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Original Article

The Uterine Artery Doppler's Diagnostic Accuracy in the Second Trimester for Preeclampsia Screening

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Abstract

Background: Hypertension during pregnancy occurs in 7-10% of pregnancies. It is divided into 3 types: Chronic hypertension, pregnancy-induced hypertension, and pre-eclampsia. It is a multisystem syndrome usually recognized by new-onset hypertension with proteinuria appearing in 2nd half of pregnancy. The incidence of preeclampsia is 5 to 7% of all pregnancies.
Objective: To determine the diagnostic accuracy of uterine artery doppler (UAD) for preeclampsia screening in the second trimester.
Study type, settings & duration: A cross-sectional and observational study was conducted at Hameed Latif Hospital, Lahore from January to June 2023.
Methodology: The non-probability purposive sampling technique was used in this study. Patients were into two groups; group A: pre-eclampsia (n=40) and group B: non-pre-eclampsia (n=85). The sample size of 125 was calculated by G-Power software. Data was collected through pre-structured proforma and entered in SPSS version 25.0.
Results: The 28 (70%) patients had positive UAD. They developed pre-eclampsia and 12 (30%) patients had negative but also developed pre-eclampsia (group A). In comparison, 15 (17.6%) patients had positive UAD but had not developed pre-eclampsia and 70 (82.4%) patients had negative UAD and had not developed pre-eclampsia. UAD and pre-eclampsia had a significant association with the *p*-value of 0.00*. Pre-eclampsia screening had a 15.5% margin of error, a 25% anticipated proportion of pre-eclampsia, a 75% UAD sensitivity, and an 86% specificity.
Conclusion: Doppler USG is accurate enough that in the future we can rely on this tool for the prediction of PE in primigravidas. So, to detect preeclampsia early and prevent perinatal morbidity and mortality, 2nd trimester UAD should be incorporated routinely.
Key words: Uterine artery doppler, pulsatility index, resistance index, preeclampsia.

Introduction

Hypertension during pregnancy occurs in 7-10 percent of pregnancies. It is divided into 3 types: chronic hypertension, pregnancy-induced hypertension, and preeclampsia. Preeclampsia (PE) is a multisystem condition that is often identified by proteinuria that develops in the second half of pregnancy along with new-onset hypertension.[1] The incidence of preeclampsia is 5 to 7 percent of all pregnancies. It is the second most prevalent cause of maternal mortality in Pakistan, with hemorrhage coming in first.[2] Every year, more than 4 million women worldwide get preeclampsia, and over 100,000 will experience an eclamptic convulsion. Two to three percent of pregnancies are complicated by preeclampsia, and two percent of these women go on to develop eclampsia.

One of the main causes of maternal morbidity and death is preeclampsia (15-20%, perinatal deaths, preterm births, and intra-uterine growth restriction.[3] Preeclampsia causes maternal and fetal complications. Maternal complications

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include HELLP, eclampsia, coagulopathy, renal, liver failure, and stroke. Low birth weight, premature births, intrauterine growth retardation, and intrauterine fatalities are examples of fetal complications.[4]

Risk factors of preeclampsia are primigravida's, obesity, BMI >32, extreme ages, family history (1st degree), hederiform mole, multiple pregnancies, fetal/placental hydrops, preexisting diabetes or hypertension, or renal disease.[4] While there is currently no effective primary prevention due to unknown reasons, preeclampsia may occur less frequently if sensitive risk factors are identified and modified.[5] Antiplatelet therapy reduces the risk of preeclampsia by around 15% for women.[6]

Uterine artery doppler (UAD) is a promising ultrasonic biophysical test. It has revolutionized the field of obstetrics since its introduction in the late 1950s.[7] It can be used to predict preeclampsia. It is a relatively quick, irradiation-free, noninvasive, inexpensive test. Hence, early identification of the illness for a minimal price is of most extreme significance. It helps distinguish unsuccessful placental perfusion. The most accurate indicator of preeclampsia is an elevated pulsatility index with notching.[4] About 5% of pregnancies undergoing conventional prenatal care had increased resistance to flow in the uterine arteries at 24 weeks of gestation.

