, p = 0.000

Table 4: Correlation between cpr and newborn apgar score

APGAR Score	CP ratio		Total
	<1	>1	
<=7	40	24	64
	62.5%	37.5%	100.0%
>7	21	115	136
	15.4%	84.6%	100.0%
Total	61	139	200
	30.5%	69.5%	100.0%

Chi-Square = 45.46, p = 0.000

Table 5: Correlation between cpr and nicu admission

NICU admission	CP ratio		Total
	<1	>1	
Yes	29	16	45
	64.4%	35.6%	100.0%
No	32	123	155
	20.6%	79.4%	100.0%
Total	61	139	200
	30.5%	69.5%	100.0%
Chi-Square = 31.56, p = 0.000			

Table 6: Correlation between CPR and stillbirth

Still birth	CP ratio		Total
	>1	<1	
Yes	1	3	4
	25.0%	75.0%	100.0%
No	138	58	196
	70.4%	29.6%	100.0%
Total	139	61	200
	69.5%	30.5%	100.0%
Chi-Square = 3.81, p = 0.05			

Results

In this study there were 75 (71.4%) women with CPR >1 delivered at or beyond 37 weeks while 64 (67.4%) delivered preterm. Similarly there were 30 (28.6%) women who delivered at term and 31 (32.6%) who delivered preterm. There was no statistical significant (p value = 0.533).

It was observed that only 16 (43.2%) patients were delivered by cesarean section and 123 (75.5%) underwent vaginal delivery with CPR>1. On the other hand 21 (56.8%) women had cesarean delivery while vaginal delivery was performed for 16 (43.2%) women with CPR <1. The correlation was statistically significant (p =0.00).the sensitivity, specificity, Positive predictive value (PPV) and negative predictive value (NPV) were 34%, 90%, 60% and 76% respectively. The intrapartum fetal distress was the major cause for increased cesarean rate.

The study showed that mothers with CPR <1 gave birth to 40 (62.5%) newborns with APGAR </=7 and 21 (15.4%) newborns

with APGAR >7. Also it was seen that mothers with CPR >1 had 24 (37.5%) neonates with APGAR </= 7 and 115 (84.6%) neonates with APGAR >7 with statistical significance (p=0.00). The sensitivity, specificity PPV and NPV were 66%, 83%, 63% and 85% respectively.

It was observed that mothers with CPR <1 had 29 (64.4%) NICU admission and those with CPR >1 had only 16 (35.6%) NICU admission. It was statistically significant (p = 0.00). The sensitivity, specificity, NPV, PPV and accuracy of CPR in relation to NICU admission were 48%, 88%, 79%, 64% and 76% respectively. Among 200 deliveries there were 196 live births and 4 stillbirths. Among which 3 (75%) patients had CPR <1 and only 1 (25%) had CPR >1. There were 196 live births and 138 (70.4%) had CPR >1 and 58 (29.6%) had CPR <1. There was a statistical significance to it (p=0.05).

Statistical Analysis:

Data was entered in Microsoft excel sheet and tabulated. IBM SPSS (Statistical package for Social sciences) version 20

was used for analysis. Descriptive analysis was done to depict the distribution in form of frequency and percentage. Chi square test was used compare the percentage and p value $< \leq 0.05$ was taken as statistically significant.

Discussion

The CPR is highly recommended tool in diagnosing poor results in growth restricted SGA fetus but its relevance in detecting abnormalities in AGA fetus is recently being recognized by various studies [13, 14]. As per various authors the ratio is more efficient than its individual component that is PI of UA and PI of MCA. During any compromise in intrauterine period the first change occurs in umbilical artery which is elicited by increased PI. But until then atleast 60-70% of the fetoplacental circulation has been hampered. The explanation given for it is the large compensatory capacity of placenta [15]. The value of cerebroumbilical Doppler ratio doesn't significantly vary after 30 weeks of gestation [16], thus in our study CPR <1 was taken as abnormal. This is in accordance with study by Sahana K et al [17]. The mean age in our study was 27 ± 5 years. The results obtained by G Yuvabalakumaran [18] and S Shaheen et al [19] in their studies also showed maximum participants in 22-26 years age group.

There was no statistical significance between CPR and period of gestation at the time of delivery ($p = 0.53$). Contrary to this study by Uma et al has concluded that low CPR is associated with prematurity [20]. Early delivery was mostly iatrogenic and was induced to avoid complications in fetus with abnormal CPR.

In the study patients with low CPR were associated with higher rate of cesarean section than patients with normal CPR. Similar results were also seen with Prior et al, S Dagade et al [21,22]. In a prospective observational cohort study by Bligh et al

[23] on 483 low risk pregnant women with CPR measurement done every two weeks from 36 weeks to delivery had concluded that for cesarean delivery for fetal cause the sensitivity, specificity, PPV and NPV were 55.5%, 87.9%, 27%, and 96.1% respectively. It was comparable to our study. Sensogodan S et al inferred that it is not the mode of delivery but the time taken during delivery which alters the obstetric outcome [24]. Growth restricted fetus fail to withstand decreased placental blood flow during uterine contraction and cesarean delivery is preferred in them. In our study the obstetric care givers were aware of patients with altered CPR. Their fetus did not undergo prolonged labor stress and were taken for cesarean section. This had created an interventional bias and is a limitation of our study but it was done to prevent fetal hypoxic injury and stillbirth. In a study by Liu et al on 476 singleton pregnancy with CPR <1 it was concluded that the ratio was significantly associated with non-reassuring fetal heart status in electronic fetal monitoring [25]

Adverse perinatal outcome determinants were defined by APGAR score at 5 minutes after birth, NICU admissions and stillbirths. Irrespective of mode of delivery there were 64 (32%) newborns with APGAR <1 among which 40 (62.5%) had CPR <1 ($p = 0.00$). This was in analogy with studies by Jamal et al and Grüttner B et al [14,26]. There were 45 (22.5%) NICU admissions among which 29 (64.4%) had CPR <1 ($p=0.00$). The ratio had high specificity (88%) and NPV (79%) but low sensitivity (48%) and PPV (64%) in predicting NICU admissions. Similar results were seen in study by Natthicha C et al [27]. There were 4 stillbirths in our study. All four were vaginally delivered. Two among them died due to abruption placentae, one underwent cord prolapsed and the one died due to maternal pyrexia. [28] It indicates that CPR is useful in detecting chronic hypoxic events and is has limited utility in acute events relate to placenta and cord accidents [11].

CONCLUSION

CPR is an independent indicator in an obstetrician's armamentarium to detect patients at risk ($\text{CPR} < 1$) in primary stage, triage them, monitor their labor strictly and deliver them early in order to procure healthy fetus.

DECLARATIONS:

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Code availability: Not applicable

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Ethical Consideration: There are no ethical conflicts related to this study.

Consent for publication: Consent taken

Contribution by Different Authors

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