ROLE OF CEREBRO-PLACENTAL RATIO IN PREDICTION OF ADVERSE PERINATAL OUTCOME IN HYPERTENSIVE DISORDER OF PREGNANCY

Amrita Giri,[1] Amit Shrestha,[2] Anshumala Joshi[1]

[1]Department of Obstetrics and Gynaecology, [2]Department of Radiology, Nepal Medical College Teaching Hospital, Attarkhel, Gokarneshwor-8, Kathmandu, Nepal,

ABSTRACT

Hypertensive disorder of pregnancy is a multisystem disorder associated with an increased risk of perinatal mortality worldwide. Doppler velocimetry of uterine, umbilical, and fetal vessels is an established method of antenatal monitoring identifying fetus at risk. The cerebroplacental ratio (CPR) is emerging as an important predictor of the adverse perinatal outcome as it considers both umbilical and middle cerebral artery doppler. The aim of this study is to find the role of CPR in the prediction of adverse perinatal outcome in the hypertensive disorder of pregnancy. A prospective descriptive study was done on women admitted to a tertiary care hospital in Kathmandu from July 2020 to June 2021 after taking ethical clearance from Institutional Review Committee. A total of 136 hypertensive pregnant women beyond 34 weeks of gestation underwent Doppler ultrasound, and CPR ratio <1.08 (done within one week of delivery) was considered abnormal. During the study, CPR was normal in 101 women (74.3%) and was abnormal in 35 women (25.7%). The study showed that the rate of cesarean section was high in women with abnormal CPR than with normal CPR (77.1% vs 45.5%). The caesarean section done for fetal distress (70.4% vs 39.1%), Apgar score < 7 in 5 minutes (14.3% vs 3.0%), NICU admission rate (54.3% vs 27.7%), and duration of NICU stay (3.9 + 4.08 vs 0.79 +1.94 days) were high in women with abnormal CPR. The cerebroplacental ratio in hypertension in pregnancy can provide useful information regarding fetal well-being and help us in improving fetal outcomes.

KEYWORDS

Hypertension in pregnancy, cerebroplacental ratio, perinatal outcome

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CORRESPONDING AUTHOR

Dr. Amrita Giri
Associate Professor,
Department of Obstetrics and Gynaecology,
Nepal Medical College Teaching Hospital,
Attarkhel, Gokarneshwor-8, Kathmandu, Nepal,
Email: amritatuladhar@yahoo.com
Orcid No: https://orcid.org/0000-0002-8286-347X
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INTRODUCTION

Hypertensive disorder of pregnancy (HDP), an umbrella term that includes pre-existing hypertension, gestational hypertension, preeclampsia, and eclampsia complicate up-to 10% of pregnancy and is responsible for 14% of direct obstetric deaths and 20% of fetal deaths in developing countries.[1,2]

Hypertension in pregnancy is due to the abnormal trophoblastic invasion of spiral arteries which increases vascular resistance in uteroplacental circulation leading to low end diastolic flow in the umbilical artery and consequent hypoxia.[1] Vasodilatation of the cerebral arteries occurs as a compensatory mechanism to preserve adequate oxygen supply to the brain. The abnormal vascular resistance in the uteroplacental and fetal circulation is studied by doppler ultrasound of the umbilical artery (UA), middle cerebral artery (MCA), and uterine artery.[3] By combining multiple vessels, the sensitivity of doppler studies can be increased.[4]

The cerebro-placental ratio (CPR) is emerging as a better predictor of adverse outcomes and is more reflective of fetal hypoxia and acidemia.[5] CPR reflects the circulatory insufficiency of the UA and the adaptive changes seen in MCA.[6] It is calculated as the pulsatility index (PI) of MCA over that of UA. The CPR is usually constant during the last ten weeks of gestation and a single cutoff value of 1.08 can be used, below which velocimetry is considered abnormal.[7,8] The UA doppler for fetal assessment is an integral part of management in hypertension in pregnancy in our institution. As CPR takes into consideration both UA and MCA doppler, it plays a vital role in monitoring fetal oxygenation in pregnancy with impaired placentation. It is thus considered a better index than using either of these alone in predicting adverse perinatal outcomes.

