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Evaluating the predictive value of fetal Doppler indices and neonatal outcome in preeclampsia

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Abstract:

Background: The predominant obstetric condition causing significant foetal and mother mortality in the Kurdistan region/Iraq is preeclampsia. The aim of research is to assess if Doppler ultrasonic indices can predict unfavorable perinatal outcomes of preeclampsia. **Patients & method:** On a sample of 35 pregnant women with preeclampsia and 35 health pregnant women, a case control research carried out in Maternity Teaching Hospital and private hospital in Duhok City-Kurdistan region/Iraq for a period of eight months from 1st of January, to 31st of August, 2024. After twenty weeks' gestation in pregnancy with one or more of (protein-urea and high blood uric acid), the preeclampsia was classified as new-onset hypertension. Three days following birth, the investigated women were monitored in order to evaluate their perinatal outcomes. **Results:** P≤0.05 Doppler indices for umbilical and uterine arteries of women with preeclampsia were much higher than those of controls. Women with preeclampsia had notably lower Doppler indices for middle cerebral artery than did controls (p≤0.05). Among preeclampsia women with early newborn mortality and intrauterine death, the mean uterine artery Doppler indices were noticeably higher (p≤0.05). **Conclusions:** For pregnant women with preeclampsia, the Doppler ultrasonic indices are quite excellent predictors of poor newborn outcomes.

Keywords: Preeclampsia, Doppler indices, Perinatal outcomes.

Introduction:

High rates of co-morbidity and mortality are associated with hypertensive diseases during pregnancy in both mothers and fetuses [1]. Preeclampsia (PE) is a group of diseases that are distinguished by gestational hypertension, proteinuria, thrombocytopenia, renal or hepatic dysfunction, cerebral and visual symptoms, or pulmonary oedema, with varying clinical presentations and mechanisms. PE is categorised as either non-severe or severe (eclampsia) [2]. The PE is the most prevalent gestational complication and the most prevalent medical hypertensive disorder during pregnancy, with a prevalence rate of 2-15% of pregnancies [3]. The PE is accountable for approximately ten to fifteen percent of maternal fatalities worldwide [4]. The prevalence of PE in Iraq is approximately 4.79% [5]. Preeclampsia with eclampsia is the leading cause of maternal mortality in the Kurdistan region [6]. The primary risk factors of preeclampsia include ethnicity, high body mass index, increased age, diabetes mellitus, null parity, and inadequate socioeconomic status [7]. The interaction between placental, maternal, and gestational vascular factors and immunological alterations is the basis for the pathogenesis of PE [8]. The disruption of maternal endothelial function and PE are the result of these alterations in the cardiovascular and inflammatory systems [9]. Consequently, the PE is a multifactorial syndrome that may manifest clinically in a variety of forms and severity [10]. The PE is also classified as early onset (<34 weeks of gestation) and late onset (≥34 weeks of gestation) [11]. The trophoblast is not invaded in early-onset PE, and it is capable of replacing normal spiral arteries, resulting in placental ischaemia and the production of oxidative stress factors [12]. Conversely, late-onset PE is associated with maternal risk factors, which result in an increase in vascular sensitivity to the natural inflammation or atherosclerosis of a normally maturing placenta. [13]. It is imperative to screen for PE in order to prevent complications and to ensure early management, thereby reducing complications and saving lives. PE is predicted using a variety of biochemical assays [14]. The number of screening tests identified by numerous authors is [15]. The early detection of PE is crucial for the identification of high-risk pregnancies. In recent years, there has been no simple test that is applicable, and PE screening necessitates a series of antenatal care visits to measure blood pressure and proteinuria [16]. Regrettably, this screening method is expensive and has low validity values [17]. Currently, significant efforts are being made to investigate the pathological alterations of the placenta, as the PE causes early aberrant growth and function of the placenta [18]. The non-invasive Doppler ultrasonography examination predicts uterine vascular involvement

size, despite the lack of thorough validation of any approach to diagnose vasospasm and vascular involvement [19]. DOPPLER ultrasonography accurately diagnosed PE in high-risk pregnant women between 11 and 14 weeks [20]. Doppler ultrasonography abnormalities include unilateral or bilateral diastolic wave cuts, excessive resistance or pulsatility indices [21]. Prevention is crucial for poor nations to reduce PE-related neonatal outcomes. To reduce PE-related perinatal outcomes such preterm, low birth weight, foetal co-morbidities, and NICU hospitalisation, accurate non-invasive basic imaging is needed [22]. This study investigated whether Doppler ultrasonography indices predict preeclampsia-related poor perinatal outcomes.

