Cerebroplacental Ratio: An Indicator of Perinatal Outcome in High-Risk Pregnancies

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Abstract

Objective: To study the predictive value of cerebroplacental ratio (ratio of pulsatility index of middle cerebral artery and umbilical artery) with obstetric Color Doppler scan after 30 weeks of gestation for detection of perinatal outcome in high risk pregnancies.

Material & Method: Prospective study of cases of high-risk pregnancies in the tertiary care centre from January 2018 to June 2019. From all the antenatal cases attending ANC OPD during the specified period 100 cases of clinically diagnosed high risk pregnancy were selected as the study group and 100 normal antenatal cases were taken as control group after 30 weeks of gestation for Doppler scan. Serial follow up of subjects with normal Doppler was done at 3 weeks and for abnormal Doppler was after every 48 hours. The S/D ratio, RI, PI values were obtained and CPR was calculated. Sensitivity, specificity and positive predictive value of CPR was calculated and analysis of data was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program.

Results & Conclusion: The best Doppler index for the prediction of adverse perinatal outcome in women with high-risk pregnancies is Cerebroplacental Ratio according to our study. Difference in CPR between two study groups was statistically significant. CPR < 1.0 showed the highest sensitivity (49%), highest specificity (100%), highest positive predictive value (100%), and highest accuracy (70%) in the prediction of overall perinatal outcome. In cases with abnormal Doppler, timely interventions lead to improved perinatal outcome. Hence, repeated Doppler study in these indices will help to reduce perinatal morbidity and mortality in high-risk pregnancies.

Keywords: Cerebroplacental Ratio (CPR), Middle Cerebral Artery-Pulsatility Index (MCA-PI), Umbilical Artery- Pulsatility Index (UA-PI), High Risk Pregnancy, Color Doppler.

Introduction

A high-risk pregnancy is identified as a pregnancy in which there is a risk of adverse outcome in the mother

and / or baby that is greater than the incidence of that outcome in general population. In India about 20-30% pregnancies belong to high risk category, which is responsible for 75% of perinatal morbidity and mortality1.

Identification of high-risk pregnancy, causes, and its complications through quality antenatal care helps in achieving favourable maternal, obstetric, and neonatal outcome2. In addition, women identified to be at high risk has to be followed up at regular intervals through routine care by the health experts at hospital and residential visits to stop the event of any maternal or fetal complications. Except for follow-up care, applicable laboratory investigations and referral services also conjointly are needed to enhance the results of outcome of pregnancy. Prognosis of the outcome also depends on the type of high-risk pregnancy among pregnant mothers3. Hence, identification of type of high-risk pregnancy at earliest stage will be helpful in leading the suitable intervention measures for pregnant women.

Doppler ultrasound provides a non-invasive methodology of activity changes in blood flow within uteroplacental and fetoplacental circulation, thereby assessing fetal wellbeing4. Doppler indices such as cerebroplacental ratio (CPR) evaluation are commonly used nowadays, and enable one to assess blood flow disturbances both in placenta-umbilical and feto-cerebral circulations5. Cerebroplacental ratio (CPR) is a new smart tool for predicting outcome in high risk pregnancies. The first CPR reported by Arbeille et al quantifies the redistribution of the cardiac output.6 According to the brain sparing theory, in any form of fetal distress, it can be seen that a decrease in the blood flow to the fetus leads to a decrease in the resistance of the cerebral arteries to prevent reduction in the blood

supply to the brain. This change is seen as an increase in the end-diastolic velocity (EDV). Thus, cerebroplacental ratio, defined as the ratio of the MCA PI to the umbilical artery PI, is an important predictor of adverse outcomes during pregnancy, and this also includes implications for the proper prediction and evaluation.

Present study carried out with the objective of studying the predictive value of cerebroplacental ratio with obstetric colour doppler scan after 30 weeks of gestation for detection of perinatal outcome in high risk pregnancies.

Materials and Methods

The study was conducted as prospective study of cases of high-risk pregnancies in the department of Obstetrics and Gynaecology in Mahatma Gandhi Medical College and Hospital, Jaipur from January 2018 to June 2019.

From among the antenatal cases registered to Obst & Gynae department of MGMCH, Jaipur 100 cases of clinically diagnosed high risk pregnancy were selected as the study group and 100 normal antenatal cases were taken as control after 30 weeks of gestation for Doppler scan.

Personal and demographic data were collected, detailed obstetric history (which includes history of PIH, GDM, DM, Anemia, Chronic hypertension), details of present pregnancy (including LMP, T1 Scan) were recorded. All these details were inserted in a Proforma and the data was statistically analysed and evaluated. Clinical and obstetric findings were recorded and lab investigations were noted.

Plan of study: Institute Ethical Committee approval was obtained before start of study. During this period, 200 pregnant women attending the OPD after 30 weeks of gestation were selected using inclusion and exclusion criteria.

Informed consent was obtained and detailed history was taken from these patients as per the proforma.

