

## Predictive Value of Cerebroplacental Ratio in Detection of Perinatal Outcome in High-Risk Pregnancies

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### Abstract

**Objective** To assess the predictive value of cerebroplacental ratio (i.e., S/D ratio of middle cerebral artery to S/D ratio of Umbilical artery) in detection of perinatal outcome in high-risk pregnancies.

**Material and Method** This retrospective study was conducted on 150 patients between 28 and 40 weeks of gestation (25 low risk and 125 high risk) who attended OPD and indoor wards of Teerthanker Mahaveer medical college and research center, Moradabad. All patients had serial color Doppler ultrasounds done after taking informed consent which was repeated at 2 weeks interval, and data were collected with regard to perinatal outcome.

**Result and Conclusion** Cerebroplacental ratio is having higher sensitivity and negative predictive value in detection of IUGR, Meconium aspiration syndrome, operative interference for fetal distress, and NICU admissions in comparison to its components. So, better prediction of neonatal outcome can be done by C/U ratio.

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## Introduction

Doppler velocimetry is the best method of surveillance for fetal hypoxemia in high-risk pregnancy. Doppler ultrasound velocimetry of uteroplacental umbilical and fetal vessels has become an established method of antenatal monitoring, allowing the noninvasive assessment of fetal circulation. Its indices provide important information on the hemodynamics of the vascularity of fetal vessels. Umbilical arteries are the common vessels assessed, but recent studies confirm the efficacy of middle cerebral artery (MCA) Doppler assessment. MCA Doppler measurement is a well-known modality for detecting fetal compromise. Studies have shown that MCA blood flow abnormalities were associated with hypoxia and adverse perinatal outcome. MCA/UA ratio reflects not only the circulatory insufficiency of the umbilical velocimetry of the placenta manifested by alterations in the umbilical S/D ratio but also the adaptive changes resulting in modifications of the middle cerebral S/D ratio. The objective of present study is to assess the predictive value of cerebroplacental ratio in detection of perinatal outcome in high-risk pregnancies in comparison to its components.

## Material and Method

This retrospective study was conducted on 150 patients between 28 and 40 weeks of gestation (25 low risk and 125 high risk) who attended OPD and indoor wards of Teert-hanker Mahaveer Medical College and Research Centre, Moradabad. All patients had undergone serial color Doppler ultrasound.

The UA color Doppler waveforms were obtained from a free-floating portion of the umbilical cord during minimal fetal activity and the absence of fetal breathing. All measurements were performed in the semi-recumbent positions with the head and chest slightly elevated. For measurement of the MCA, an axial view of the fetal head was obtained at the level of cerebral peduncles, and then the color Doppler was used to visualize the circle of Willis, and Doppler sample volume was placed within 1 cm of the origin of the MCA that was easily identified as a major branch running anterolateral from the circle of Willis toward the lateral edge of the orbit and having best reproducibility [1]. The angle between the ultrasonographic beam and direction of blood flow was always  $<30^\circ$ . The Doppler signals were recorded with a 3.5 MHz curved array duplex transducer. The UA pulsatility index was considered abnormal when the values were  $>2$  SD, and the MCA pulsatility index was considered abnormal when the values were  $<5$ th percentile. MCA/UA S/D  $< 1$  was considered abnormal. Doppler ultrasound was repeated at 2 weeks interval although some

studies advocate weekly while others 2–4 weekly assessment [2, 3]. Data were collected with regard to perinatal outcome. 16 cases were lost during follow-up period.

## Results

In our study of 150 cases, 25 cases (16.67 %) were without risk factors, while 125 cases (83.33 %) were with risk factors like Preeclampsia, IUGR, anemia, Bad obstetric history, postdated pregnancy, and twin pregnancy (Table 1).