Preeclampsia can be predicted more accurately by abnormal uterine artery waveforms than by intrauterine growth restriction. The best doppler index for prediction is either a pulsatility index by itself or in conjunction with notching.[8] Almost 35% of women with an elevated pulsatility index went on to develop preeclampsia.[9] Compared to 24 weeks, the occurrence of high impedance is almost 2-3 times more common at 20 weeks.[10] When predicting severe preeclampsia, abnormal doppler is more accurate than mild preeclampsia. When shown at 20–24 weeks, it provides reliable predictions. Persistence of the diastolic notch "beyond 24 weeks" or anomalous flow velocity ratios have been linked to insufficient trophoblastic invasion. PE ranged from 3.2 to 44.3 in high-risk women and from 0.4 to 18.7 in low- or unknown-risk patients.[8]

Unilateral pulsatile index abnormality, bilateral pulsatile index abnormality, unilateral resistance index abnormality, bilateral resistance index abnormality, unilateral notch, and bilateral notch were related to PE. Preeclampsia risk rose by 13 for every 0.1 increase in the median multiple of the mean pulsatile index and by 22 for every 0.1 increase in the median multiple of the mean resistance index. A useful assessment technique is a multiple of the median for the resistance and pulsatile indices. Preeclampsia development and abnormal uterine artery ultrasonography indices are closely related.[11]

UAD ultrasonography is also thought to be an effective screening method because the majority of biomarkers based on endothelial dysfunction are thought to be unreliable and imprecise.[12] Jan and Rasool et al concluded that the uterine artery Doppler notch with increased sensitivity of 60 was the best predictor of preeclampsia.[13] According to a study conducted in 2020, a total of 162 women evaluated their uterine artery for the diastolic notch, out of 162, 34 women had a diastolic notch of which almost all later developed preeclampsia.[14]

Doppler scans can predict various pregnancy-related disorders, such as IUGR, fetal distress, premature birth, placental abruption, and placental insufficiency, in addition to preeclampsia. This can greatly lower mother and fetal mortality.[15] When it comes to predicting preeclampsia, abnormal doppler ultrasonography has a decent overall sensitivity. When it came to particular Doppler indices, the resistance index was less specific than the notching of the uterine artery.[16] Doppler ultrasound's overall sensitivity, specificity, and positive and negative predictive values in predicting PE were 71.4, 26.3, 23.8, and 74, respectively, based on the resistance index cut-off and uterine artery notching. The existence of uterine artery notch (unilateral/bilateral) was shown to be the most specific indicator of preeclampsia, whilst R.I >0.58 (unilateral/bilateral) was determined to be the most sensitive doppler ultrasonography index.[16] In Pakistan, uterine artery doppler is limited to specialized obstetrics units. Numerous investigations have shown that the UAD has a 75% sensitivity and an 86% specificity. Fifty percent of pregnancies end in preeclampsia due to increased resistance to flow in a uterine artery.[10] One study showed that 25% of females had preeclampsia. The rates of preeclampsia after a positive uterine artery doppler among high-risk patients were 3.2-44.3%. By identifying women who are at risk, surveillance can be increased and the use of preventive medicines can be explored. To find out the uterine artery doppler's diagnostic accuracy in the second trimester for preeclampsia screening.

Methodology

It was a cross-sectional and observational study conducted at a tertiary care hospital, Hameed Latif Hospital, and the data was collected from January to June 2023. The sampling technique

used in this study was non-probability and purposive. The sample size was calculated with the help of G-Power. 125 cases were included in this study. The selection criteria are given below: on ultrasonography, every patient who was pregnant only once, primigravida, or patient with a history of PE, placental abruption, intrauterine growth restriction, intrauterine death (an antenatal record) with normal blood pressure, and family history of preeclampsia were included. The patients with chronic hypertension, diabetes mellitus, and other medical disorders, multiple pregnancies, fetal anomalies, and intrauterine death were excluded. A verbal consent was obtained by the patients during the data collection procedure. All the information was recorded through specially designed Performa. All the data was entered into SPSS software (Statistical Package for the Social Sciences) version 25.0. Frequencies were represented as numbers and percentages for the continuous data. To compare the categorical variables, the chi-Square test was used. The uterine artery doppler's accuracy, sensitivity, specificity, positive and negative predictive values, and precision were also computed.