Method:

The design of this study was a case-control study conducted for eight months from January 1 to August 31, 2024, at a teaching hospital for obstetrics and gynecology and a private hospital in Duhok city, Kurdistan region, Iraq. The study population included pregnant women with preeclampsia who visited the hospital consultation clinic during the study period. Inclusion criteria were women of childbearing age (18-45 years) with preeclampsia. Exclusion criteria were multiple pregnancies, pregnancies with fetal structural or chromosomal abnormalities, patients with other medical conditions (diabetes, chronic hypertension), and patients who refused to participate in the study. The study protocol was approved by the Ethics Committee of the Higher Council of Medical Experts of Kurdistan and the hospital authorities, and verbal informed consent was given by the women. After meeting the inclusion and exclusion criteria, 35 pregnant women with preeclampsia were selected. Another 35 healthy pregnant women (controls) were selected as a sample from women of childbearing age who visited the clinic and had no history of preeclampsia. The researchers collected data directly from the enrolled women and entered them into a prepared questionnaire. The questionnaire was created by the researchers. The questionnaire included the following information: age, gestational age, umbilical artery ultrasound Doppler indices (resistance index [RI] and pulsatility index [PI]), fetal middle cerebral artery ultrasound Doppler indices (RI and PI), and ultrasound examination. Doppler indices fetal uterine artery (RI and PI). Pulmonary embolism was diagnosed by obstetricians based on new-onset hypertension at 20 weeks of gestation accompanied by one or more of the following symptoms (protein urea and high serum uric acid). Doppler ultrasound was performed transabdominally with a convex transducer. Three arteries were examined: the uterine artery (assessed immediately after crossing the pelvic vessels and averaged to avoid deformation caused by lateral placenta accreta), the umbilical artery

(the umbilical artery was measured in a free umbilical cord loop), and the middle cerebral artery (obtained from a cerebral artery loop within 2 mm of the origin of the MCA). The results were recorded on a form created specifically for the study and in each patient's medical record. The ultrasound machine was a Philips Affiniti 70G ultrasound machine with a curved sensor transducer and a frequency of 5 MHz. The women in the study were followed up for three days after delivery to assess perinatal outcomes. The collected data were statistically analyzed using the Statistical Package for Social Sciences version 26 software. The t-test for independent samples was used to analyze continuous variables. If the significance level (p-value) was 0.05 or less, it was considered statistically significant.

Results:

In this study, thirty-five pregnant women with preeclampsia (PE) and thirty-five healthy pregnant women (controls) were included. No significant differences were observed between women with PE and controls regarding age and gestational age. (***Table 1***)

Table 1: Distribution of age and gestational age according to study groups.

Variable	**Study groups**				**P**
	Preeclampsia		**Controls**		
	No.	**%**	**No.**	**%**	
Age					0.8 NS
20-29 years	21	60.0	19	54.3	
30-39 years	12	34.3	14	40.0	
40 years	2	5.7	2	5.7	
Gestational age					0.36 NS
Early preterm	3	8.6	2	5.7	
Late preterm	26	74.3	22	62.9	
Term	6	17.1	11	31.4	

NS=Not significant.

The Doppler RI and PI means for umbilical and uterine arteries of women with PE were significantly higher than RI and PI means for umbilical and uterine arteries of controls ($p \leq 0.05$). The Doppler RI and PI means for middle cerebral artery of women with PE were significantly lower than RI and PI means for middle cerebral artery of controls ($p \leq 0.05$). (***Table 2***)

Table 2: Distribution of Doppler indices according to study groups.

Variable	**Study groups**		**P**
	Preeclampsia	**Controls**	
	Mean±SD	**Mean±SD**	
UMA-RI	0.68±0.18	0.52±0.06	**<0.001** S
UMA-PI	1.1±0.38	0.86±0.11	**0.001** S
MCA-RI	0.74±0.08	0.85±0.05	**<0.001** S
MCA-PI	1.38±0.18	1.92±0.19	**<0.001** S
UTA-RI	0.58±0.15	0.48±0.06	**0.001** S
UTA-PI	1.14±0.31	0.8±0.12	**<0.001** S

S=Significant.

