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ORIGINAL ARTICLE

Comparison of Outcome of Normal and High-Risk Pregnancies Based Upon Cerebroplacental Ratio Assessed by Doppler Studies

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Abstract

Objectives To evaluate the cerebroplacental ratio which is the ratio of pulsatility index of fetal middle cerebral and umbilical arteries, in normal and high-risk pregnancies during 30–36 weeks of gestation.

Methods In this study, we included 70 patients, who were scanned for Doppler parameters of Middle cerebral artery and Umbilical artery pulsatility index ratio of fetus, between 30 and 36 weeks, and then were followed till delivery. Thirty-five patients with normal pregnancy and 35 patients with high-risk pregnancy were included. Perinatal outcome was evaluated in relation to indices ratio.

Results There was cerebroplacental ratio of <1.00 in eight cases of the study group in comparison with the control group in which there is no case of <1.00 value. It was

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associated with poor perinatal outcome in terms of need for lower segment cesarean section for fetal distress, Apgar <8 at 5 min, and admission to nursery.
Conclusion Cerebroplacental ratio is highly sensitive in diagnosing hemodynamically compromised fetuses and very useful for the prediction of adverse perinatal outcome in these fetuses.

Keywords Intrauterine growth retardation · Pulsatility index (PI) · Middle cerebral artery (MCA) · Umbilical artery (UA)

Introduction

Doppler is a noninvasive method for evaluation of feto-placental circulation without any disturbance to human pregnancy.

It gives valuable information about hemodynamic situation of the fetus and is an efficient diagnostic test of fetal jeopardy that helps in management of high-risk pregnancy [1].

The use of doppler can be credited leading to a significant decrease in perinatal mortality and morbidity. The color Doppler ultrasound gives us information directly on vascular resistance and indirectly on blood flow. The present study had been planned to measure cerebroplacental ratio in predicting perinatal outcome.

Aims and Objectives

In this study, we evaluated the cerebroplacental ratio which is the ratio of pulsatility index of fetal middle cerebral and umbilical arteries, in normal and high-risk pregnancies during 30–36 weeks of gestation.

Materials and Methods

It was a prospective study, which included 70 patients (with informed consent), who were scanned for Doppler parameters between 30 and 36 weeks and then were followed up till delivery: 35 patients with normal pregnancy (control group) and 35 patients with high-risk pregnancy (study group).

Inclusion Criteria (High-Risk Pregnancy)

1. Singleton pregnancy.
2. The gestational age of patient should be between 30 and 36 weeks.
3. At least one of the following risk factors was present in the study group patient:
   - Gestational hypertension
   - Essential hypertension
   - Prior neonatal death
   - Diabetes mellitus
   - Malnutrition
   - Anemia

Exclusion Criteria

(a) Multiple pregnancy
(b) Congenital anomalies in the fetus.

Obstetrics color Doppler was done on pregnant women (between 30 and 36 weeks) who attended the Obstetrics OPD/IPD at Asian Institute of Medical Sciences, Faridabad, between February 2014 and June 2015. Due approval was taken from ethics committee.

Complete evaluation of all patients was done in the following format:

Detailed clinical history
General and systemic examination
Color Doppler USG evaluation.

Recordings from the umbilical artery (UA) were obtained by placing the sample volume in the lumen of the artery away from the placental and fetal cord insertion. After recording a technically satisfactory Doppler waveform, the pulsatility index (PI) and S/D ratio were noted.

Recordings from the middle cerebral artery (MCA) were obtained on a transverse section of fetal head, at the level of the thalami and cavum waveform, and pulsatility index and S/D ratio were noted.

Cerebroplacental Ratio [2–8] = PI of MCA/PI of UA

Outcome was calculated as:

(a) Perinatal outcome:
In terms of birth weight, Apgar score, admission to NICU, and days of stay in NICU.
(b) Obstetrical outcome:
In terms of mode of delivery.

Results

In the control group, one patient (2.9%) had umbilical artery velocimetry PI ratio >1.42, while 34 (97.1%) had umbilical artery velocimetry PI ratio ≤1.42, and in the study group, six patients (17.1%) had umbilical artery velocimetry PI ratio above the gestational-age-specific cutoff value and 29 (82.9%) had umbilical artery PI ratio

Table 1 Umbilical artery velocimetry PI ratio in both groups with gestational-age-specific cutoff values

UA PI	Controls		Cases		*P* value
	Frequency	%	Frequency	%	
≤1.42	34	97.1	29	82.9	0.106
>1.42	1	2.9	6	17.1	
Total	35	100	35	100	

P value = 0.106 (not significant)

Table 2 Middle cerebral artery (MCA) velocimetry PI ratio in both groups with gestational-age-specific cutoff values

MCA PI	Controls		Cases		*P* value
	Frequency	%	Frequency	%	
≥1.50	26	74.3	21	60.0	0.203
<1.50	9	25.7	14	40.0	
Total	35	100	35	100	

P value = 0.203 (not significant)

Table 3 MCA/UA PI ratio in both groups using a single cutoff value of 1.00

MCA/UA PI	Controls		Cases		*P* value
	No. of cases	%	No. of cases	%	
>1	35	100.0	27	77.1	0.005
<1	0	0.0	8	22.9	
Total	35	100	35	100	

below the gestational-age-specific cutoff value. The difference between two groups was not statistically significant (Table 1).