The ethical approval was obtained from the Ethical Review Board of Hameed Latif Hospital, Lahore vide letter no. HLH/IRB/2022-010.

Results

The total number of patients was divided/ into two groups, in which 40 patients (32%) had developed pre-eclampsia (group A) and 85 patients (68%) had not pre-eclampsia (group B).

Out of 40 patients, mostly patients 22 (55%) belonged to the age category 25-34 years in group A, while in group B, a total of 85 patients, 54 (63.5%) belonged to 25-34 years.

Regarding BMI, 36 (90%) patients in group A, while in group B, 77 (90.6%) had <30 kg/m^2. As for parity, in group A, 23 (57.5%) patients were nulliparous, while in group B, 43 (50.6%) were multiparous.

Gestational age was divided into three categories, in group A, 18 (45.0%) patients belonged to <34 weeks, while in group B, 44 (51.8%) belonged to ≥37 weeks and the p-value was 0.00* (Table-1).

In both groups, most patients did not have a history of PE. When we talk about the family history of PE, in both groups, most patients were without a family history of PE. A total of 40 (100%) patients had no history of placental abruption in group A, while in group B, 5 (14.1%) patients had a history of placental abruption, and 80 (94.1%) patients were without abruption history.

Table 1: Demographic variables.

Variables	*Pre-eclampsia (n%)*		*p-value*
	Positive (n=40) n (%)	*Negative (n=85) n (%)*	
Age (years)			0.65
<25	12 (30.0)	20 (23.5)	
25-34	22 (55.0)	54 (63.5)	
≥35	6 (15.0)	11 (12.9)	
BMI (kg/m_2)			1.00
<30	36 (90.0)	77 (90.6)	
≥ 30	4 (10.0)	8 (9.4)	
Parity			0.59
Nulliparous	23 (57.5)	42 (49.4)	
Multiparous	17 (42.5)	43 (50.6)	
Gestational age (weeks)			0.00*
<34	18 (45.0)	12 (14.1)	
34-37	17 (42.5)	29 (34.1)	
≥ 37	5 (12.5)	44 (51.8)	
Abortion			0.17
Yes	12 (30.0)	37 (43.5)	
No	28 (70.0)	48 (56.5)	

*p-value < 0.05 shows a statistical association in variables

Table 2: History of different parameters to Pre-eclampsia.

Parameters	*Pre-eclampsia*		*p-value*
	Positive (n=40) n (%)	*Negative (n=85) n (%)*	
History of pre-eclampsia (patient)			1.00
Yes	5 (12.5)	12 (14.1)	
No	35 (87.5)	73 (85.9)	
Family history of pre-eclampsia			0.70
Yes	16 (40.0)	38 (44.7)	
No	24 (60.0)	47 (55.3)	
History of abruption			0.17
Yes	---	5 (5.9)	
No	40 (100)	80 (94.1)	
History of intrauterine growth restriction (IUGR)			0.46
Yes	9 (22.5)	14 (16.5)	
No	31 (77.5)	71 (83.5)	
History of intrauterine death (IUD)			0.42
Yes	4 (10.0)	14 (16.5)	
No	36 (90.0)	71 (83.5)	
Uterine artery doppler notch (UAD)			0.00*
Yes	28 (70.0)	15 (17.6)	
No	12 (30.0)	70 (82.4)	

* p-value < 0.05 shows a statistical association

As for IUGR and IUD, in group A, 9 (22.5%) and 4 (10.0%) patients had history of IUGR and IUD and 31 (77.5%) and 36 (90.0) were without history of IUGR and IUD respectively, in group B, 14 (16.5) patients had history of IUGR and IUD and 71 (83.5%) were without history of IUGR and IUD respectively. 28 (70.0%) patients had positive UAD and developed pre-eclampsia (group A), while 15

(17.6%) patients had positive UAD and had not developed pre-eclampsia. UAD and PE had a significant association with the p-value of 0.00* (Table-2).

