

## Predictive Value of Cerebroplacental Ratio by Doppler Ultrasonography in Evaluation of Perinatal Outcome in High Risk Pregnancies

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### Abstract

### Original Research Article

**Objective:** To see the predictive value of cerebroplacental ratio for evaluation of perinatal outcome in patients with high risk pregnancies. **Methods:** We included 112 patients recovered in our hospital with the diagnosis of gestational hypertension, preeclampsia, eclampsia, anaemia, anaemia with IUGR, preeclampsia with IUGR, oligohydramnios, previous still birth of unknown origin between (28-36) weeks of gestation from 1<sup>st</sup> July, 2018 to 30<sup>th</sup> June, 2019. All patients underwent accurate colour Doppler velocimetry examination available in our hospital. Pulsatility index ratio of MCA and UA (CPR) was evaluated in each case. CPR<1 was considered abnormal. Outcome variables were birth weight less than 10<sup>th</sup> percentile, neonatal death, still birth, emergency caesarean section for fetal distress, low APGAR score, admission to NICU and the duration of treatment. **Results:** In 70 patients abnormal CPR was seen. Abnormal UA PI and MCA PI were seen in 66 and 46 patients respectively. 91.42% of patients with abnormal CPR had adverse outcome. 83.87% and 91.30% of patients with abnormal UA PI and MCA PI had adverse outcome. CPR in high risk cases had highest sensitivity (91.42%), PPV (91.42%), NPV (89.28%) and diagnostic accuracy (89.28%). MCA had the highest specificity (90.47%). **Conclusion:** We found CPR to be a better index in predicting perinatal outcome in high risk pregnancies than MCA PI and UA PI alone. The use of CPR in the monitoring of high risk cases may contribute to a large extent in timely management of such cases for a better result.

**Keywords:** Umbilical artery, Middle cerebral artery, Pulsatility index, Cerebroplacental ratio.

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## INTRODUCTION

A high risk pregnancy is one in which some conditions put the mother, the developing fetus, or both at higher than normal risk for complications during or after the pregnancy & birth [1]. Such patients are very often associated with cerebroplacental insufficiency. Early and regular prenatal care helps many women to have healthy pregnancies and deliver without any complications.

Now a days, Doppler ultrasound velocimetry has become an established non invasive method of antenatal monitoring for assessment of uteroplacental, umbilical & fetal vessels [2]. Its indices like Pulsatility Index (PI), Resistance Index (RI), Systolic-Diastolic Ratio (S/D ratio) provide important information on the hemodynamics of the vascular area under study [3]. Changes in the waveforms of the fetal vascular areas provides information and helps in predicting adverse outcome [4].

Cerebro-Placental Ratio (CPR) incorporates data of both umbilical artery (placental status) and middle cerebral artery (fetal response) and is a better index of detecting perinatal outcome than using either of them alone.

In normal pregnancies the diastolic component in the cerebral arteries is lower than in the umbilical arteries at any gestational age. Therefore, the cerebrovascular resistance remains higher than the placental resistance and the middle cerebral artery / umbilical artery ratio is greater than 1 i.e. CPR > 1. This index becomes less than 1 if the flow distribution is in the favor of brain in pathological conditions.

In pregnancy with chronic fetal hypoxia, the blood volume in the fetal circulation is redistributed in favor of vitally important organs, i.e., the heart, kidney and brain [5]. This results in increase in diastolic flow due to vasodilatation of the MCA resulting in a decrease in its PI. There is reduction in placental

perfusion and an increase in flow towards the brain – Brain Sparing Effect – to compensate for fetal hypoxia and is associated most of the times with fetal growth restriction.

High risk pregnancies carry a higher risk of maternal and perinatal morbidity and mortality. Various methods of antepartum fetal surveillance are available now-a-days, but method which can predict intrauterine fetal compromise with surety is still under study. Various authors have found CPR to be a better predictor, but this is yet to be established. We also tried to evaluate the predictive value of CPR through this study. Its role in predicting fetal outcome in such cases will immensely help management of such cases. It is expected that the present study will throw some light in his regard.