In the control group, nine (25.7%) patients had PI ratio <1.5, 26 (74.3%) patients had PI ratio ≥1.5 percentile, while in the study group, only 14 (40.0%) had PI ratio below the gestational-age-specific cutoff value and 21 (60.0%) had PI ratio above the gestational-age-specific cutoff value. The difference between two groups was not statistically significant. According to ROC curve, AUC 0.606 and SD 0.068 and 95% CI 0.472–0.739 (Table 2).

Table 3 shows MCA/UA PI ratio in the study population using a single cutoff value of 1.00. No patient (0.00%) in the control group had MCA PI/UA PI ratio <1.00, i.e., all of the patients (100.0%) had the ratio value more than the cutoff value. However, eight (22.9%) patients in the study group had MCA/UA PI ratio <1.00 and 27 (77.1%) had ≥1.00. Difference between two groups was statistically significant.

The outcomes were divided into major and minor groups (Table 4). In the control group, there were no stillbirth, two NICU admission, four premature birth, no post-natal complication, five delivered by LSCS due to fetal distress. In the study group, there was no stillbirth, five cases were in need of ventilator, 14 had NICU admission, 28 had premature birth, 10 had respiratory distress syndrome, five had necrotizing enterocolitis, 15 had cesarean section due to fetal distress, and three had Apgar score <8.

As shown in Table 5, among all the Doppler indices evaluated, MCA/UA PI <1.0 showed the highest sensitivity

Table 5 Adverse (major + minor) perinatal outcome of both groups according to Doppler indices: performance characteristics

Criteria	Sensitivity	Specificity	Predictive value		Prevalence
			Positive	Negative	
UA PI >1.4	20.59	97.22	87.5	56.5	48.6
MCA PI <1.5	48.57	73.9	73.9	61.7	50.0
MCA/UA PI <1.0	57.14	100.0	100.0	70.0	52.0

Table 4 Adverse perinatal outcomes in both groups

Adverse perinatal outcome indicator[a]		Control no.	Study no.	Total no.	*P* value	Si
Major						
1	Stillbirth	0	0	0	0.0	NS
2	Need of ventilator	0	5	5	0.054	NS
3	NICU stay >2 days	2	14	16	0.001	S
4	Premature birth	4	24	28	<0.001	HS
5	RDS	0	10	10	<0.001	HS
6	NEC	0	5	5	0.054	NS
Minor						
7	LSCS for fetal distress	5	15	20	0.008	S
8	5 min Apgar score <8	0	3	3	0.239	NS

Si significance, *S* significant, *NS* not significant, *HS* highly significant, *NEC* necrotising enterocolitis, *RDS* respiratory distress syndrome

[a] One newborn can have more than one adverse outcome

Table 6 Performance characteristics of MCA/UA ratio in the prediction of intrauterine growth retardation [2–8]

Parameter assessed	Authors	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy
Pulsatility index < 1.08	Dhand et al.	57	67	87	29	–
Pulsatility index < 2SD	Rajesh and Agamya	68.8	100	100	26.3	–
Pulsatility index < 1.08	Gramellini	40	100	100	62.5	70
Pulsatility index < 1.08	Bano et al.	44.4	100	100	64.3	72.2
Pulsatility index < 1.00	Present study	22.9	100.0	100.0	56.5	61.4

(57.14%), the highest negative predictive value (70.0%), the highest specificity (100.0%), and the positive predictive value (100.0%) in the prediction of overall perinatal outcome.

Discussion

The use of Doppler ultrasound in high-risk pregnancies appears to improve obstetric outcomes and is a promising tool in reducing prenatal deaths. Fetuses with abnormal Doppler velocimetry had a significantly higher incidence of preterm birth, low birth weight, and admission to NICU (Table 6).

In the present study, MCA/UA PI ratio with a single cutoff value <1.00 has achieved high specificity and positive predictive value of 100.0 and 100.0% each with relatively low sensitivity.

Maged et al. [9] in their study concluded that late-onset SGA fetuses with normal Doppler velocimetry on diagnosis show progression from 37 weeks gestation with worsening cerebroplacental ratio followed by a decrease in MCA PI.

Various studies have noticed a similar poor neonatal outcome in fetuses with abnormal Doppler velocimetry. Our study revalidates the findings. There were more number of cesarean sections and NICU admissions in abnormal Doppler indices in various studies; in the present study, 24 cases out of 35 high-risk pregnancies had cesarean section—15 for fetal distress—and 16 babies required NICU admissions. Predictive value of Doppler for fetal outcome is shown in Table 5, which differs in various studies

Despite the differences in observations between various authors based on different study designs, all these studies have common observations which are noteworthy:

1. Higher specificity is obtained by using the ratio (MCA/UA PI) in the prediction of intrauterine growth retardation.
2. High negative predictive values in prediction of major adverse perinatal outcome.

Conclusion

For the prediction of adverse perinatal outcome in women with high-risk pregnancies, the best Doppler index, according to our work, is MCA/UA PI 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.

Ever since the introduction of Doppler technology, repetitive noninvasive 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. Venous changes follow the arterial pattern and occur in severely compromised fetus and predict poor perinatal outcome.

Compliance with Ethical Standards

Conflict of interest The authors have no conflict of interest.

Ethical Standard The research is in compliance with ethical standard. Permission has been taken and is approved by institutional ethical committee.

Informed Consent Informed consent was obtained from all patients for being included in the study.

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