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Uterine Artery Doppler Pulsatility Index in the First Trimester as a Forecaster of Pre-Eclampsia in Primary Gravida

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ABSTRACT

Objective: To uncover a correlation between a high uterine artery pulsatility index on Doppler ultrasound and the early onset of pre-eclampsia to reduce maternal and fetal morbidity and mortality.

Study Design: Quasi-experimental study.

Place and Duration of Study: Department of Gynecology and Obstetrics, Combined Military Hospital, Multan Pakistan, from Jun 2020 to Dec 2021.

Methodology: After Ethical Approval and informed consent, the umbilical artery pulsatility (UAPI) of the patients was measured by a transabdominal scan(TAS) between 75 and 100 days. Raised UAPI was correlated with early onset pre-eclampsia.

Results: One hundred and sixty pregnant women were included in the study, out of which 34(21.3%) women developed pre-eclampsia, and 126(78.8%) were normal patients. Maternal weight (p=0.001), maternal BMI (p=0.002), gestational age and weight at delivery (p=0.001), and uterine artery doppler pulsatility index (p=0.001) had statistically significant differences with pre-eclampsia and regular patients among the target population.

Conclusion: First-trimester uterine artery pulsatility index on Doppler ultrasound is a beneficial technique to recognize the women by risk status and target them to prevent pre-eclampsia.

Keywords: Doppler ultrasound, Pre-eclampsia, Pulsality index.

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INTRODUCTION

Pre-eclampsia is a new onset of Pregnancy-Induced Hypertension (PIH) and proteinuria with or without end-organ damage, kidneys, and liver in a previously normotensive lady.[1]

In developed countries, pre-eclampsia has an incidence of 6%.[2] However, in Pakistan, the incidence of pre-eclampsia rises to 19% in one of the studies.[3] It impacts complications in 5-7% of pregnancies and dominates maternal and fetal morbidity and mortality worldwide.[4] Yearly, 63,000 maternal and 50,000 infant casualties are predictably attributed to pre-eclampsia.[5] Apart from deaths, pre-eclampsia substantially affects maternal and fetal morbidity. It can lead to serious complications for the mother, such as HELLP syndrome (Hemolytic Anemia, Elevated Liver Enzymes and Low Platelet count), eclampsia, stroke and death, as already discussed.[6,7]

Doppler ultrasound is a noninvasive operator-dependent investigation that can anticipate the conceivable patients who will acquire pre-eclampsia in very early gestation.[8,9] Doppler ultrasound measures the Uterine Artery Pulsatility Index (UAPI), the difference between maximum systolic flow minus minimum diastolic flow in the uterine artery divided by the mean arterial flow. The value above the 95th centile in both uterine arteries presents a high risk of developing pre-eclampsia.[10]

This study measured the UAPI at 75 and 100 days of gestation to find a correlation between a high PI and the early onset of pre-eclampsia to decrease maternal and fetal mortality and morbidity.

METHODOLOGY

The quasi-experimental study was conducted at the Department of Gynecology and Obstetrics, Combined Military Hospital, Multan Pakistan, from June 2020 to December 2021. Ethical approval from the Ethical Review Board Committee, (IREB Letter no:13/Trg/2022) was taken. The sample size was calculated by WHO Sample Size Calculator using the population prevalence proportion of pre-eclampsia as 5.6%.[8] Non-probability consecutive sampling technique was used to gather the sample.

Inclusion Criteria: Women with single pregnancy and primary gravida were included in the study.

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Exclusion Criteria: Women with medical comorbidities like hypertension, diabetes mellitus, impaired renal function, etc., twin pregnancy, and infertility treatment with a BMI of more than 29.

All the patients and their husbands gave written informed consent before participating in the study, patients who fulfilled the inclusion as mentioned earlier and exclusion criteria were included in the study. A detailed consultation and assessment of the patient, including medical co-morbidities, hypertension, obesity, infertility treatment etc., was brought about and catalogued.