Of 125, 43 patients (34.4%) had primary-gravida and 82 (65.6%) had multi-gravida. Out of 43 patients, 26(60.5%) had no previous history of pre-eclampsia and 17 patients (39.5%) had pre-eclampsia. Similarly in multi-gravida, out of 82 patients, 59 (72.0%) had no previous history of pre-eclampsia and 23 patients (28.0%) had pre-eclampsia.

Parameters	*Gravida*		*p-value*
	Primary Gravida (PG) n (%)	*Multi Gravida (MG) n (%)*	
Pre-eclampsia			0.22
Positive	17 (39.5)	23 (28.0)	
Negative	26 (60.5)	59 (72.0)	
Uterine artery doppler notch (UAD)			0.04*
Positive	20 (46.5)	23 (28.0)	
Negative	23 (53.5)	59 (72.0)	

The 20 patients (46.5%) had primary-gravida with positive UAD, 23 (53.5%) had negative UAD, 23 (28.0%) had multi-gravida with positive UAD, and 59 (72.0%) had negative UAD respectively (*p*-value =0.04) (Table-3). 15.5% margin of error and expected percentage of pre-eclampsia of 25%, the sensitivity of artery uterine doppler (UAD) 75 %, and specificity was 86% for screening of PE.

Discussion

The purpose of the study was to assess the uterine artery Doppler's predictive value for preeclampsia. A closer prenatal follow-up was recommended based on an abnormal uterine doppler since this study indicates that 28 out of 125 women experienced preeclampsia.

Therefore, doppler analysis can be useful for improving perinatal outcomes, detecting pregnancies at high risk, and determining the appropriateness of prenatal monitoring. With a positive predictive value of 33.3, the pulsatility index is a superior predictive measure. In Sami and Taskeen's study, the uterine artery doppler velocimetry's sensitivity for predicting PE was 80, which is similar to the current study.[13]

According to a study, 23 out of 120 patients had abnormal UAD 19 had pre-eclampsia. Pre-eclampsia detection sensitivity and specificity were 83 and 85.[17]

In another investigation, the unusual uterine artery Doppler scan's sensitivity and specificity for preeclampsia prediction were 57.14 and 95.83 in the low-risk group and 73.33 and 86.48 in the high-risk group, respectively.[18]

A study demonstrated that Doppler testing of the uterine artery between 20 and 23 weeks has significant diagnostic value.[19] A uterine artery notch, a higher resistance index (RI), and an elevated pulsatility index (PI) are good markers of PE, according to research.[8] Sensitivity (78) and specificity (66) of pre-eclampsia were strongly correlated with the existence of a notch or bilateral notch, RI, and PI MoM compared to late-onset or no pre-eclampsia (before 34 weeks of gestation). When it came to the development of preeclampsia in low-risk women, second-trimester parameters with an elevated pulsatility index with notching had the greatest positive probability ratio (7.5).[20] The left uterine artery PI showed good validity in predicting the condition, whereas the right uterine artery RI exhibited the best specificity among these indices.[21] In this same study, the UAD test took an average of 22.6 weeks to complete. Following the scan, 1781 of these women with a 5.7 incidence rate had pre-eclampsia.[22]

Given the obscurity of its etiology, PE is difficult to forecast. It is commonly recognized that first-time moms cannot be included in the most reliable clinical predictor of PE, which is a prior history of pre-eclampsia. In our study, we included 43 primigravida who had no previous history of PE, and of these 17 patients had PE. Preeclampsia in a subsequent pregnancy is seven times more common in a woman who has had it in a prior pregnancy.[23] It is a documented fact that with increasing age there is an increased risk of certain pregnancy difficulties. In one research, preeclampsia was far more common in women who were older mothers.[24] In our study, 25 to 34-year-old mothers, 22 patients had preeclampsia, and those above 35 years, 6 patients had preeclampsia.

Therefore, it may be inferred that uterine artery doppler studies can be used to examine uteroplacental circulation non-invasively, given the correlation between aberrant doppler tests and outcomes such as preeclampsia, intrauterine growth restriction, and perinatal mortality. Increased resistance index (R.I.), persistence of the uterine artery notch, and elevated PI can all be used to predict PE and IUGR with accuracy. Therefore, widespread use of second-trimester uterine artery doppler should be implemented to diagnose preeclampsia early and avoid fetal morbidity and death.

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