Section: Obstetrics and Gynaecology

Original Research Article

SIGNIFICANCE OF SECOND TRIMESTER UTERINE ARTERY DOPPLER IN PREDICTING PREECLAMPSIA IN SOUTH INDIAN PREGNANT WOMEN

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ABSTRACT

Background: To evaluate the usefulness of uterine artery Doppler screening in the Second-trimester gestation women for predicting the risk for preeclampsia, and to identify sensitivity, and specificity of the doppler indices- Notching, and Pulsatility Index (PI).

Materials and Methods: This study is aprospective, observational study in 250 second-trimester gestation women (20-24 weeks) in the Department of Antenatal Clinic, KGH Hospital, (Tertiary Health Care Centre) Triplicane, and Institute of Obstetrics and Gynaecology, Egmore, Chennai, India from February 2019 to December 2022. After consent, and fulfilling inclusion criteria, the study participant's gestational age, antenatal investigation, BMI, blood pressure, clinical markers, Proteinuria, impaired uterine artery flow, Uterine Artery Doppler (UAD), and preeclampsia status were observed and recorded.

Results: A total of 250 women between 20-24 weeks in the second trimester were selected for this study. Doppler imaging was used to identify prediction of the risks of Preeclampsia with the help of tools notching and pulsatility index. Out of the 250 participants in the study, 192 women had negative notching, whereas 58 women had positive notching. The proportion within notching was 94.8% in the 192 notching negative study individuals, the percentage within preeclampsia was 90.1% and the total percentage was 72.8% in the preeclampsia-absent study subjects. Out of the 58 study participants who met the inclusion criteria, 34.5% of the preeclampsia absentees had notched, and 9.9% had preeclampsia, for a total percentage of 8.0%. Preeclampsia accounted for 100.0% of the 250 cases, while the overall rate within notching was 100%. The specificity: 0.90099 (95% CI: 0.84-0.93), false negative: 0.052083 (95% CI: 0.02-0.09), and false positive: 0.344828 (95% CI: 0.22-0.48) are the correlations between notching and preeclampsia. A significant association was found between preeclampsia, and notching ($\chi 2$=104.433, p-value-<0.000). The aggregate proportion of the % within PI among the 250 cases was 100.0%. There was a 100.0% total percentage of preeclampsia. An insignificant association was found between PI and preeclampsia.

Conclusion: Our study participants who were in their second trimester showed a strong association between notching and preeclampsia. Notching during the second trimester had a sensitivity of 79% (95% CI between 64% and 89%) and a specificity of 90% (95% CI between 84% and 93%). With a p-value of less than 0.000, 65% of the data had a positive predictive value and 94% had a negative predictive value ($\chi 2$=104.433). Preeclampsia and PI were not significantly correlated. Doppler is an important tool for forecasting preeclampsia in high-risk second-trimester women.

Keywords: Second-trimester, Impaired Uterine Artery Flow (IUAF), Gestation, Uterine Artery Doppler (UAD), Preeclampsia, Notching, Pulsatility Index (PI).

INTRODUCTION

Preeclampsia is a multisystem ailment that usually affects 2%–5% of expectant mothers. It is one of the main causes of morbidity and mortality in both the mother and the fetus, particularly when the condition develops early. Perinatal mortality was 500,000 and maternal mortality was 76,000 annually worldwide. In addition, compared to women in high-resource nations, women in low-resource countries are more likely to experience pre-eclampsia and hypertensive disorders of pregnancy.[1]

When gestational age is estimated to be between 11 and 13 + 6 weeks gestation, the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) recommends the first ultrasound scan because it offers a chance to measure nuchal translucency and identify any gross fetal abnormalities.[2]

Elevated uterine artery vascular resistance to blood flow is linked to an increased risk of subsequent development in both high-risk and low-risk pregnancies of preeclampsia and IUGR. Expectant mothers who have normal uterine artery blood flow resistance are at a lower risk of experiencing obstetric difficulties later on due to uteroplacental insufficiency. In women undergoing regular antenatal care, altered impedance to uterine artery flow identifies around 50% of cases that progress to preeclampsia. An abnormal Doppler finding is more sensitive when predicting severe preeclampsia, and about 75% of the preeclampsia were identified by Doppler.[3]

One of the most useful procedures for identifying birth defects in fetus is the Doppler examination in the second trimester of pregnancy which will identify around 80% of significant defects such as Hydrocephalus, microcephaly, cleft lip and palate, heedlessness, cleft spine, diaphragmatic hernia, renal agenesis, coating defects, fluid in the belly, bone disorders, bone dysplasia, and a-chondrodysplasia.[4]

Uterine artery indices in Doppler ultrasonography can predict low birth weight if they are aberrant and predicting adverse pregnancy outcomes during the secondand third trimester of pregnancy can be significantly improved by examining uterine artery Doppler indices.[5] In the second and third trimesters (20–24 weeks of gestation), Doppler of the uterine artery is the most reliable indicator of preeclampsia, especially when taking into account the link with intrauterine growth restriction.[6]