MATERIALS AND METHODS

A prospective descriptive study was carried out in the department of Obstetrics and Gynecology at Nepal Medical College Teaching Hospital (NMCTH) for one year from July 2020 to June 2021 after taking ethical clearance from Institutional Review Committee, NMCTH. Women admitted to the antenatal ward with a singleton pregnancy with a diagnosis of gestational hypertension and pre-eclampsia at or beyond 34 weeks were enrolled for the study. Women with multiple pregnancy, polyhydramnios, diabetes in pregnancy, chronic medical diseases like renal and cardiac disease, and with fetal anomalies were excluded from the study. Obstetric ultrasonography and a Doppler study were done on the day of admission. During the Doppler study, pulsatility index, resistive index, and the systolic-diastolic ratio of the umbilical artery and middle cerebral artery were calculated. The cerebroplacental ratio was calculated as PI of the middle cerebral artery divided by PI of the umbilical artery. A CPR of more than 1.08 was considered normal and that less than 1.08 was considered abnormal. The CPR value within one week of delivery was considered for correlation with the mode of delivery and adverse perinatal outcome. The adverse perinatal outcomes considered were: caesarean section for fetal distress, low birth weight, apgar score <7 at 5 minutes of life, indication and duration of Neonatal Intesive Care Unit (NICU) admission, and stillbirth and neonatal death. Based on CPR value, the study population were divided into two groups i.e. Group A with normal CPR and Group B with abnormal CPR. A proforma was created; the data were entered and analyzed using SPSS (Statistical Package for Social Sciences) version 21.

Gestational hypertension was defined as new onset of blood pressure ≥140/90mm Hg on two occasions 4 hours apart at ≥20 weeks of gestation in the absence of proteinuria or new signs of end-organ dysfunction.[1]

Pre-eclampsia was defined as new onset of blood pressure ≥140/90mm Hg on two occasions 4 hours apart at ≥20 weeks of gestation with a new onset of one or more of the following: significant proteinuria, platelet count <100,000/microliter, serum creatinine >1.1mg/dl, liver transaminases at least twice the upper limit of normal value, pulmonary edema, and cerebral or visual symptoms.[1]

RESULTS

A total of 136 women were recruited for the study during the period of one year and 104 women were diagnosed with gestational hypertension, 22 with mild pre-eclampsia, and ten were diagnosed with severe pre-eclampsia. Among 136 hypertensive women, the cerebro-placental ratio was normal in 101 women (74.3%) and was abnormal in 35 women (25.7%). The general characteristics of the study population are shown in Table 1. Among the study population, 51.5% of women were primigravida and 48.5% were multigravida.

Table 1: Maternal and fetal characteristics of the study population

Characteristics	n	%
Types of hypertensions		
Gestational hypertension	104	76.5
Mild pre-eclampsia	22	16.2
Severe pre-eclampsia	10	7.3
CP Ratio		
>1.08	101	74.3
<1.08	35	25.7
Age		
≤19 years	3	2.2
20 - 29 years	84	61.8
30 - 39 years	46	33.8
≥40 years	3	2.2
Gravida		
Primi	70	51.5
Multi	66	48.5
Gestational age		
≥37 weeks	118	86.8
<37 weeks	18	13.2
Mode of delivery		
Normal delivery	63	46.3
LSCS	73	53.7
Birth weight		
<2.5kg	11	8.1
≥2.5kg	125	91.9
Apgar score <7 at 5 mins	8	5.9
Admission to NICU	47	34.5

The majority of the women (61.8%) were in the age group 20-29 years with the mean maternal age being 27.75 (±4.56) years. Most women delivered at term (86.8%), while the preterm delivery occurred in 13.2%. The mean gestational age was 37.88 (±1.5) weeks. The LSCS rate was 53.7%, and 45.5% of women delivered vaginally. The mean birth weight was 3.05 ± 0.45 kg. The Apgar score of less than 7 in 5 minutes of life was seen in 5.9% of babies and 34.5% of babies were admitted to NICU for various indications. The mean NICU stay was 1.55 ± 2.94 days.