Common poor neonatal outcomes of women with PE were prematurity (45.7%), cesarean section delivery (62.9%), early neonatal death (14.3%), intrauterine death (17.1%), NICU admission (48.6%) and low birth weight (48.6%). (***Table 3***)

Table 3: Neonatal outcomes of women with PE.

Variable	**No.**	**%**
Timing of delivery		
Preterm	16	45.7
Term	19	54.3
Mode of delivery		
Vaginal	13	37.1
Cesarean section	22	62.9
Fetal outcome		
Uneventful	7	20.0
Early neonatal death	5	14.3
Intrauterine death	6	17.1
NICU admission	17	48.6
Fetal birth weight		
Low	17	48.6
Normal	18	51.4
Total	**35**	**100.0**

The mean umbilical artery resistance index was significantly higher among PE women with preterm delivery (p=0.04). The mean uterine artery resistance index was significantly higher among PE women with preterm delivery (p=0.04). The MCA indices and PI of umbilical and uterine artery means were not significantly related to neonatal outcomes of pregnant women with PE (p>0.05). (***Table 4***)

Table 4: Distribution of Doppler indices of PE women in regard to prematurity.

Variable	**Outcome**		**P**
	Preterm	**Term**	
	Mean±SD	**Mean±SD**	
UMA-RI	0.75±0.21	0.62±0.12	**0.04** S
UMA-PI	1.22±0.45	1.01±0.29	0.1 NS
MCA-RI	0.75±0.1	0.74±0.07	0.36 NS
MCA-PI	1.34±0.2	1.41±0.15	0.27 NS
UTA-RI	0.63±0.18	0.53±0.1	**0.04** S
UTA-PI	1.21±0.34	1.08±0.28	0.25 NS

S=Significant, NS=Not significant.

The mean umbilical artery RI and PI were significantly higher among PE women with cesarean section delivery (p≤0.05). The mean middle cerebral artery RI and PI were significantly lower among PE women with cesarean section delivery (p≤0.05). The mean uterine artery resistance index was significantly higher among PE women with cesarean section delivery (p=0.03), while uterine artery PI was not significantly related to delivery mode (p=0.06). (***Table 5***)

Table 5: Distribution of Doppler indices of PE women in regard to delivery mode.

Variable	**Outcome**		**P**
	Vaginal	**Cesarean**	
	Mean±SD	**Mean±SD**	
UMA-RI	0.6±0.07	0.73±0.21	**0.04** S
UMA-PI	0.94±0.2	1.2±0.43	**0.05** S
MCA-RI	0.8±0.05	0.71±0.08	**0.002** S
MCA-PI	1.46±0.09	1.33±0.2	**0.03** S
UTA-RI	0.51±0.09	0.62±0.16	**0.03** S
UTA-PI	1.02±0.22	1.21±0.34	0.06 NS

S=Significant, NS=Not significant.

The means of umbilical artery RI and PI were significantly higher among PE women with low birth weight ($p \leq 0.05$). The mean middle cerebral artery PI was significantly lower among PE women with low birth weight (p=0.04). The mean uterine artery resistance index was significantly higher among PE women with low birth weight (p=0.01), while uterine artery PI was not significantly related to birth weight (p=0.07). (***Table 6***)

Table 6: Distribution of Doppler indices of PE women in regard to birth weight.

Variable	**Outcome**		**P**
	Low BW	**Normal BW**	
	Mean±SD	**Mean±SD**	
UMA-RI	0.76±0.21	0.61±0.1	**0.01** S
UMA-PI	1.27±0.42	0.95±0.26	**0.01** S
MCA-RI	0.72±0.09	0.76±0.07	0.17 NS
MCA-PI	1.31±0.18	1.44±0.16	**0.04** S
UTA-RI	0.64±0.18	0.52±0.08	**0.01**S
UTA-PI	1.24±0.37	1.05±0.24	0.07 NS

BW=Birth weight, S=Significant, NS=Not significant.

The mean umbilical and middle cerebral arteries RI and PI were not significantly different in regard to fetal outcomes of women with PE ($p > 0.05$). The mean uterine artery RI and PI were significantly higher among PE women with early neonatal death and intrauterine death (p=0.04, p=0.01, respectively). (***Table 7***)

Table 7: Distribution of Doppler indices of PE women in regard to fetal outcomes.