In conjunction with second-trimester uterine artery Doppler, the quantitative evaluation of the placental vasculature and volume during the first trimester can be regarded as a potentially useful tool for the early prediction of unfavorable pregnancy outcomes (preeclampsia).[7] Doppler screening shows encouraging predictive accuracy with early detection of adverse pregnancy outcomes in high-risk pregnancies chances for intervention, which may enhance the results for both the mother and the fetus, and Doppler screening in the second trimester of pregnancy may improve PE and FGR risk categorization and facilitate prompt therapies aimed at reducing unfavorable pregnancy outcomes.[8] The complete sensitivity of 100% of uterine artery Doppler ultrasonography in forecasting severe preeclampsia implies that this modality of ultrasound imaging might be utilized as a dependable means of effectively anticipating severe preeclampsia, particularly during the second trimester of pregnancy.[9]

Preeclampsia prevention in obstetrics is still a significant concern. Preeclampsia and intrauterine growth restriction (IUGR) symptoms typically appear in the second or third trimester of pregnancy; however, the pathophysiology underlying both conditions begins in the first trimester.[10] Resistivity Index (RI) could be considered a good predictor of later preeclampsia based on second-trimester Doppler ultrasonography at 24 weeks of gestation. Similar to PI, there were substantial differences in the median RI values between the control, hypertensive and preeclamptic groups.[11]

Earlyonset of preeclampsia and IUGR are predicted by Uterine Artery Doppler during the second trimester. Umbilical artery Doppler is a vital tool in the evaluation of fetal hypoxic impairment, particularly in the early stages of the condition. It aids in the identification of small-for-gestational-age fetuses at increased risk. It assists in the timing of delivery, hence perinatal outcomes.[12] Third-trimester umbilical artery doppler in low-risk populations, to predict unfavorable pregnancy outcomes is restricted. It may be beneficial to use umbilical artery Doppler velocimetry to anticipate unfavorable outcomes in pregnant women at high risk.[13]

With the insights of the above literature, some studies indicate that Doppler has to be used in high-risk pregnancies alone, and some literature narrates, that Doppler can be used for both high-risk and low-risk pregnancies, and every single piece of information on clinical diagnosis of pre-eclampsia in the second trimester of pregnancy is essential, hence we conducted this present study in second trimester pregnant women regardless of the risk levels.

Ethical clearance

With the ethical committee's approval and guidance, this study is carried out in the selected study subjects.

Conflicts-None

Funding-None

Inclusion Criteria

- Pregnant women of 20-24weeksin the Second Trimester

Exclusion Criteria

- Pregnant women in the first trimester and over 24 weeks of gestation.

- Pregnant women who are unable to provide consent.

MATERIALS AND METHODS

Methodology

Study Participants, Design, Duration, and Setting

This study is conducted on 250 pregnant women of 20-24 weeks of gestational, and the study design is observational, and prospective study. The study was conducted from February 2019 to December 2022 in the setting of the Department of Antenatal Clinic, KGH Hospital, (Tertiary Health Care Centre) Triplicane, and Institute of Obstetrics and Gynecology, Egmore, Chennai, India.

Study Variables

Gestational Hypertension

After 10 minutes of rest, blood pressure readings were taken while the subject was seated, and four hours later, a diagnosis was made when the subject's blood pressure reached 140/90 mmHg and a blood pressure reading of at least 140/90 mmHg was taken twice, with a minimum of 4 hours between each measurement.

Preeclampsia

After 10 minutes of rest, blood pressure readings were taken while the subject was seated, and four hours later. The diagnosis was made when the subject's blood pressure reached 160/110 mmHg along with other features like Oliguria (500 ml/24 hours. Presence of Epigastric pain, Thrombocytopenia, Proteinuria (5gms/24 hours), 3 positive dipsticks and FGR.

Uterine Artery Doppler (UAD)

Uterine Arteries Doppler imaging was done for the study participants in the 20-26 weeks of gestation. The study participants were examined in a semi-recumbent position under real-time ultrasonography using a Volusion GE machine at a frequency of 2-3 MHz after being on bed rest for 10 minutes. The transabdominal probe was positioned in the lower lateral quadrant of the abdomen, both medially and longitudinally. When locating the uterine artery as it crosses the external iliac artery, colour flow mapping is useful. 1cm downstream of the sample volume was this crossover point.

Study Procedure

During the second trimester, they were observed and examined for clinical investigations such as BP, BMI, Doppler, and the presence of preeclampsia, and the results were recorded.

Data Collection

Demographic data of study participants such as age, gestational age, BP, BMI, Doppler, and presence of preeclampsia were collected and recorded.