Based on CPR value, the study population were divided into two groups i.e. Group A with normal CPR and Group B with abnormal CPR and data were analyzed as shown in Table 2.

The women in both groups were comparable in terms of age, gestational age, and gravida. The abnormal CPR values were seen significantly higher in women diagnosed with pre-eclampsia than gestational hypertension. The study shows that the rate of caesarean section was significantly higher in women with abnormal CPR than with normal CPR. (77.1% vs 45.5%, p-value: = 0.0015). The indications of caesarean section were analyzed in these two groups and it was found that LSCS done for fetal distress was seen significantly higher in women with abnormal CPR than with normal CPR (70.4% vs 39.1%, p-value: =0.015).

The mean birth weight of the babies was similar in both groups (3.02 ± 0.4 vs 3.12 ± 0.59, p-value: = 0.27). The apgar score less than 7 in 5 minutes of birth was also seen significantly higher in the abnormal CPR group when compared with the normal CPR group (14.3% vs 3.0%, p-value: = 0.02). Regarding NICU admission, 28/101 babies (27.7%) needed NICU admission in the normal CPR group while 19/35 babies (54.3%) needed admission in the abnormal CPR group, which was statistically significant (p-value: = 0.0069). The duration of NICU stay was also significantly longer in the low CPR group than in the normal CPR group (3.9 ± 4.08 vs 0.79 ±1.94 days, p-value: <0.001). There were no stillbirth or neonatal death in either group during the study period. The various indications for NICU admission are shown in Table 3.

DISCUSSION

Hypertensive disorder of pregnancy is not only the leading cause of maternal morbidity and mortality but is also an important cause of perinatal morbidity and mortality. Doppler velocimetry studies of the placental and fetal circulation have become an integral part of investigations for fetal well-being in hypertensive pregnant women and play an important role in predicting fetal outcomes and helping in reducing perinatal death.

The present study shows that among 136 hypertensive women, 76.5% were cases of gestational hypertension, and 23.5% were diagnosed with pre-eclampsia.

The mean age of the study population was 27.75 ± 4.56 years which is similar_to that reported by Konwar *et al*[9] as 26.6±3.1 years and as 25.75 years by Salvi *et al.*[10] Though hypertension is a disease of primigravida, in contrary to other

Table 2: Maternal and fetal outcome based on CPR values			
Characteristics	**Normal CPR > 1.08 (n = 101)**	**Abnormal CPR < 1.08 (n = 35)**	**P value**
Mean CPR	1.69 ± 0.38	0.99 ± 0.06	
Types of hypertension			
Gestational hypertension (104)	82 (78.8%)	22 (21.1%)	0.0373
Pre-eclampsia (32)	19 (59.4%)	13 (37.1%)	
Mean maternal age	27.59 ± 4.54	28.20 ± 4.67	0.5
Gravida			
Primigravida	54 (53.5%)	16 (45.7%)	0.06
Multigravida	47 (46.5%)	19 (54.3%)	
Mode of delivery			
LSCS	46 (45.5%)	27 (77.1%)	0.0015
Normal delivery	55 (54.4%)	8 (22.8%)	
LSCS for fetal distress (37)	18 (39.1%)	19 (70.4%)	0.015
Mean birth weight	3.02 ± 0.4)	3.12 ± 0.59	0.27
Apgar score < 7 in 5 mins	3 (3.0%)	5 (14.3%)	0.02
NICU admission	28 (27.7%)	19 (54.3%)	0.0069
Mean duration of NICU stay	0.79 ± 1.94	3.9 ± 4.08	<0.001

Table 3: Indications for NICU admission			
Indications for admission	**Total**	**Normal CPR**	**Abnormal CPR**
Neonatal sepsis	11	4	7
TTN	9	8	1
Grunting for observation	8	7	1
Meconium aspiration syndrome	6	2	4
Perinatal depression	4	1	3
Congenital pneumonia	2	2	0
Respiratory distress syndrome	3	0	3
Neonatal jaundice	2	2	0
HIE 1^0	1	0	1
Cleft lip and palate	1	1	0

studies, the prevalence of primigravida and multigravida were almost similar in our study (51.5% vs 48.5%).