Inclusion criteria

1. Singleton pregnancy

2. 30 to 42 weeks of gestation age of fetus

3. At least one of the following risk factors -

➢ Advanced maternal age

➢ Gestational hypertension

➢ Gestational diabetes mellitus

➢ Maternal Heart disease

➢ Anemia and malnutrition

➢ Pregnancy after 40 weeks

➢ Rh iso-immunized pregnancy

➢ Oligohydramnios

➢ Prior neonatal deaths

➢ IUGR

Exclusion criteria

1. Gestational age less than 30 weeks

2. Multiple pregnancy

3. Congenital anomalies in the fetus

The patients were followed by serial clinical and Doppler assessment of umbilical and middle cerebral artery after recruitment between 30-42 weeks of gestation and the result of the last Doppler assessment within 10 days of delivery was considered in the subsequent co-relation with perinatal outcome. Serial follow up for normal Doppler was 3 weeks and for abnormal Doppler was after every 48 hours. The S/D ratio, RI, PI values were obtained and CPR was calculated.

All cases were kept under surveillance and decision for termination was based on CPR. Outcome of pregnancy was obtained including nature of labour, birth weight, APGAR score, IUD & other neonatal complications.

Observations & Results

Graph 1: Comparison of mode of delivery (spontaneous / induced) in the study group.
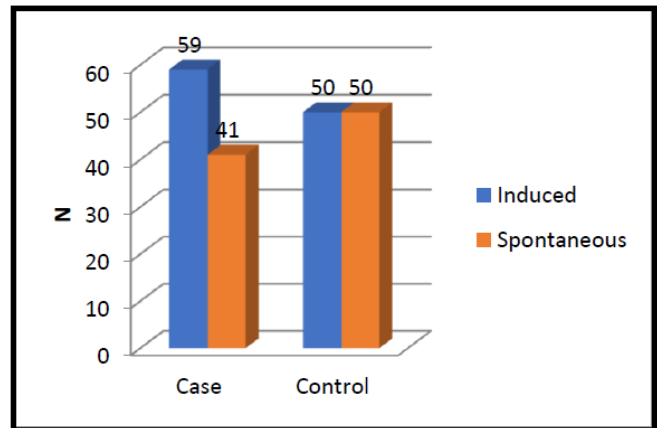

P value <0.01 (S)

Delivery was induced in 59% patients and were spontaneously delivered in 41% patients among case whereas 50% patients each among control group.

Table 1: Distribution of outcome of high-risk pregnancy in study groups.

	Case	Control	P value
Preterm birth	35	8	0.05
LSCS	24	8	0.001 (S)
IUGR	12	1	0.01 (S)
Anaemia	8	2	0.67
Low Birth weight	29	3	0.001 (S)
APGAR score (<7)	39	5	0.001 (S)
NICU admission > 24 hrs	51	39	0.001 (S)
Total	100	100	

Caesarean section, IUGR, Low birth weight APGAR less 7 score and NICU admission more than 24 hours showed statistically significant result with high risk pregnancy group as compared to control group.

Graph 2: Cerebroplacental Ratio
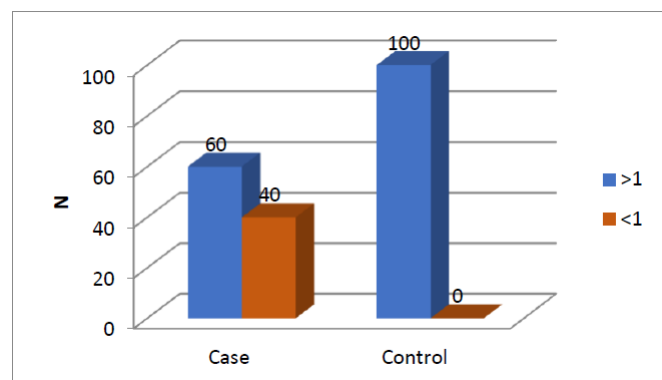
MCA/UA PI ratio (CPR) in the study population using a single cut off value of 1.00. No patient (0%) in the control group had MCA PI/UA PI ratio (CPR) < 1.00, i.e., all of the patients (100%) had the ratio value more than the cut off value. However, 40% patients in the study group had MCA PI/UA PI ratio (CPR) < 1.00 and 60% had >1.00. Difference in cerebroplacental ratio between two study groups was statistically significant.

Table 2: Diagnostics value of doppler findings for adverse pregnancy outcome.

	Sensitivity	Specificity	PPV	NPV	Accuracy
UA PI	33	70.2	50	53.7	52.6
MCA PI	39	81	67.24	57.04	60
CPR	49	100	100	62.5	70

UA PI (>1.4) showed the sensitivity (33%), specificity (70.2%), positive predictive value (50%), negative predictive value (53.7%) and accuracy (52.6%).

MCA PI (<1.5) showed the sensitivity (39%), specificity (81%), positive predictive value (67.24%), negative predictive value (57.04%) and accuracy (60%).

All the Doppler indices evaluated, CPR < 1.0 showed the highest sensitivity (49%), highest specificity (100%), highest positive predictive value (100%), highest negative predictive value (62.5%) and highest accuracy (70%) in the prediction of overall perinatal outcome.

