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Assessment of Fetal Middle Cerebral Artery Systolic/Diastolic Ratio; for Predicting Fetal Outcome in Preeclampsia Patients Using Doppler Ultrasonography

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Abstract	Original Research Article

Preeclampsia (PE) is a pregnancy complication characterized by high blood pressure, albuminuria and edema. PE is leading cause of maternal and perinatal morbidity and mortality. The study aimed to assess the fetal middle cerebral artery (MCA) systolic diastolic ratio (S/D ratio) in PE patients. A prospective case-control study performed in Sudan at Omdurman Maternity Hospital, feto-maternal unit. 100 PE patients and 120 healthy pregnant women matched for age, parity, and gestational age (GA) served as controls, all were subjected to routine ultrasound (US) followed by Doppler, the data was discussed and presented in percentage between patients age, GA, Parity, Diastolic, systolic and S/D Ratio. Doppler Analysis and its correlated to fetal outcome were discussed. Then statistically the results were analyzed. Doppler US results, from MCA considered as strong independent predictors in excluding adverse fetal outcome in PE.
Keywords: Doppler, Preeclampsia, maternal, perinatal, morbidity and mortality.

INTRODUCTION

PE is a pregnancy-specific syndrome characterized by reduced organ perfusion secondary to vasospasm and endothelial pathophysiology. The reported incidence of PE is 5-8% [1]. This condition is a leading cause of maternal mortality and is responsible for considerable perinatal morbidity and mortality [2].

Although the etiology of pre-eclampsia remains unclear, current thought is that it follows from the failure of second-wave trophoblastic invasion in the late first and early second trimesters [3]. As a result of the failed replacement of the spiral artery muscularis, these arteries do not transform into low-resistance conduits and uteroplacental resistance fails to decrease. In order to improve placental perfusion, it may be hypothesized that there is compensatory production of vasodilator substances by the placenta [4].

Circulatory adaptation occurs in the form of cerebral vasodilatation, resulting in the redistribution of the cardiac output to provide an adequate oxygen supply to the brain. These changes, which help fetus to adapt to a hostile environment, may correlate with fetal neonatal health. Ante-partum assessment is based on the premise that identification and timed delivery of the hypoxic and acid tic fetus will prevent intrauterine fetal death and decrease the risk of long-term adverse effects. As a result of the prolonged fetal hypoxia [5], Fetal middle cerebral artery Doppler assessment is an important part of assessing fetal cardiovascular distress and fetal anemia or fetal hypoxia[4].

OBJECTIVE

To assess the fetal middle cerebral artery-systolic diastolic ratio in Preeclampsia patients using Doppler ultrasound for predicting fetal outcomes

MATERIALS AND METHODS

A descriptive cross sectional study, deal with Doppler ultrasonography findings for fetal MCA S/D ratio In PE Patients, 100 pregnant women with PE were

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enrolled in cases study, with viable singleton pregnancies, aged between 17 to 42 years old and had GA between 26–40 weeks which was documented by confirmed last menstrual period (LMP) and/or first-trimester ultrasound dating, and did not have any obstetric or other morbidity except for PE were included in the study. PE was diagnosed according to the criteria of the International Society for the Study of Hypertension in Pregnancy: (Pre-eclampsia was defined as an arterial pressure greater than 140/90 mm Hg on two separate occasions, with associated proteinuria (>1+ on dipstick and/ or >0.3 g litre±1 on a 24-h collection), occurring after the 20th week of gestation) [6]. The pregnancy could be complicated by IUGR, defined as ultrasound-estimated fetal weight of less than the 10th percentile for GA. 120 healthy pregnant women, matched for age, parity, and GA served as controls. A pregnant woman qualified for the study if she received no medication during the pregnancy except for iron supplement. All women performed in supine position, subjected to routine ultrasound followed by color Doppler, equipped with Toshiba Power Vision 6000, with 3.5 MHz convex transducer, flow measurements of fetal MCA S/D ratio were taken in a transverse plane slightly closer to base of skull, at the level of the greater wings of the sphenoid bone, the sample volume was placed after the origin of MCA. An angle of zero degree is used typically. One exam on each patient was carried out include one middle cerebral artery. Patient characteristics that were recorded include maternal age, parity, GA, blood pressure and MCA Doppler measurements, and then fetal outcome monitored and statistically analyzed.

Pregnant women with multiple pregnancies, having history of chronic hypertension, gestational diabetes, cardiac disease, and middle cerebral artery pathology were excluded. A previously reported mentioned that error for MCA measurements are less than 10% [7-9]. The data have been analyzed by a Statistical Package for Social Sciences (SPSS) by using various statistic methods, for tested the normality of distribution by visual comparison, comparing each distribution with the normal distribution.