## MATERIAL AND METHODS

A one year Hospital based prospective study was conducted in Assam Medical College & Hospital, Dibrugarh in which 112 high risk cases were studied.

Pregnancies between 28-36 weeks of gestation and having either gestational hypertension pre-eclampsia, eclampsia, anemia, gestational diabetes IUGR, oligohydramnios, previous stillbirth of unknown origin were included.

## EXCLUSION CRITERIA

Patients who didn't have an early ultrasound and an anomaly scan, patients not giving consent for serial Doppler follow-up, multiple pregnancies, fetal anomalies, patients who couldn't be followed up completely till delivery.

### Procedure

In all the cases thorough history taking, clinical examination and routine obstetric examination was done. Basic investigations including anomaly scan was done in all the cases. Those pregnancies were selected in whom the gestational age was reliable based on a best estimate from menstrual history, clinical gestational age and confirmed by an early first trimester ultrasound examination using CRL or BPD.

USG Doppler was done in all the cases. In cases which showed abnormal Doppler and had to be terminated immediately, a single USG was done. In those where pregnancy continued for further period, repeat Doppler was done at weekly intervals in those with abnormal Doppler findings and 2 weekly intervals in which those with normal Doppler findings. Patients who came in early labour & and in whom a single Doppler study could be done before delivery were also included. However, the Doppler findings of the first examination were taken for studying the perinatal outcome. During the period of minimal fetal activity, the UA colour Doppler waveforms were attained by

selecting a free-floating portion of the umbilical cord. The patients were made to lie in a semi-recumbent position with the head and chest slightly elevated and then the measurements were performed. For measurements of the MCA, an axial view of the fetal head was obtained at the level of sphenoid bone, and then the colour Doppler was used to visualize the circle of Willis and Doppler sample volume was placed within 1cm of the origin of the MCA which was identified as a major branch running anterolateral from the circle of Willis toward the lateral edge of the orbit and having best reproducibility. The angle between the ultrasonographic beam and direction of blood flow was maintained at  $<30^\circ$ . The Doppler signals were recorded with a 3.5 MHz curved array duplex transducer. The Doppler machine used was Samsung RS80A.

The pulsatility index (PI) of umbilical artery (UA) and middle cerebral artery (MCA) was noted and the MCA/UA PI ratio (CPR) was calculated. The UA PI was considered abnormal when the values were  $>95^{\text{th}}$  percentile for the gestational age, and the MCA PI was considered abnormal when the values were  $<$  lower limit for the gestational age. Cerebroplacental ratio i.e. MCA PI/UA PI  $<1$  was considered abnormal.

Doppler USG results were analyzed for prediction of adverse perinatal outcome. Patients were divided into two groups depending on the cerebroplacental ratio. CPR  $>1$  was considered as normal and CPR  $<1$  was considered as abnormal. Follow up of patients were done to see the delivery and the perinatal outcome.

Pregnancy was considered to have adverse outcome when any of the following complications were present-birth weight (less than 10th percentile), neonatal death, still birth, emergency caesarean section for fetal distress, low APGAR score (5 min APGAR score less than 7), admission to NICU for meconium aspiration, preterm, low birth weight, post resuscitation care, hypoxic ischemic encephalopathy, hypoglycemia, hyperbilirubinemia.

## STATISTICAL ANALYSIS

Statistical analysis was done by using proportions. The sensitivity, specificity, positive predictive value, negative predictive Value and diagnostic accuracy were determined for all Doppler measurements.

## RESULTS

Doppler studies of all the 112 cases were done to see the UA and MCA PI and their ratio (CPR) and were analyzed. Majority of the cases i.e. 62 (55.36%) were in 21-25 years age group. The mean maternal age was  $24.13 \pm 3.58$  years. Majority of the cases were around 33 weeks of gestation. There were a total of 58.04% primigravida.