Three cases (12 %) among control group had abnormal Doppler findings, while 88 % had normal Doppler findings. Umbilical artery Doppler was abnormal in 38.27 % cases of PIH, 53.33 % cases of IUGR, and 76 % cases of PIH and IUGR, while the values are 26.47, 30, and 52 % for MCA Doppler. 80 % cases of Preeclampsia and IUGR had abnormal C/U ratio (Tables 2, 3). In our study, patients with risk factors had higher incidence of abnormal Doppler findings. Our findings were in accordance with Satish Sharma et al. [4].

Cerebroplacental ratio was abnormal in 13 cases (38.24 %) of preeclampsia without IUGR and 80 % cases of preeclampsia with IUGR.

Alaa Ebrashy et al. [5] also reported abnormal cerebroplacental ratio in 41.8 % cases of preeclampsia without IUGR and 84.2 % cases of preeclampsia with IUGR. Our study corresponds with this study.

In our study, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for detection of IUGR for umbilical artery Doppler were 48.15, 80.67, 53.06, and 77.41 %, while that for MCA Doppler were 59.25, 88.89, 72.72, and 81.35 %. For abnormal C/U ratio, the values were 85.18, 89.72, 80.70 %, and 92.30. So, C/U ratio is most sensitive with higher PPV for detection of IUGR.

**Table 1** Distribution of cases with respect to high-risk factors

Sl no.	Risk factors	No. of cases	Percentage
1.	No risk factors (control)	25	16.67
2.	High-risk cases	125	83.33
	a. PIH	34	22.66
	b. IUGR	30	20
	c. PIH & IUGR	25	16.67
	d. PIH + Anemia	17	13.33
	e. BOH	6	4
	f. Postdated	7	4.67
	g. Twins	6	4
	Total	150	100

**Table 2** Abnormal doppler findings in high-risk patients

Sl no.	Risk factor	Normal Doppler findings		Abnormal Doppler findings					
				UA		MCA		Cerebroplacental ratio	
		No.	%	No.	%	No.	%	No.	%
1.	No risk factor (n = 25)	22	88	3	12	3	12	3	12
2.	Risk factors								
	a. PIH	20	58.82	13	38.24	9	26.47	13	38.24
	b. IUGR	12	40	16	53.33	9	30	15	50
	c. PIH + IUGR	–	–	19	76	13	52	20	80
	d. PIH + Anemia	11	64.71	4	23.53	5	29.41	6	35.29
	e. BOH	3	50	3	50	2	33.33	2	33.33
	f. Postdated	4	57.14	2	28.57	3	42.86	1	14.28
	g. Twins	5	83.33	1	16.67	–	–	–	–

**Table 3** Mode of delivery in relation to doppler findings

Sl. no.	Doppler findings	No. of cases	Vaginal		Instrumental		Cesarean	
			No.	%	No.	%	No.	%
1.	Normal Doppler	77	58	75.32	4	5.19	15	19.48
2.	<i>Abnormal Doppler</i>							
a.	Umbilical artery							
i.	Raised S/D ratio	49	26	53.06	1	2.04	22	44.89
ii.	AEDF	7	0	0	0	0	7	100
iii.	REDF	5	2	40	0	0	3	60
b.	MCA							
i.	Decreased S/D	44	20	45.46	0	0	24	54.54
ii.	Decreased cerebroplacental ratio	57	27	47.37	0	0	30	52.63

Singh et al. [6] found sensitivity, specificity, PPV, and NPV as 63.4, 90, 81, and 77 %. Our study was comparable to his study.

M.K. Tarzami et al. [7] also found C/U as a better predictor of perinatal outcome in comparison to its components.

In our study, sensitivity, specificity, PPV, and NPV for operative interference for fetal distress for increased UA S/D ratio were 66.67, 78.04, 74.89, and 89.72 %, respectively, while the values were 72.73, 78.05, 54.55, and 91.53 % for MCA Doppler and 90.91, 78.04, 52.63, and 96.97 % for C/U ratio. So, C/U ratio is most sensitive and with higher PPV than its components.

In absent end diastolic flow (AEDF) and reversed end diastolic flow (REDF) patients, low Apgar scores were seen in 6 cases (85.71 %) and 3 cases (60 %), respectively, while poor Apgar was seen in 33.33 % cases of decreased C/U ratio.