Table 3: Association of abnormal doppler indices and pregnancy outcome in cases and control group

Abnormal Doppler indices	HIGH RISK				Total
	Low birth weight	APGAR <7	NICU	IUGR	
UA PI (>1.4)	20	21	20	19	33
MCA PI (<1.5)	19	20	21	22	39
CPR (<1)	25	26	27	25	40
Abnormal Doppler indices	CONTROL				Total
	Low birth weight	APGAR <7	NICU	IUGR	
UA PI (>1.4)	9	8	7	7	22
MCA PI (<1.5)	7	6	6	5	19
CPR (<1)	0	0	0	0	0

CPR score showed higher number of patients in low birth weight, APGAR<7, NICU and IUGR among high risk groups as compared to UA PI and MCA PI. Control group did not report patients with CPR <1.

Discussion

Present study shows that prevalence of high-risk pregnancy was 33.64% (95% CI 27.31-39.97%). This finding is in concordance with findings of some Indian and world studies like Bharati et al (31.4%)[7] and Paudel I et al (30.8%).[8] Higher prevalence was found in study conducted by Oyibo P et al (35.1%),[9] Dutta P et al (44.6%)[10], Kashani E et al (63.5%)[11] while lower prevalence of high risk pregnancy was found in studies like Mishra P et al (20%)[12] and Akthar H et al (4.5%)[13].

Current study shows that proportion of caesarean section was higher in study subjects with high risk pregnancy 24% as compared to those with control group (8%). This difference was statistically highly significant. Similar findings were reported in study done by Kashani E et al (2012) in which proportion of caesarean section was higher in study subjects with risk factor (79.6%) than proportion of caesarean section in study subjects without risk factor (20.4%). Samiya M[14] et al (2008) showed higher proportion (32.5%) of caesarean section in case group as compared to proportion (2.5%) in control group. Proportion of caesarean section was higher in present study probably due to better management of pregnancy and fetal survival. Of those who underwent Caesarean delivery for foetal distress, 36.4% had an abnormal CPR compared with 10.1% (p <.001) that had a normal CPR[15].

Majority of IUGR cases were observed in high risk group, reason being most of the pregnancies in high risk group were complicated by hypertensive disorders resulting fetal growth restriction. Stay in NICU for more than 24hrs was seen in high risk group babies

than in low risk, because of preterm deliveries and fetal growth restriction. Result was supported by Urvashi et al (2018)16. There is a higher rate of NICU admission in foetuses with an abnormal CPR (< 1). Kovanci E et al 2015, by using multivariate logistic regression analysis, they found

a significant association between an abnormal CPR and NICU admission in both AGA and SGA babies.

In the study population 39% babies had APGAR score less than 7. The study was dissimilar with one study17 i.e. 94% had APGAR score less than 7 in 5 minute and 5% had APGAR score less than 7 in 5 minutes. Kibaru JG18 et al (2015), multivariable regression analysis demonstrated that an abnormal CPR has significant contribution to predict a 5-minute APGAR score less than 7.

The ratio of PI of MCA/UA is more sensitive than MCA PI alone in predicting adverse neonatal outcome. It should be more than 1 then it is normal. In the present study, MCA/UA PI ratio with a single cut off value less than 1.00 has achieved high specificity and positive predictive value of 100.0 and 100.0% each with relatively low sensitivity (49%).

El-Sayed E (2018)19 et al showed in their study that the sensitivity, specificity, PPV, NPV of UA PI were 70%, 46%, 56.5%, 60.5% and 58% respectively. The Middle cerebral artery PI showed sensitivity, specificity, PPV, NPV of 70%, 60%, 63.6%, 66.7% and 65% respectively. In a study by Gramalleni D (1990)20 et al, CPR was calculated in high risk pregnancies only and they reported that sensitivity, specificity, PPV, NPV as 68.0%, 98.4%, 94.4%, and 88% respectively.

Several similar studies were conducted by investigators like Berkowitz GS (1988)21 et al and Fairlie FM (1991)22 et al, who also have demonstrated similar correlation between abnormal Doppler indices of fetal vessels and adverse perinatal outcome and fetal distress. Mari G et al, have suggested that cerebral Doppler indices are associated with adverse perinatal outcome, while others like Gramellini D (1992) et al and Ozeren M (1999)23 et al have proposed the cerebral-umbilical ratio as a better predictor of adverse perinatal outcome. Hence, the cerebral/umbilical PI ratio (CPR ratio) has been recognized as the most sensitive and specific indicator of likelihood of IUGR and adverse perinatal outcome in high-risk pregnancies.

Conclusion

Ever since the introduction of Doppler technology, repetitive non-invasive hemodynamic monitoring in pregnancy has been a great help to improve perinatal outcome in complicated pregnancies. The Doppler patterns follow a longitudinal trend with early changes in the umbilical artery followed by middle cerebral artery and other peripheral arteries.

For the prediction of adverse perinatal outcome in women with high-risk pregnancies, the best Doppler index, according to our work, is CPR ratio. In cases with abnormal Doppler, timely interventions lead to improved perinatal outcome. Hence, repeated Doppler study in these indices will help to reduce perinatal morbidity and mortality in high-risk cases.

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