Study of Fetal Doppler indices in prediction of adverse neonatal outcome in preeclamptic patients.

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Abstract

Background: Globally, preeclampsia (PE) is a major contributor to maternal and neonatal death. It accounts for 10–15% of maternal deaths that are direct, and 99% of these deaths take place in low-income nations. Depending on the parameters employed, many PE screening methods are documented in the literature. Nonetheless, the research generally agrees that no single-parameter screening tool has demonstrated the ability to adequately compensate for preexisting maternal risk of PE with specificity and sensitivity for clinical application.

Aim of the work : is to evaluate the role of fetal Doppler indices in predicting adverse perinatal outcomes in patients with preeclampsia .

Patients and techniques: This is a retrospective study that was carried out between December (2021) and July (2023) at Mouwasat Hospital, Qatif and King Faisal Military Hospital (Armed Forces Hospital southern region), Khamis Mushait. This study comprised 61 pregnant women who were viable singletons and at least 34 weeks along in their pregnancy all of them were diagnosed with preeclampsia or pregnancy induced hypertension. They were split into two groups: 40 cases had a favorable perinatal outcome, and 21 cases with an unfavorable perinatal outcome were of the same age and gestational age. Chronic hypertension, liver, kidney, and collagen vascular disorders, diabetes mellitus, and foetal deformity were among the exclusion criteria.

• Urine analysis and maternal arterial blood pressure measurements were performed on both groups. Doppler examination of the fetoplacental circulation and ultrasound estimate of gestational age were assessed. The newborns were also evaluated for birth weight, admission to the neonatal intensive care unit, and Apgar score assessment at five minutes.

Results: • The mean PI, RI and S/D index of UA were significantly higher in the case group compared to the controls. The Doppler indices of the MCA showed no significant difference between both groups except for S/D index, Moreover, CPR and DV PI showed significant difference between both groups

CPR had the highest sensitivity 86.4% and specificity 88% for detection of adverse perinatal outcomes.

Conclusion: The best measure that can be used exclusively to predict unfavorable delivery outcomes is CPR (< 1.12).

Keywords: preeclapmsia , Doppler indices.

Introduction

Preeclampsia is best described as a pregnancy-specific illness that can affect nearly every organ system. Because of the increased vascular resistance and decreased utero-placental perfusion, it is associated with a higher risk of foetal hypoxia and stunted foetal development. In response to hypoxia, the foetus uses a compensation mechanism to maintain constant oxygen delivery to the brain by shifting blood flow and cardiac output to the brain. (1)

A condition unique to human pregnancy, preeclampsia is a leading cause of maternal death and a major contributor to neonatal morbidity and mortality. Two popular prenatal surveillance techniques, the non-stress test and the foetal biophysical profile, could not be sensitive or accurate enough to detect foetuses with an early compromise. (2)

Early PE (delivery < 34+0 weeks' gestation), preterm PE (delivery < 37+0 weeks' gestation), late-onset PE (delivery > 34+0 weeks' gestation), and term PE (delivery ≥ 37+0 weeks' gestation) are the four categories into which preeclampsia is divided. (3)

A rapid, noninvasive method that provides crucial details on the fetus's haemodynamic condition is Doppler velocimetry. The foetal vasculature most frequently studied in the setting of challenging pregnancy is the umbilical and middle cerebral arteries. (4)

A cerebral/umbilical (C/U) ratio that depicts the umbilical-placental and cerebral vascular beds may be useful in identifying foetuses with lower cerebral resistance and/or greater placental resistance. (5), Several studies have demonstrated that the C/U ratio is a more reliable indicator of a poor newborn outcome when both vascular Doppler readings are considered independently. (6)

This study sought to determine whether Doppler ultrasonography could predict a poor perinatal outcome in cases of pregnancy-induced hypertension.

Subjects and methods

This retrospective analysis was carried out between December (2021) and July (2023) at Mouwasat Hospital Qatif and King Faisal Military Hospital (Armed Forces Hospital southern region), Khamis Mushait , Saudia arabia.