**Table-1: Showing Distribution of Cases**

CLINICAL DIAGNOSIS	NUMBER (n = 112)	PERCENTAGE (%)
Gestational Hypertension	21	18.75
IUGR	21	18.75
Pre-eclampsia	16	14.29
Pre-eclampsia +IUGR	15	13.39
Anemia	15	13.39
Eclampsia	8	7.14
Anemia +IUGR	7	6.25
Oligodramnios	5	4.46
Gestational Diabetes	2	1.79
Previous Still Birth Pregnancies	2	1.79

**Table-2: Showing Doppler Parameters**

RISK FACTORS	NORMAL DOPPLER FINDINGS		ABNORMAL DOPPLER FINDINGS					
	N	%	UA		MCA		CPR	
			N	%	n	%	N	%
Gestational Hypertension	5	23.8	13	61.9	8	38.09	13	61.9
Preeclampsia	3	18.75	10	62.5	5	31.25	13	81.25
IUGR	6	28.57	14	66.66	13	61.90	14	66.66
Preeclampsia+IUGR	3	20	8	53.33	6	40	8	53.33
Anemia	9	60	2	13.33	4	26.66	5	33.33
Eclampsia	1	12.5	5	62.5	5	62.5	7	87.5
Anemia+IUGR	1	14.28	6	85.7	3	42.8	6	85.7
Oligohydramnios	0	0	3	60.0	2	40.0	4	80.0
Gestational Diabetes	1	50	1	50	0	0	0	0
Previous still birth of unknown origin	2	100	0	0	0	0	0	0

**Table-3: Showing Distribution of Adverse Outcome**

HIGH RISK FACTORS	NUMBER (n = 112)	ADVERSE OUTCOME	
		N	%
Gestational Hypertension	21	13	61.90
IUGR	21	14	66.66
Pre-eclampsia	16	12	75.00
Pre-eclampsia +IUGR	15	8	53.33
Anemia	15	6	40.00
Eclampsia	8	6	75.00
Anemia +IUGR	7	6	85.71
Oligodramnios	5	5	100.00
Gestational Diabetes	2	1	50.00
Previous Still Birth Pregnancies	2	0	0.00

**Table-4: Showing Doppler Indices and Perinatal Outcome**

DOPPLER INDEX	True Positive	True Negative	False Positive	False Negative	Sensitivity	Specificity	PP V	NP V	Diagnostic Accuracy
UA PI	52	32	10	18	74.28	76.19	83.87	64	75
MCA PI	42	38	4	28	60	90.47	91.30	57.57	71.42
CPR (MCA PI/UA PI)	64	36	6	6	91.42	85.71	91.42	85.71	89.28

## DISCUSSION

### Demographic Profile

In our study, 55.3% belonged to (21-25) year age group. Ghose R *et al.*, [6] had 51.8% of their study population in the age group of (21-25) years. Srilakshmi

KN *et al.*, [7] had 68% of the cases in the age group of (20-24) years.

### High Risk Factors Distribution

Our study included 18.75% cases of gestational hypertension, 14.29% of preeclampsia,

13.39% cases of preeclampsia with IUGR, 7.14% cases of eclampsia, 18.75% cases of IUGR etc. Lakhkar BN *et al.*, [8] studied Doppler in 13.7% cases of

preeclampsia, 36.6% cases of IUGR, 50% cases of preeclampsia with IUGR.

**UMBILICAL ARTERY PULSATILITY INDEX IN PREDICTION OF ADVERSE PERINATAL OUTCOME**

STUDIES	SENSITIVITY	SPECIFICITY	PPV	NPV
Srilakshmi KN <i>et al.</i> , (2014) [7]	66.66%	93.10%	87.5%	79.40%
Ghosh R <i>et al.</i> , (2017) [6]	56.8%	82.1%	-	-
Munikumari T <i>et al.</i> , (2017) [9]	91%	84.6%	84%	91%
Present Study (2018–19)	74.28%	76.19%	83.87%	64%

The results for sensitivity, PPV, NPV of our study for UA PI in high risk pregnancies were comparable to Srilakshmi KN *et al.*, [7]. The specificity of Ghosh R *et al.*, [6] & our study was comparable. The difference in the sensitivity and NPV of our study and Munikumari T *et al.*, [9] may be attributed to the less number of cases in their study. Umbilical artery represents fetoplacental system and primarily reflects placental resistance. PIH leads to more increase in placental resistance resulting in changes in UA PI values. Ghosh R *et al.*, [6] had more numbers of

oligohydramnios cases, whereas Srilakshmi KN *et al.*, [7] & our study had more number of PIH cases. Probably this can be attributed to difference in studies.