In our study, the caesarean section rate was significantly higher in abnormal CPR group (77.1%) than in normal CPR group (45.5%). Our findings are consistent with that reported by Alalfy *et al*[11] where they reported that patient with abnormal CPR were significantly more likely to be delivered by caesarean section (88.6%) when compared with normal CPR (53.6%). Similarly, Hazra *et al*[12] found that caesarean section rate was 62.5% in hypertensive women with abnormal CPR and only 22.2% in women with normal CPR. Abdelwahid *et al*[13] also found that hypertensive women with CPR >1 had higher incidence of elective caesarean delivery (112, 80.0%) than in control group (17, 12.1%).

When indications for caesarean section were analyzed in this study, it was found that the majority of caesarean section were done for

fetal distress in abnormal CPR group (19/27, 70.4%) than in normal CPR group (18/46, 39.1%). Similar to our study, Shahinaj *et al*[14] reported that 74.0% of caesarean section in their study were done for fetal distress in abnormal CPR group as compared to 62.5% in normal CPR group. Prior *et al*[15] also suggested that infants with a cerebroumbilical ratio <10th percentile were 6 times more likely to be delivered by caesarean section for fetal compromise than those with the ratio ≥10th percentile (odds ratio, 6.1; 95.0% confidence interval, 3.03–12.75). Khalil *et al*[16] did a study on 9772 women in 2017 and they reported that low CPR was associated with increased operative delivery for fetal compromise (Adjusted OR 1.4; 955 CI 1.10-1.78 p=0.006) In another study done by Jade L *et al*,[17] they reported that CPR less than 10th centile was associated with higher rate of caesarean section and also rate of emergency caesarean section for non-reassuring fetal status were higher in low CPR cohort than in normotensive women (19.2% vs 10.7%, p value <0.001).

In our study, the Apgar score less than 7 at 5 minutes of birth was also seen more in abnormal CPR group (14.28%) than in normal CPR group (3.0%). Similar to our study, Yalti *et al*[18] reported that apgar score at 1 and 5 minutes were found to be lower in group with CPR < 1 than in group with CPR >1 (9.4 ± 0.5 vs 8.4 ±1 p value < 0.001). In consensus to our study, Gaikwad *et al*[19] found that apgar score less than 7 in 5 minutes was seen in 46.9% of babies with abnormal CPR.

In our study, 19/35 (54.3%) of babies born to women with abnormal CPR were admitted to neonatal intensive care unit as compared to 28/101 (27.7%) babies born to women with normal CPR. The duration of NICU stay was also higher in abnormal CPR group when compared with normal CPR group (3.8 ± 4.08 days vs 0.79 ± 1.94 days). Shahinaj *et al*[14] in their study found that perinatal morbidity increased significantly in the group with abnormal CPR and 77.6% of neonates required NICU admission in abnormal CPR group as compared to 47.4% of neonates in normal CPR group. There was a significant difference in the duration of NICU stay (10.6 days vs 6.5 days p value <0.001) in abnormal vs normal CPR group. Adiga *et al*[20] reported that 48/95 (50.5%) babies required NICU admission for more than 24 hours. Mahmoud *et al*[11] also found the higher NICU admission rate of 72.7% in the babies born to women with abnormal CPR and the median duration of NICU stay was also longer in this group (11 days). Smitha *et al*[21] reported the NICU admission rate as 45.65% and Salvi *et al*[10] reported it as 60% in abnormal CPR group whereas the admission rate was only 10% in normal CPR group and Bonnevier *et al*[22] reported it as 43.3%.

The present study shows that abnormal cerebroplacental ratio when compared to normal in hypertensive pregnant women is associated with increased rate of caesarean section and LSCS for fetal distress, Apgar score less than 7 at 5 minutes of birth, NICU admission and prolonged NICU stay. The low CPR value can be taken as a good option in predicting adverse neonatal outcome as it provides useful information regarding fetal well-being and help us in improving fetal outcome.

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