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Predictive value of Cerebroplacental blood flow ratio for fetal heart rate disturbances and perinatal outcome

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Abstract:

Background: Doppler ultrasound velocimetry foetal vessels have become established method of antenatal monitoring, allowing non-invasive assessment of foetal circulation. **Aims:** To determine the usefulness of Doppler velocimetry, based on cerebroplacental ratio (C/U) evaluation, in predicting intrapartum fetal heart rate abnormalities and adverse neonatal outcome in uncomplicated pregnancies from 36 to 40 weeks. **Subjects and Methods:** this is prospective study include 300 uncomplicated pregnant women, age ranged from 17 to 45 years, with gestational age 36 to 40 weeks. **Results:** there was significant relation between CPR and adverse neonatal outcome p-value <0.001 with sensitivity, specificity and PPV, NPPV of CPR in detecting neonatal adverse outcome 100%. **Conclusion:** better prediction of neonatal outcome can be done by C/U ratio.

Keywords: Cerebroplacental ratio, Doppler Ultrasound, Middle cerebral artery Umbilical artery.

Introduction:

Fetal hypoxia is one of the major causes of high perinatal morbidity and mortality rates. It may lead to various neurodevelopment disabilities, ranging from difficulties in school to dyslexia, attention deficit hyperactivity disorder (ADHD), vision or hearing impairment, and mental disorders, including cerebral palsy **(1).**

Doppler velocimetry is the best method of surveillance for fetal hypoxemia during 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 **(2).**

Doppler ultrasound indices such as cerebroplacental ratio (CPR) evaluation are commonly used nowadays. It enables to assess the fetal response to hypoxia by detecting blood flow distribution pattern in placento-umbilical and feto-cerebral circulations **(3).**

Aims: To determine the usefulness of Doppler velocimetry, based on cerebroplacental ratio (C/U) evaluation, in predicting intrapartum fetal heart rate abnormalities and adverse neonatal outcome in uncomplicated pregnancies from 36 to 40 weeks.

Subjects and Methods:

This is prospective study include 300 uncomplicated pregnant women, age ranged from 17 to 45 years, with gestational age 36 to 40 weeks from march 2018 to October 2018 at AL Azhar university hospital Damietta.

Ethics:

The study was approved from the ethical committee of the department of obstetrics and gynecology, faculty of medicine, AL Azhar university Damietta.

The patients submitted to the study were counseled about the procedure; its value and hazards and the aim of the study. Thereafter, a written consent was obtained from each patient.

Inclusion criteria:

- Patient's age ranged from 17 to 45 years.
- Gestational age ranged between 36 and 40 weeks.

Exclusion criteria:

- Patients age before 17 and after 45 years.
- Diabetic and hypertensive patients.
- Patients with coexisting chronic diseases.
- Gestational age before 36 and after 40 weeks.

All patients were subjected to:

A. Full medical, obstetric history and examination.

B. Laboratory investigation includes

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Complete blood picture ,liver functions tests ,kidney function tests , random blood sugar ,2 hours post prandial and urine analysis

C. Doppler ultrasound
Fetal transcranial and umbilical Doppler ultrasound using IgE (voluson 730 PRO V) machine

D. Monitoring fetal heart rate intrapartum by using CTG (cardiotocography).

E. Written consent from each patient.

Statistical analysis:

Data was subjected to computer assisted statistical analysis using SPSS package. Nominal data was described as frequency and percentage and compared using Chi Square tests. Numerical data was described as mean and standard deviation and compared using t test. P value less than 0.05 was considered significant

Results:

This study conducted on 300 pregnant women with mean maternal age was 32.02 years, mean parity 1.72 and mean gestational age at delivery was 37.98weeks,mean birth weight was 2825.1 and 54% of patients had cesarean section,46% had vaginal delivery.

Regarding mean UA-PI and MCA-PI was 0.89, 1.17 respectively.CTG was normal in 60% of patients and 40% had abnormal CTG in form of Late decelerations in 18%, Fetal bradycardia 6%, Variable decelerations in 4% and Fetal tachycardia in 12% (table1).

As regard postnatal data mean Apgar score 1ST min was 7.48 and at 5th min was 7.56 and mean PH was 7.25, mean PO2 was 36.94 and mean pCO2 was 51.32, 60% of patients shows no abnormal neonatal outcome on the other hand 40% had abnormal neonatal outcome and 28% admitted to NICU (table2,figure1).

CPR cutoff value was below 1.1 and consider below >1.1 abnormal level, 48% of patients showing abnormal CPR with mean level 1.33(figure2).There was significant relation between maternal age , mode of delivery, birth weight, UA-PI,MCA-PI, abnormal CTG, Apgar score either at 1 or 5 minutes, PH,PO2,PCO2 and CPR with p-value <0.001.