Sixty-one pregnant women with "persistently high systolic (≥ 140 mm Hg) or diastolic (≥ 90 mm Hg) blood pressure with proteinuria (≥ 0.3 g)" were diagnosed with preeclampsia.

a 24-hour urine collection, or a dipstick test result of ≥ 1+ (which is equivalent to 30 mg/dL in a single urine sample) for protein.

The study was approved by ethics committees of Mouwasat hospital and Armed Forces Hospital Southern Region (code AFHSRM-REC/2023/OB/GYNAE/663).

A viable singleton pregnancy was one of the patients' inclusion criteria. Also, based on the earliest ultrasonographic findings and/or the verifiable date of the previous menstrual period's commencement, the foetal gestational age must be 34 weeks or higher.

Chronic hypertension, renal, hepatic, collagen-vascular disorders, diabetes mellitus, and foetal deformity were among the study's exclusion criteria. Also, women with premature rupture of membranes and antepartum hemorrhage were excluded.

Ultrasound and Doppler study:

Foetal viability, biometric maturity, and placental site ultrasound screening. Doppler velocimetry was performed on the foetal

middle cerebral artery, ductus venosus, and umbilical artery (UA).

Using a Voluson730 Pro V unit (GE healthcare, Zipf, Austria) fitted with a broad band multi frequency convex probe 3.5/7MHz, ultrasonographic exams and Doppler blood flow studies were conducted.

If the foetal middle cerebral artery, ductus venosus, and umbilical artery (UA) were all above the 95th percentile, the arterial Doppler flow was considered abnormal.

Data on the following perinatal outcomes were gathered: birth weight, length of stay in the neonatal intensive care unit (NICU) , Apgar score at 5 minutes (more than or equal to 7 = normal, less than 7 = abnormal), gestational age at delivery, and delivery mode (vaginal delivery or caesarean section). One definition a poor perinatal outcome was the existence of at least one of the following: admission to the NICU, an Apgar score of less than 7 at five minutes, or a caesarean delivery due to foetal distress.

Statistical analysis

Statistical analysis was performed using Statistical Package for Social Science version 22 (SPSS ,2013) IBM Corp., Armonk, NY, USA.

Results

Favorable perinatal Outcome group was in 40 cases and adverse perinatal Outcome group was in 21 cases, demographic characteristics of studied groups are shown in tables 1, There was no significant differences in the mean maternal age, parity and BMI between the two groups as shown in table 1.

The mean systolic/diastolic blood pressure in adverse perinatal Outcome was 159.05 ± 6.25/104.05 ± 6.64 mmHg and it was 157.1 ± 6.59/101.63± 7.79 mmHg in Favorable perinatal Outcome group (no significant difference). Mean gestational age at delivery in adverse perinatal Outcome was 37.14 ± 0.96 weeks as compared to 37.47 ±

0.75 weeks in Favorable perinatal Outcome (no significant difference). 81% of women in adverse perinatal Outcome had operative delivery (caesarean due to fetal distress) as compared to only 25% (due to failed induction or failure to progress) in Favorable perinatal Outcome. Mean birth weight in adverse perinatal Outcome was 2303.33 ± 111.67 gm and it was 2684.8 ± 269.78 gm in Favorable perinatal Outcome (high significant difference). Mean Apgar was 8.28 ± 0.55 in Favorable perinatal Outcome and it was 7.05 ± 1.02 in adverse perinatal Outcome (high significant difference), 5 out of in adverse perinatal Outcome, their neonates required NICU admission. There was no significant difference between the two groups regarding umblical PH (table 2). The mean PI, RI and S/D index of UA were significantly higher in the case group compared to the controls. The

Doppler indices of the MCA showed no significant difference between both groups except for S/D index, Moreover, CPR and DV PI showed significant difference between both groups (table 3).

The sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy of various parameters of Doppler indices of both UA and MCA of including RI, PI and we found the UA RI sensitivity, specificity, PPV, NPV and overall accuracy were 77%, 80%, 79%, 78% and 79% respectively, while those of the UA PI were 66.7%, 80.0%, 76.1%, 71.2% and 73% respectively. The MCA RI sensitivity, specificity, PPV, NPV and overall accuracy were 72.1%, 73%, 73.2%, 72.2% and 72% respectively, while those of the MCA PI were 69.3%, 80.7%, 77.2%, 71.9% and 75% respectively. the cerebroplacental ratio showed the highest diagnostic values in comparison with other Doppler indices, it showed 86.4% sensitivity, 88% specificity, 87.7% PPV, 86.8% NPV and 87% overall diagnostic accuracy, The diagnostic values of DV PI in diagnosis

of adverse perinatal outcomes were 57.1%, 67.5%, 63.6%, 60.8% and 62% regarding sensitivity, specificity, PPV, NPV and overall accuracy respectively (table 4). ROC curve of various Doppler parameters showed that CPR had the highest sensitivity 86.4% and specificity 88% for detection of adverse perinatal outcomes at cut off value of 1.12.

Table (1): Clinical characteristics of the study population

Parameter	Favorable perinatal Outcomegroup (n = 40)	Adverse perinatal outcome group (n = 21)	P
Maternal Age (years) Mean ± SD	28.92 ± 4.68	29 ± 5.94	0.95
BMI Mean ± SD	28.31 ± 6.7	27.1 ± 3.4	0.44
Parity No. Multi PG	37 3	18 3	0.39

Table (2): Clinical characteristics and perinatal outcome in studied groups

Parameter	Favorable perinatal Outcomegroup (n = 40)	Adverse perinatal outcome group (n = 21)	P
Blood pressure (mmHg) (mean ± SD)			
Systolic Diastolic	157.1 ± 6.59 101.63 ± 7.79	159.05 ± 6.25 104.05 ± 6.64	**0.27** **0.23**
Gestational age at birth (weeks)			
Mean ± SD	37.47 ± 0.75	37.14 ± 0.96	**0.14**
Mode of delivery (no, %)			
C/S VD	10 (25%) 30 (75%)	17 (81%) 4 (19%)	**0.003**
Neonatal birth weight			
Mean ± SD	2684.8 ± 269.78	2303.33 ± 111.67	**< 0.001**
5-minute Apgar score			
Mean ± SD	8.28 ± 0.55	7.04 ± 1.02	**< 0.001**
NICU admission			
No (%)	0 (0%)	5 (20.33%)	**0.003**
Umblical PH			
Mean ± SD	7.28 ± 0.07	7.25 ± 0.06	**0.16**

Table (3): Ultrasound and Doppler characteristics of the studied groups

Parameter	Favorable perinatal Outcome group (n = 40) (mean ± SD)	Adverse perinatal outcome group (n = 21) (mean ± SD)	P
UA PI	1.1 ± 0.06	1.17 ± 0.04	**< 0.001**
UA R/I	0.67 ± 0.04	0.7 ± 0.02	**< 0.001**
UA S/D	3.27 ± 0.09	3.43 ± 0.1	**< 0.001**
MCA PI	1.5 ± 0.09	1.45 ± 0.08	0.053
MCA R/I	0.67 ± 0.11	0.66 ± 0.07	0.66
MCA S/D	3.08 ± 0.24	2.91 ± 0.18	**0.01**
CPR	1.36 ± 0.12	1.24 ± 0.08	**< 0.001**
DV PI	1.05 ± 0.24	1.21 ± 0.23	**0.01**

Table (4): Efficacy and cut off values of various Doppler parameters in predicting adverse perinatal outcome

Variable	Sensitivity	Specificity	PPV	NPV	Accuracy	Cut off value
UA RI	77%	80%	79%	78%	79%	0.63
UA PI	66.7%	80.0%	76.1%	71.2%	73%	1.05
UA S/D	72.6%	77.5%	75.1%	74%	75%	3.19
MCA RI	72.1%	73.1%	73%	72.3%	72.1%	0.55
MCA PI	69.3%	80.7%	77.2%	71.9%	75%	1.38
MCA S/D	71.4%	80.5%	79%	74%	76%	2.63
CPR	86.4%	88%	87.7%	86.8%	87%	1.12
DV PI	57.1%	67.5%	63.6%	60.8%	62%	0.75