Trans Abdominal Ultrasound (TAS) was conducted in all subjects by the same radiologist using Xario 100 ultrasound machine (Canon Medical systems) with a 3.5-MHz sector transducer at 75 and 100 days of gestation. Each uterine artery was comprehended by placing the transducer in the lower lateral abdominal quadrant to identify the external iliac vessels. The uterine artery is determined using colour Doppler flow in ultrasound. The insonation angle was kept at 30 degrees, and the sampling gate size of 2mm. The right and left UAPI was calculated, and the mean was computed. The samples were obtained during normal maternal respiration. Regular antenatal checkups were executed at four-weekly intervals until 28 weeks and then fortnightly till 36 weeks. Our team documented blood pressure and proteinuria using the dipstick method at each follow-up. Twenty-four-hour urine collection verified positive proteinuria.

Increased blood pressure was interpreted as systolic blood pressure higher than 140mmHg and diastolic pressure more than 90mmHg. There have to be two studies of increased blood pressure six hours apart. More than 300 milligrams of protein in 24 hours of urine collection or two values of plus one proteinuria on dipstick analysis characterized positive proteinuria.

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 23.00 and MS Excel 2016 software. Shapiro test was used to check the normality of data. The Median (IQR) was calculated for continuous variables. Frequency and percentage were calculated for categorical variables. Mann-Whitney U test was used. The diagnostic accuracy of the mean PI of the uterine arteries was represented by a 2x2 table. The *p*-value of ≤ 0.05 was considered significant.

RESULTS

One hundred sixty pregnant women who met the inclusion/exclusion criteria were included in the study. The median maternal age was 25(27-23) years, ranging from 19 to 36 years. The median maternal weight was 72(78-65) kgs. The median maternal height was 1.65(1.67–1.63) meters. The median maternal BMI was 26.19(28.22–24.19) kg/m^2, the median gestational age at sampling was 85(88–82) days, as shown in Table-I.

Table-I: Demographic & Clinical Features of Patients (n=160)

Study Parameters	Median (IQR)
Maternal Age (years)	25(27-23)
Maternal Weight (kg)	72(78-65)
Maternal Height (meter)	1.65(1.67-1.63)
Maternal BMI (kilogram/meter2)	26.19(28.22-24.19)
Gestational age at sampling (days)	85(88-82)
Gestational age at delivery (weeks)	37(41-32)
Gestational weight at delivery (grams)	3200(3510-2075)
Uterine Artery Doppler Pulsatility Index	1.42(1.83-1.21)

Of the total, 34(21.3%) women developed pre-eclampsia, and 126(78.8%) were normal patients. Maternal weight (p=0.001), maternal BMI (p=0.002), gestational age and weight at delivery (p=0.001), and UAPI (p=0.001) had statistically significant differences between patients with pre-eclampsia and regular patients among the target population. However, maternal age (p=0.320), maternal height (p=0.351) and gestational age at sampling (p=0.138) had no statistically significant difference, as shown in Table-II. The diagnostic accuracy of the mean PI of the uterine arteries was shown in Table-III.

Table-II: Comparison Demographic and Clinical Features of Patients with Preeclampsia and Normal Pregnant Women among the Target Population (n=64)

Characteristics	Normal Median (IQR) (n=30)	Pre-Eclamptic Median (IQR) (n=34)	*p*-value
Maternal Age (years)	25(27-23)	25(29-23)	0.320
Maternal Weight (Kilogram)	73 (79-66.75)	67 (73-61.75)	0.001
Maternal Height (Meter)	1.65 (1.67-1.63)	1.66 (1.67-1.63)	0.351
Maternal BMI (Kilogram/Meter2)	26.11 (29.12-24.09)	25.48 (27.15-23.46)	0.112
Gestational age at sampling (Days)	85 (89-81.75)	84 (86.25-81.75)	0.138
Gestational age at delivery (Weeks)	39.4 (39.6-38.6)	34.55 (36.85-33.47)	0.001
Gestational weight at delivery (Grams)	3400 (3512.50-3200)	2200 (2385-2075)	0.001
Uterine Artery Doppler Pulsatility Index	1.32 (1.49-1.14)	2.07 (2.50-1.95)	0.001