Values are given as percentage or mean+/- SD. Decreases of S/D ratio value, in the MCA were considered as an abnormal artery result.

Table-1: Clinical characteristics of cases group and their controls

Parameter	Preeclampsia (n=100) Followed cases=88	Controls (n=120) Followed cases=80
Age (means, years)	5.86 ± 28.77	27.99±5.158
Gestational age (means ±Std., weeks)	33.57±4.354	33.14±4.848
Systolic	12.001 ± 151.48	113.72±6.847
Diastolic	8.672 ± 99.12	74.61±6.423
S\D ratio	.88371 ± 3.2347	3.7533± .83525
family history(n, %)	54(54%)	0
Pregnancies with IUGR (n, %)	46(52.2%)	2(2.5)%
Pregnancies with preterm (n,%)	29(33.0)%	0
Pregnancies with IUFD (n, %)	14(15.9)%	0

Table-2: Shows severity of preeclampsia in cases group

Severity	Frequency	Percent	Valid Percent	Cumulative Percent
Mild	55	55.0	55.0	55.0
Severe	45	45.0	45.0	100.0
Total	100	100.0	100.0	

Table-3: Shows frequency distribution of parity for cases group

Parity	Frequency	Percent	Valid Percent	Cumulative Percent
PG	33	33.0	33.0	100.0
1	14	14.0	14.0	14.0
2	14	14.0	14.0	28.0
3	14	14.0	14.0	42.0
Multiparous	25	25.0	25.0	67.0
Total	100	100.0	100.0	

Table-4: Shows means and std. deviation of MCA S\D ratio for presence of IUGR, preterm delivery and IUFD in cases group

Fetal outcomes		S\D ratio (Mean& Std. Deviation)
IUGR	No	3.4407 ± .99725
	Yes	3.1148 ± 3.114
Preterm	No	3.3219 ± .83246
	Yes	3.1655 ± .96394
IUFD	No	3.3657 ± .86112
	Yes	2.7664 ±.80028

Table-5: Shows means and std. deviation of MCA S/D ratio for severity of preeclampsia in cases group:

Severity of PE	S/D ratio	
	Means	Std. Deviation
Mild	3.4640	.95547
Sever	3.0380	.71288

Table-6: Independent sample t- test for equality of means in IUGR, preterm, IUFD and Severity of PE cases and MCA S\D ratio in cases group

Characteristic	t-test for Equality of Means						
	T	Dt	Sig.(2-tailed	Means Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
S\D ratio (IUGR)	-1.765-	86	.081	-.32593-	.18462	-.69298-	.04108
	-1.740-	74.273	.086	-.32593-	.18727	-.69905-	.04719
S\D ratio (Preterm)	-.786-	86	.434	-.15635-	.19899	-.55192-	.23923
	-.747-	49.105	.459	-.15635-	.20925	-.57683-	.26414
S\D ratio (IUFD)	-2.413-	86	.018	-.59925-	.24837	-1.09300-	-.10550-
	-2.538-	19.155	.020	-.59925-	.23615	-1.09325-	-.10525-
S\D ratio (Severity of PE)	-2.330-	86	.022	-.42596-	.18284	-.78943-	-.06249-
	-2.392-	85.036	.019	-.42596-	.17811	-.78009-	-.07183-

Table-7: Shows parity for controls group

Parity	Frequency	Percent	Valid Percent	Cumulative Percent
PG	29	24.0	24.0	100.0
1	15	12.4	12.4	12.4
2	32	26.4	26.4	38.8
3	15	12.4	12.4	51.2
Multiparous	30	24.8	24.8	76.0
Total	121	100.0	100.0	

Table-8: Shows MCA- S/D ratio and outcome for controls group:

Outcome		S\D ratio
IUGR	Mean	4.6500
	N	2
	Std. Deviation	.49497
P Value		0.509

Table-9: Shows independent sample t- test for equality of means in IUGR cases in controls group

IUGR	t-test for Equality of Means						
	T	Dt	Sig.(2-tailed	Means Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
S\D ratio	1.311	78	.194	.53067	.40472	-.27506-	1.33639
	1.513	4.770	.193	.53067	.35069	-.38407-	1.44540

Table-10: t-test for equality of means for cases and controls groups:

Cases and controls	t-test for Equality of Means						
	T	Dt	Sig.(2-tailed	Means Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
S\D ratio	4.466	218	.000	.5186	.1161	.2898	.7475
	4.443	206.197	.000	.5186	.1167	.2885	.7487
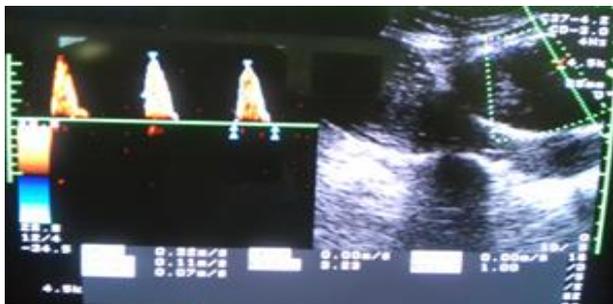
Image-1: MCA Wave Forms in PE Patient with 33 years, PG, 35 weeks 2 .2S/D ratio, preterm delivery and IUFD, (Absent Ed).