There was significant relation between CPR and adverse neonatal outcome and NICU admission p-value <0.001(table3).Sensitivity, specificity and PPV, NPPV of CPR in detecting neonatal adverse outcome in our study was 100% (table4).

Table (1): Distribution of the studied cases according to Abnormal CTG record (n = 300)

Abnormal CTG record	No.	%
No	180	60.0
Yes	120	40.0
Late decelerations	54	18.0
Fetal bradycardia	18	6.0
Variable decelerations	12	4.0
Fetal tachycardia	36	12.0

Table (2): Descriptive analysis of the studied cases according to different parameters (n = 300)

	Min. – Max.	Mean ± SD.	Median
UA-PI	0.71 – 0.99	0.89 ± 0.09	0.92
MCA-PI	0.98 – 1.57	1.17 ± 0.18	1.16
Apgar score after 1-minute	2.0 – 10.0	7.48 ± 2.41	8.50
Apgar score after5-minute	4.0 – 10.0	7.56 ± 1.57	8.0
pH	6.80 – 7.60	7.25 ± 0.20	7.30
pO_2 [mm Hg]	12.0 – 56.0	36.94 ± 13.75	34.0
pCO_2 [mm Hg]	22.0 – 95.0	51.32 ± 21.35	45.0

Table (3): Comparison between the two studied groups according to adverse neonatal outcome

Adverse neonatal outcome	CPR				p
	Abnormal (n =144)		Normal (n =156)		
	No.	%	No.	%	
No	36	25.0	144	92.3	<0.001*

Yes	108	75.0	12	7.7	

Table (4): Agreement (sensitivity, specificity) for CPR to predict the fetal abnormality

	AUC	95% C.I		p	Cutoff	Sensitivity	Specificity	PPV	NPV
		LL	UL						
CPR	1.00	1.00	1.00	<0.001*	<1.1	100	100	100	100

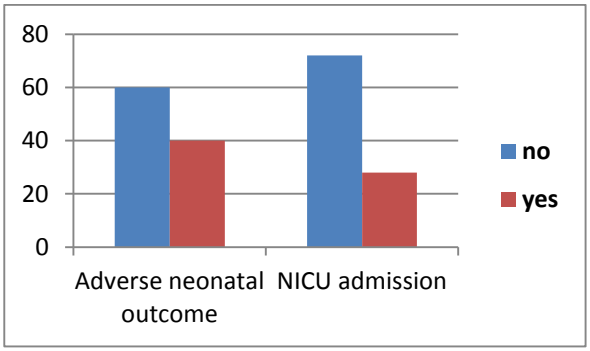

Figure 1: Distribution of the studied cases according to different parameters

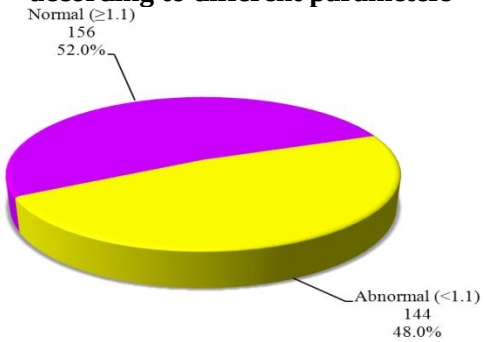

Figure 2: Distribution of the studied cases according to CPR (n = 300)

Discussion:

The fetal cerebroplacental ratio (CPR) is the ratio of the fetal middle cerebral artery (MCA) pulsatility index (PI) to umbilical artery (UA) PI. It is believed to be a proxy for suboptimal fetal growth given it quantifies both suboptimal placental function and subsequent fetal circulatory adaptations. It is believed that the CPR better predicts adverse perinatal outcomes than its individual components and better than conventional anthropometric models [4].

In the current study we aimed to determine the usefulness of Doppler velocimetry, based on cerebroplacental ratio (C/U) evaluation, in predicting intrapartum fetal heart rate abnormalities and adverse neonatal outcome in uncomplicated pregnancies from 36 to 40 weeks, 300 pregnant women were included.

In the current study we found that mean maternal age was 32.02 years ,mean parity 1.72 and mean gestational age at delivery was 37.98weeks,mean birth weight was 2825.1 and 54% of patients had cesarean section,46% had vaginal delivery.

In **Ghosh *et al.*** [3] they conclude 65 pregnant women with gestational age of 40-42 weeks and control groups include the same number of pregnant women with gestational age
of 36-40 weeks. and found that Most of the pregnant mothers (71.54%) are between 20-50 years of age, 70.77% in post-dated pregnancy and 72.31% are in dated pregnancy (36-40 weeks of gestation). Majority of the pregnant women are primi-gravida in both the groups (57.77%).