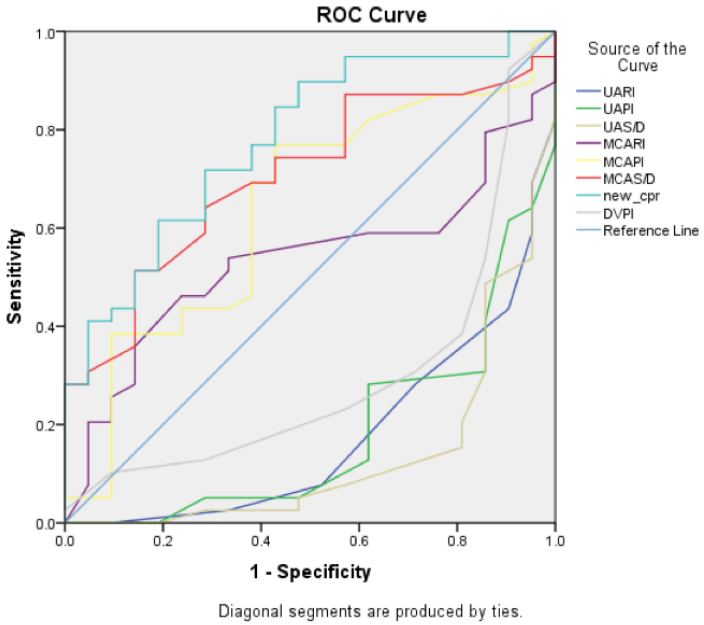

Figure (1): ROC curve of various Doppler parameters in studied groups

Discussion

Doppler ultrasonography appears to enhance certain obstetric care outcomes and shows promise in lowering perinatal fatalities in high-risk pregnancies. Obesity, low birth weight, and NICU admission were considerably more common in foetuses with aberrant Doppler velocimetry. (7)

A repeatable, non-invasive method for haemodynamic monitoring and detecting variations in blood flow and aberrant vascular resistance to this flow in the uteroplacental circulation and fetoplacental circulation, colour Doppler investigations aid in evaluating the health of the foetus. In high-risk obstetric cases, this vascular Doppler examination primarily influences the decision-making process. (8)

When comparing the doppler findings of both UA and MCA and DV PI in neonates with good and adverse perinatal outcomes, we discovered a significant difference between the two groups. Neonates with good outcomes had superior doppler findings than those with adverse outcomes.

The sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy of varies parameters of doppler indices of both UA and MCA of including RI, PI and S/D and we found the UA RI sensitivity, specificity, PPV, NPV and overall accuracy was 77%, 80%, 79%, 78% and 79% respectively, while those of the

UA PI were 66.7%, 80%, 76.1%, 71.2% and 73% respectively and

those of the UA S/D were 72.6%, 77.5%, 75.1%, 74% and 75% respectively. The diagnostic values of DV PI in diagnosis of adverse perinatal outcomes were 57.1%, 67.5%, 63.6%, 60.8% and 62%

regarding sensitivity, specificity, PPV, NPV and overall accuracy respectively.

These results represent that the UA RI has a better values in prediction of adverse perinatal outcomes than the UA S/D and PI.

The sensitivity, specificity, PPV, NPV, and diagnostic accuracy of the UA RI were 37.84%, 79.71%, 50%, 70.51%, and 65.09%, respectively, according to the study by Gaikwad et al., which is consistent with the diagnostic values of umbilical artery PI in predicting adverse perinatal outcomes. (9)

The UA PI's sensitivity, specificity, PPV, NPV, and diagnostic accuracy were 90.26%, 80.57%, 82.24%, 88.35%, and 84%, respectively, according to a different study conducted by Smitha et al. in 2014. (10)

Current results showed that The MCA RI sensitivity, specificity, PPV, NPV and overall accuracy were 72.1%, 73.1%, 73%, 72.3% and 72.1% respectively, while those of the MCA PI were 69.3%, 80.7%, 77.2%, 71.9% and 75% respectively, and those of MCA S/D were 71.4%, 80.5%, 79%, 74% and 76% respectively.

The MCA RI's sensitivity, specificity, PPV, NPV, and overall accuracy were 81.01%, 94.2%, 50%, 66.33%, and 65.09%, respectively, according to Gaikwad et al. (2017). The MCA PI's were 21.62%, 85.51%, 44.44%, 67.05%, and 63.21%, while the MCA S/D's were 24.32%, 97.1%, 81.82%, ,70.53% and 71.7%. (9)

The cerebroplacental ratio (MCA PI/UA PI) has been computed and assessed as a predictor of unfavourable perinatal outcomes in numerous research.