Image-2: MCA wave forms in PE with 22yr., III, 31 weeks, 3.5 S/D ratio

DISCUSSION

Our study was hypothesized that MCA S/D ratio is predictive of the development of adverse perinatal outcome in PE patients, this supports our previous study which showing a reduced MCA-RI is a sensitive method for assessing IUGR.

In this study: 220 cases sub-divided in two groups: 100 cases group and 120 controls group. Mean maternal age was 28.77± 5.86 for the cases and 27.99±5.15 for the controls (table1), so it shows no differences between study groups .This show difference with Lopez-Mendez *et al*. [10] whom reported that maternal age was PE risk factor with differences among groups which they study, this differentiation may be due to their small sample volume.

Out of 100 cases group (33.3%) were primigravida (PG) (table 3) where in controls group out of 120 patients 24% were PG (table7), 54% of cases have had family history of PE, where in controls group there were no one (table 1), these results supports the facts that nulliparity and family history of PE have been supported as PE risk factors in several studies [11, 12]. The mean of GA was 33.57±4.35 for the cases. And 33.14±4.48 for controls (table 1), so it shows no differences between study groups. The mean of diastolic was 99.12±8.67 and of systolic was 151.48±12.001 for cases group, 74.61±6.423 and 113.72±6.84 respectively for controls group (table 1).

The mean of S/D ratio was 3.2±0.88 for cases group and 3.7±0.83 for controls group. Regarding severity of PE 55% present with mild PE, with the mean: 3.4±0.95 S/D ratio, versus 45% present with sever PE with the mean: 3.0± S/D ratio, (table 2&5) Padmini C. P.*et al*. [13] found that Out of 80 cases, 41cases (52%) were mild PE and 39 cases (48%) were severe PE. From 100 cases group and 120 controls group 88cases and 80 cases respectively were followed up, 52.3% from cases group developed IUGR(table1), with the means: 3.1±0.72 for S/D ratio (table4), with Significant 2-tailed PV 0.086 with 95% Confidence Interval of the Difference, (table 6). Versus 47.7% not developed IUGR with means: 3.4± 0.99. Where in controls were2.5% (table1) with means 4.6±0.49 S/D ratio, (table8).

A number of longitudinal studies have assessed several fetal vessels with Doppler US and have reported that the cerebral circulation is of the first blood flows to become abnormal in IUGR [14, 15]. Abnormal umbilical Doppler indices and abnormal cerebral-umbilical ratio are strong predictors of IUGR and of adverse perinatal outcome in preeclampsia [16].

Preterm delivery present in 33% cases group (table1), with means 3.1 ±0.96 S/D ratio, (table4), versus 67% did not with means 3.3±0.83 with Significant 2-tailed PV 0.459 S\D ratio, with 95% Confidence Interval of the Difference, (table 6). 15.9% from cases group shows IUFD (table1), with the means: 2.7±0.80 S/D ratio, (table4), versus 84.1did not shows IUFD, with means 3.3±0.86 S/D ratio, with Significant 2-tailed PV 0.020 with 95% Confidence Interval of the Difference, (table 6).

These results matching B. Mallikarjunappa *et al*. [17] results that found among 100 PE cases, preterm deliveries 32%, perinatal death 16%, low birth weight 38%, fetal distress 14%.

(Means under 3.27 S/D ratios, is consider abnormal). When we study over all cases and controls group MCA-S/D ratio, t-test for equality of means significant 2-tailed was 0.000 for S\D ratio with 95% confidence interval (table (10).

CONCLUSION

There was a strong correlation between the MCA S/D ratio and adverse neonatal outcome in pregnant women with preeclampsia. Doppler study should be the primary tool of choice for fetal surveillance in PE patients. In our study the values of MCA-S/D ratio in PE patients were found reduced and play an important role in monitoring the fetal growth and thereby may help to determine the optimal time for delivery, so it is useful guide to reduce perinatal mortality and morbidity, and helps us to take time to plan and manage the patients in future deliveries.

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