Table-III: Diagnostic Accuracy of Pulsatility Index (PI) of the Uterine Arteries (n=160)

	Normal	Pre-Eclampsia
Less than 1.85	105	3
Equal to and more than 1.85	35	17

sensitivity=85%, specificity=75%, positive predictive, value=16.7%, negative predictive value=98.83%, diagnostic accuracy=75.56%

DISCUSSION

Pre-eclampsia affects the quality of life in the pregnant woman.[10] It is one of the primary factors of maternal morbidity and mortality. It implicates the neonate with IUGR and considerable perinatal morbidity and mortality.[11,12] It places plenty of monetary obligations on the healthcare system.

In our research study, the gestational age at birth in an average pregnant female was 39.4 weeks, distinguished from pre-eclamptic women in which it was 34.5 weeks. This disagreement was statistically significant, with a *p*-value equal to 0.001. Coviello *et al*. found that in pre-eclamptic women, gestational age at labour was between 24 weeks and 32 weeks.[13] Blackwell *et al*. studied 215 women with pre-eclampsia that had birth before 34 weeks.[14]

We established that the median birth weight in pre-eclamptic women was 2200 grams, in contrast to 3400 grams in average pregnant women. This outcome was statistically significant (p=0.001). As a primarily placental disease, pre-eclampsia is a prominent risk component for low birth weight.[15] A study conducted in Uganda found mean birth weight for pre-eclampsia patients was 2.48kg.[16] They also established that at 28 weeks, the mean birth-weight discrepancy between pre-eclampsia cases and controls was 0.58kg (p<0.05), narrowing to 0.17kg at 39 weeks. A local study did not show a significant association between maternal hypertension and IUGR.[17]

The precise rationale which leads to pre-eclampsia still needs to be clarified, however, it is principally a placental disease. Abnormal placental development and remodelling lead to enhanced vascular resistance in spiral arteries, which results in relative hypoxemia.[18] This placental tissue, in turn, leads to maternal endothelial dysfunction, which concludes in maternal vasoconstriction and multiorgan damage. In addition, Doppler ultrasound picked increased vascular resistance in spiral and uterine arteries.

Doppler ultrasound measures PI in uterine arteries. An elevated value of the PI implies increased vascular resistance, which can be a forecaster of pre-eclampsia. We calculated the PI in the first trimester and took a cut-off value of 1.85. We found the median PI of uterine arteries in the first trimester to be 1.32 in ordinary women and 2.07 in pre-eclamptic ladies, and the result was statistically significant (p=0.001). Doppler ultrasound studies repeated at regular intervals gave more valuable results. Nevertheless, unfortunately, it curtails the opportunity for early prophylaxis in high-risk patients. Low-dose aspirin at 150 mg/day commencing from 14 weeks of gestation till 36 weeks of pregnancy in women at increased threat for preterm pre-eclampsia stemmed in a lower incidence of this diagnosis than placebo.

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CONCLUSION

A high UAPI of Doppler ultrasound at the first trimester of gestation provides reasonable sensitivity and specificity to anticipate the early onset of pre-eclampsia. However, an adverse finding does not entirely omit the diagnosis of pre-eclampsia. To prevent pre-eclampsia, patients with positive Doppler ultrasound should be commenced on low-dose aspirin in the first trimester. Doppler ultrasound in the second trimester gives superior results than the first trimester; however, early prevention of pre-eclampsia cannot be started in these cases.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

PAH & SA: Critical review, drafting the manuscript, approval of the final version to be published.

AA & AA: Data acquisition, data analysis, approval of the final version to be published.

NA & SB: Conception, study design, data interpretation, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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