When compared to other Doppler indices, the cerebroplacental ratio in the current study had the greatest diagnostic values (at value < 1.12), with 86.4% sensitivity, 88% specificity, 87.7% PPV, 86.8% NPV, and 87% total diagnostic accuracy.

The cerebroplacental ratio (MCA PI/UA PI) was also found to have the best specificity and positive predictive value (98.55% and 94.44%, respectively) in predicting unfavourable perinatal outcomes, according to Gaikwad et al. (2017) .(9). Also, El-Demiry

et al. (2020) found that CPR value < 1 was a good predictive parameter for adverse perinatal outcome in pregnant women with hypertensive disorders. Sensitivity, specificity, PPV and NPV were 66.7%, 94.8%, 87.5% and 84% respectively. (15)

According to Eman et al. (2022), the cerebroplacental ratio's diagnostic values for sensitivity, specificity, PPV, NPV, and overall accuracy were, respectively, 81%, 89%, 84%, 86%, and 85%. (11)

High DV PI was associated with adverse perinatal outcomes in the current study. Consistent with our findings, Ustaa et al. discovered a correlation between a poor perinatal outcome and a high or abnormal (DV PI) in complex pregnancies. 53.3% and 74.6%, respectively, were the study's sensitivity and specificity for forecasting unfavourable perinatal outcomes . (12)

In cases of adverse prenatal outcome, the mean gestational age at delivery was 37.14 ± 0.96 weeks, while in cases of favourable prenatal outcome, it was 37.47 ± 0.75 weeks. Compared to only 25% of women with favourable prenatal outcomes, 81% of women with unfavourable prenatal outcomes had a surgical birth (caesarean). In the group with a favourable prenatal outcome, the mean birth weight was 2684 ± 269.78 gm, while in the group with a negative prenatal outcome, it was 2303.33 ± 111.67 gm. The mean Apgar was 8.27 ± 0.55 for favourable prenatal outcomes and 7.05 ± 1.02 for adverse prenatal outcomes. Of the 21 group with adverse prenatal outcomes, 5 had neonates that needed to be admitted to the NICU.

Our findings on low birth weight were consistent with those of Eman et al. (2022), who found that 34.9% of cases had low birth weight. However, only 16.1% of PIH individuals had low birth weight, according to Muti et al. (2015). We were criticised by Smitha et al. (2014), who found that 64.0% of the newborns had low birth weight. (10,11,13)

Preeclampsia and poor Apgar scores were found to be strongly and significantly correlated (p-value <0.001) in a number of studies that addressed PIH in pregnant women. (11)

Numerous studies have also found a strong correlation between PIH, particularly preeclampsia, and the need for newborn intensive care unit admission. According to the study by Gaikwad et al. (2017), 40.54% of babies required admission to the intensive care unit. 45.65% of neonates require NICU admission, according to a research by Smitha et al. (2014). However, in their study, Hazra et al. (2013) found that 24% of babies required NICU care. (9, 10, 14)

In conclusion, fetal Doppler parameters in pre eclamptic pregnant women are of value in prediction of unfavorable delivery outcomes. CPR value < 1.12 is a good tool to predict unfavorable delivery outcome in pregnancies complicated with pre-eclampsia.

Availability of data: data will be available from the corresponding author upon reasonable request.

Conflict of interest: The authors declare that they have no competing interests.

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List of abbreviation:

Abbreviation	Description
NICU	Neonatal intensive care unit
PI	Pulsatility index
RI	Resistance index
S/D	Systolic/Diastolic
UA	Umblical artery
MCA	Middle cerebral artery
CPR	Cerebroplacental ratio
DV	Ductus venosus
PPV	Positive predictive value
NPV	Negative predictive value
mm Hg	Millimeter Mercury
gm	Gram
GE	General electric
C/U	Cerebral/Umblical
SD	Standard deviation
NS	Non significant
TLC	Total leucocytic count
PIH	Pregnancy induced hypertension
ICU	Intensive care unit
CBC	Complete blood count
SPSS	Statistical package for social sciences
PE	Pre eclampsia

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