Variable	**Outcome**				**P**
	Uneventful	**Early ND**	**IUD**	**NICU**	
	Mean±SD	**Mean±SD**	**Mean±SD**	**Mean±SD**	
UMA-RI	0.57±0.07	0.8±0.29	0.72±0.14	0.68±0.17	0.15 NS
UMA-PI	0.95±0.06	1.4±0.69	1.28±0.39	1.02±0.29	0.09 NS
MCA-RI	0.76±0.07	0.72±0.1	0.7±0.07	0.76±0.08	0.41 NS
MCA-PI	1.42±0.04	1.32±0.29	1.28±0.16	1.41±0.17	0.35 NS
UTA-RI	0.5±0.02	0.72±0.22	0.64±0.17	0.54±0.12	**0.04**S
UTA-PI	0.9±0.05	1.34±0.41	1.36±0.39	1.1±0.24	**0.01**S

ND=Neonatal death, IUD=Intrauterine death, NICU=Neonatal intensive care unit, S=Significant, NS=Not significant

Discussion:

Preeclampsia is the leading cause of elevated maternal and perinatal mortality rates. Early detection of women with preeclampsia or its complications is important in the triage of cases, the allocation of resources, and selecting an appropriate management plan [23]. The current study found that Doppler RI and PI means for umbilical and uterine arteries of women with PE were significantly higher than RI and PI means for umbilical and uterine arteries of controls ($p \leq 0.05$). These findings are in agreement with the results of a recent longitudinal cohort study conducted in Nigeria, which reported higher RI and PI means of umbilical and uterine arteries in women with PE as compared to controls [17]. In this study, Doppler RI and PI means for the middle cerebral artery of women with PE were significantly lower than the RI and PI means for the middle cerebral artery of controls ($p \leq 0.05$). These findings are consistent with results of a previous Indian study that found lower means of Doppler RI and PI for the middle cerebral artery of women with PE in comparison to controls [24]. The present study showed that common poor neonatal outcomes of women with PE were prematurity (45.7%), caesarean section delivery (62.9%), early neonatal death (14.3%), intrauterine death (17.1%), NICU admission (48.6%), and low birth weight (48.6%). These findings are close to the results of a recent cross-sectional Iraqi study that documented a higher prevalence of PE with frequent neonatal outcomes than other developing countries due to low health infrastructure, a lack of screening tools, and poor antenatal care services [25]. In the current study, the means of the umbilical and uterine artery resistance index were significantly higher among PE women with preterm delivery ($p = 0.04$). These findings are similar to results of a previous Indian prospective study that revealed a significant role of the Doppler umbilical and uterine artery resistance index in the prediction of preterm birth among preeclamptic pregnant women [26]. Our study found that Doppler umbilical and uterine artery resistance and pulsatility indices were significantly higher among preeclamptic pregnant women who underwent caesarean section delivery. Similarly, a recent prospective study carried out in India reported higher means of Doppler umbilical and uterine artery resistance and pulsatility indices among preeclamptic pregnant women who underwent caesarean section delivery [27]. This study also showed that mean middle cerebral artery RI and PI were significantly lower among PE women with caesarean section delivery ($p \leq 0.05$). This finding coincides with the results of a previous study conducted in Albania [28]. In the present study, means of umbilical artery RI and PI were significantly higher among PE women with low birth weight. Consistently, a recent case-control

study conducted in Nigeria revealed that Doppler umbilical artery indices were useful in the prediction of low foetal birth eight [29]. On the other hand, our study found that mean middle cerebral artery PI was significantly lower among PE women with low birth weight (p = 0.04). This finding is parallel to the results of the previous Sweden study [30]. In our study, the mean uterine artery resistance index was significantly higher among PE women with low birth weight (p = 0.01). This finding is parallel to the results of the recent Iraqi prospective study [31]. Our study revealed that mean uterine artery RI and PI were significantly higher among PE women with early neonatal death and intrauterine death (p = 0.04, p = 0.01, respectively). These findings are in agreement with the results of a recent prospective study carried out in Egypt, which reported that Doppler uterine artery indices are the better predictors of poor perinatal outcomes among preeclamptic pregnant women.

Conclusion:

The Doppler ultrasound indices are good predictors of poor neonatal outcomes for pregnant women with preeclampsia. The use of Doppler ultrasound indices at early gestational age is useful in screening for preeclampsia. This study recommended use of Doppler indices for women with high risk of preeclampsia in screening for poor neonatal outcomes.

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