Fong K.W *et al.*, [10] & Gramellini D *et al.*, [11] had higher specificity (86.6%, 91.1%) of UA PI, but their sensitivity (44.7%, 40%) was less and not comparable to our study. The difference can be attributed to the inclusion of only IUGR cases in their studies.

**MIDDLE CEREBRAL ARTERY PULSATILITY INDEX IN PREDICTION OF ADVERSE PERINATAL OUTCOME**

STUDIES	SENSITIVITY	SPECIFICITY	PPV	NPV
Srilakshmi KN <i>et al.</i> , (2014) [7]	83.33%	85%	89.28%	77.27%
Ghosh R <i>et al.</i> (2017) [6]	56.8%	76.8%	-	-
Munikumari T <i>et al.</i> , (2017) [9]	87.5%	46%	60%	80%
Present Study (2018–19)	60%	90.47%	91.30%	57.57%

The sensitivity of our study was similar to Ghosh *et al.*, [6]. The difference in sensitivities between our study and the other two studies may be attributed to the less number of cases in their study. The difference

in specificity between our study and Munikumari T *et al.*, [9] may be attributed to the small sample size in their study.

**CPR IN PREDICTION OF ADVERSE PERINATAL OUTCOME**

STUDIES	SENSITIVITY	SPECIFICITY	PPV	NPV
Ghosh R <i>et al.</i> , (2017) [6]	59.6%	92.9%	84.8%	75.32%
Srilakshmi KN <i>et al.</i> , (2014) [7]	95%	87%	88%	85%
Munikumari T <i>et al.</i> , (2017) [9]	95.8%	84.6%	85%	95%
Present Study (2018–19)	91.42%	85.71%	91.42%	85.71%

Our study result goes well with most of the studies. The sensitivity of Ghosh R *et al.*, [6] was less than our study. Ghosh R *et al.*, did not include patients who came in labour in their study group, but our study included even patients in early labour with a single USG Doppler report. This may have resulted for the

increase in sensitivity in our study. The sensitivity of our study varied from Fong K.W *et al.*, (51.3%) [10] & Gramellini D *et al.*, (40%) [11]. These two studies included only IUGR cases and Fong KW *et al.*, [10] had larger sample size, this may have contributed to the difference in sensitivities.

**DOPPLER PARAMETERS**

DOPPLER INDEX	SENSITIVITY	SPECIFICITY	PPV	NPV
UA PI	74.28	76.19	83.87	64
MCA PI	60	90.47	91.30	57.57
CPR (MCA PI/UA PI)	91.42	85.71	91.42	85.71

In our study, we found that CPR was the better predictor for adverse perinatal outcome in comparison to UA PI, MCA PI and had higher Sensitivity, PPV & NPV. MCA PI had the higher Specificity. In Srilakshmi

KN *et al.*, [7] study, CPR had higher Sensitivity, NPV than UA PI and MCA PI. UA PI had higher Specificity & PPV than CPR & MCA PI. In Munikumari T *et al.*, [9] study CPR had higher Sensitivity and PPV for

prediction of adverse perinatal outcome than did the MCA Pulsatility Index and the UA PI.

Ghosh R *et al.*, [6] found CPR as the best index in predicting the adverse perinatal outcome in high risk pregnancy and had the highest Sensitivity, Specificity, PPV, NPV in comparison to MCAPI & UA PI. This variation in the predictive values may be attributed to the differences in the high risk factors distribution under study as well as the difference in sample size.

## CONCLUSION

We found CPR to be a better index in predicting perinatal outcome in high risk pregnancies than MCA PI & UA PI alone. The use of CPR in the monitoring of high risk cases may contribute to a large extent in timely management of such cases for a better result. Studies including large sample size can definitely establish this result.

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