In the current study we found that CTG was normal in 60% of patients and 40% had abnormal CTG in form of Late decelerations in 18%, Fetal bradycardia 6%, Variable decelerations in 4% and Fetal tachycardia in 12%.

In ***Ropacka-Lesiak et al.*** [1] they showed that Abnormal CTG record in 62.3% of cases group and 19% of normal control group in form of Fetal bradycardia, Fetal tachycardia, Late decelerations, Variable decelerations and Narrow or silent oscillations**.**

In the current study we found that mean UA-PI and MCA-PI was 0.89, 1.17 respectively and we used a single cut-off value of 1.1 for all cases .Above this value,Doppler velocimetry was considered normal and, below it, abnormal. Using this cut-off value, we could divide the study population into two groups: Those with a normal ratio and those with an abnormal ratio. 48% of patients showing bnormal CPR with mean level 1.33.

The threshold that described an abnormal CPR varied between studies including <5th centile [5,6] , <10th centile [7] and values < 0.90 [8], 1 [6], <1.05 [9] , <1.09 [10] <1.1 [11] , <1.3 [12] and <0.6765 MoM[13].

Najam *et al.* [2] found that Cerebroplacental ratio was abnormal in 13 cases (38.24 %) of preeclampsia without IUGR and 80 % cases of preeclampsia with IUGR. **Alaa Ebrashy *et al.*** [14] also reported abnormal cerebroplacental ratio in 41.8 % cases of preeclampsia without IUGR and 84.2 % cases of preeclampsia with IUGR [14].

In the current study as regard postnatal data mean Apgar score 1ST min was 7.48 and at 5th min was 7.56 and mean PH was 7.25,mean PO2 was 36.94 and mean pCO2 was 51.32,60% of patients shows no abnormal neonatal outcome on the other hand 40% had abnormal neonatal outcome and 28% admitted to NICU .

In **Ghosh *et al.*** [3] they found that Out of 65 post-dated mothers, 18 have adverse perinatal outcome but 65 control mothers have normal perinatal outcome which was lower than our result.

In the current study we found that there was significant relation between maternal age and CPR with p-value <0.001.there was significant relation between CPR and mode of delivery, birth weight p-value <0.001 on the other hand there was insignificant relation between CPR and parity, gestational age at delivery p-value 0.362,0.097 respectively.

In agreement with our result **Ghosh *et al.*** [3] found that there was No statistical significant difference is found in Doppler parameter as regard gestation age.

In the current study we found that there was significant relation between CPR and CTG abnormality as abnormal CTG accompanied with abnormal CPR p-value <0.001.

In agreement with our result **Ropacka-Lesiak *et al.*** [1] found that in the study group, the percentage of abnormal CTG records (62.3%) was significantly higher when compared to controls (19.0%). A detailed analysis of intrapartum FHR patterns showed statistically significant differences between the study and the control group with regard to the various parameters characterizing CTG**.**

In the current study we found that that there was significant relation between CPR and adverse neonatal outcome, Apgar score either at 1 or 5 minutes, PH, PO2, PCO2 and NICU admission p-value <0.001. **Bano *et al*.** [15] found that Twenty of the 90 pregnancies showed an abnormal C/U ratio (1.08). Of these, 20 (100%) fetuses were SGA and all had an adverse perinatal outcome.

In agreement with our result **Ropacka-Lesiak *et al*.** [1] found that The study revealed birth weight, 1- and 5-minute Apgar score, umbilical cord pH, BE, pO2, and pCO2 to be significantly lower in patients when compared to the control group. Moreover, the prevalence of adverse neonatal outcome and the number of small for gestational age newborns (SGA), values of 1- and 5-minute Apgar score < 7, pO2 < 15 mm Hg, pCO2 > 45 mm Hg, pH < 7.2, BE < –12 mEq/l and occurrence of MSAF were significantly higher in the study group [1]**.**

In the current study we found that sensitivity, specificity and PPV,NPPV of CPR in detecting neonatal adverse outcome in our study was 100%.

In **Bano *et al.*** [15] found that the C/U ratio was a better predictor of SGA newborns and adverse perinatal outcome than either the MCA PI or UA PI alone. The C/U ratio demonstrated a 100% specificity and PPV in diagnosing IUGR and predicting adverse perinatal outcome, but had a low sensitivity of 44.4% and an NPV of 64.3% in diagnosing IUGR, but a relatively higher sensitivity of 83.3% and an NPV of 94.3% for predicting adverse perinatal outcome. The sensitivity and NPV of the C/U ratio were comparable to those of UA PI, but much higher than those of MCA PI [15]**.**

Najam *et al.* [2] found that 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 this differences with our levels due to this study concludes high risk pregnancy only**.**

Conclusion:

Our study revealed that the CPR index shows the highest sensitivity in prediction of FHR abnormalities and adverse neonatal outcome in uncomplicated pregnancies.

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