HIE was seen in 16.31, 22.72, and 21.05 % cases of abnormal UA, MCA, and decreased C/U ratio group, respectively.

Cerebroplacental ratio had 96.15 % sensitivity to 99.2 % NPV for detection of MAS.

In our study, sensitivity, specificity, PPV, and NPV for NICU admission detection were 50, 80.3, 48.9, and 80.95 % for UA Doppler; 64.58, 88.69, 70.45, and 85.71 % for MCA Doppler; and 75, 82.92, 63.15 and 89.47 % for increased C/U ratio. Neonatal death occurred in 40 % cases of REDF group.

In our study, it was concluded that C/U ratio had better value than MCA or UA S/D ratio alone. This is in accordance with Ebrashy et al. [8].

## Discussion

In our retrospective study, an attempt has been made to detect role of C/U ratio in assessment of fetal well-being and perinatal outcome. Doppler flow velocimetry of the fetal MCA may assist in perinatal diagnosis and management of complicated pregnancies. Because the MCA/UA ratio

**Table 4** Perinatal outcome in relation to doppler findings

Neonatal features	Normal Doppler (n = 77)		Abnormal Doppler (n = 73)									
			U/S S/D increased (n = 49)		AEDF (n = 7)		REDF (n = 5)		MCA S/D decreased (n = 44)		↓ CU ratio (n = 57)	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
IUGR	8	10.39	26	53.06	6	85.71	3	60	32	72.72	46	80.7
Poor Apgar score	1	1.29	12	24.49	6	85.71	3	60	17	38.63	19	33.33
Hypoxic ischemic encephalopathy	1	1.29	8	16.32	4	57.14	2	40	10	22.72	12	21.05
Meconium aspiration	1	1.29	16	32.65	4	57.14	3	60	20	45.45	25	43.85
NICU admissions	12	15.58	24	48.97	6	85.71	3	60	31	70.45	36	63.16
CS for fetal distress	3	3.89	22	44.89	7	100	3	60	24	54.54	30	52.63
Neonatal death	2	2.59	8	16.33	2	28.57	2	40	08	18.18	09	15.78
Still birth	–	–	2	4.08	1	4.28	2	40	02	4.5	04	7.14

incorporates data not only on placental status but also on fetal response, it is potentially more advantageous in predicting perinatal outcome (Table 4). Doppler data combining both umbilical and cerebral velocimetry provides additional information on fetal consequences of the placental abnormality. Abnormal MCA/UA Doppler ratio is strongly correlated with worse fetal prognosis. Fetal MCA is a high-resistance vessel and corresponds to 7 % of fetal cardiac output. Sequential changes occur in umbilical artery and MCA according to extent of fetal compromise. Initially, there is rise in UA S/D ratio and decrease in MCA S/D ratio. After then as fetal hypoxia increases, MCA S/D ratio becomes lower than UA S/D ratio. 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 MCA/UA ratio is greater than 1. The index becomes less than 1 which is called “centralization of flow” is abnormal, if the flow distribution is in favor of the brain in pathological pregnancies. A fetus is considered to have brain-sparing effect when the ratio is <5th percentile for the gestational age [9]. Long-term follow-up of IUGR fetuses with normal umbilical artery Doppler but MCA Doppler having pulsatility index less than 5th percentile shows poor neurodevelopmental outcome [10].

## Conclusion

From the above study, this has been concluded that cerebroplacental ratio is having higher sensitivity and NPV in detection of IUGR, meconium aspiration syndrome, operative interference for fetal distress, low apgar detection, and NICU admission in comparison to its components. So, better prediction of neonatal outcome can be done by C/U ratio even in advance stages of placental insufficiency.

**Compliance with Ethical Requirements and Conflict of Interest** Informed consent from all the patients was taken, and there were no ethical issues connected with the study. Rehana Najam, Sarika Gupta, and Shalini declared that they have no conflict of interest.

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