Analysis

The collected data from 250 study participants during their second trimester were analyzed for the association of the absence of preeclampsia with notching, PI, sensitivity, specificity, and 95%CI and tabulated in the result section.

Statistical Analysis of Data

Microsoft Windows SPSS version 20 was used to analyze the collected for this study, and the demographic details are shown as descriptive statistics using the range, mean, and standard deviation for metric data and range, median, and interquartile range for discrete data. After calculating the frequency proportions distribution, category variables such as PI, Notching, and Preeclampsia were further analysed for statistical significance with the Chi-Square test, and a p-value of <0.05 was considered statistically significant.

RESULTS

A total of 250 (study participants) pregnant women with a gestation of 20-24 weeks were selected for this study. We analysed the association between Preeclampsia, and Notching in Second-trimester study participants, and tabulated it in Table 1. Among the 250 study participants preeclampsia-negative was found in 202 women, and among the 202 preeclampsia-negative women notching was negative in 182 women, and notching was positive in 20 women. Among the 250 study participants, Notching was negative in 192 women, and positive in 58 women. In the 192 notching negative study participants, in preeclampsia absent study participants, the % within notching was 94.8%, and the % within preeclampsia was 90.1% with an overall percentage of 72.8%. Of the 58 notching positive study participants, in preeclampsia absent study participants, within notching percentage was 34.5%, and within preeclampsia percentage was 9.9% with an overall percentage of 8.0%. Among the 250 cases, the overall percentage was 100% within notching, and the overall percentage of preeclampsia was 100.0%. [Table 1]

We analyzed and calculated the Pearson Chi-square using Fisher's Exact test and found that the association between the notching and preeclampsia in the second-trimester women was statistically significant ($\chi 2$=104.433, p-value-<0.000). [Table 2]

The sensitivity, specificity, and 95% CI for the association between notching and preeclampsia in second-trimester women were analyzed and tabulated in Table 3. Sensitivity- 0.791667 (95%.CI-0.64-0.89), specificity-0.90099 (95%.CI-0.84-0.93), false negative-0.052083 (95%.CI-0.02-0.09), and false positive-0.344828 (95%.CI-0.22-0.48). [Table 3]

We further also analysed the association between Preeclampsia, and PI in second-trimester women, and presented in Table 4. Among the 250 study participants preeclampsia-negative was found in 202 women, and among the 202 preeclampsia-negative women PI was negative in 144 women, and PI was positive in 58 women, their % within PI was 82.8%, and the % within preeclampsia was 71.3% with an overall percentage of 57.6%. Of the 58 PI-positive study participants among the preeclampsia-absent

study participants, % within PI was 76.3%, and % within preeclampsiawas28.7% with an overall percentage of 23.2%. Among the 250 cases, the overall percentage of the % within PI was 100.0%. the overall percentage of the % within preeclampsia was 100.0%. [Table 4]

We found an insignificant association between the PI and preeclampsia in the second-trimester women. [Table 5]

The sensitivity, specificity, prevalence, and 95% CI for the association between PI and preeclampsia in second-trimester women were analyzed and tabulated in Table 6. Sensitivity- 0.375 (95%.CI-0.24-0.52), specificity-0.712871 (95%.CI-0.64-0.77), false negative-0.172414 (95%.CI-0.12-0.23), and false positive-0.763158 (95%.CI-0.64-0.85). [Table 6]

Table 1: Association of Preeclampsia, and Notching in the Second-trimester Women

Notching (n=250)		Preeclampsia - Absent	Preeclampsia - Present	Total
Negative (n=192)	Count	182	10	192
	Expected Count	155.1	36.9	192.0
	% within Notching	94.8%	5.2%	100.0%
	% within Preeclampsia	90.1%	20.8%	76.8%
	% of Total	72.8%	4.0%	76.8%
Positive (n=58)	Count	20	38	58
	Expected Count	46.9	11.1	58.0
	% within Notching	34.5%	65.5%	100.0%
	% within Preeclampsia	9.9%	79.2%	23.2%
	% of Total	8.0%	15.2%	23.2%
Total (n=250)	Count	202	48	250
	Expected Count	202.0	48.0	250.0
	% within Notching	80.8%	19.2%	100.0%
	% within Preeclampsia	100.0%	100.0%	100.0%
	% of Total	80.8%	19.2%	100.0%

Table 2: Pearson Chi-square-Notching and Preeclampsiain the Second-trimester Women

Fisher'sExact/ Pearson Chi-square					
Chi-Square Tests	Value	df	Asymp. Significant (2-sided)	Fisher's ExactSig.(2-sided)	Fisher's ExactSig.(1-sided)
Pearson Chi-square	104.433[a]	1	0.000		
Continuity Correction	100.582	1	0.000		
Likelihood Ratio	91.261	1	0.000	<0.000*	<0.000*
Linear-by-Linear Association	104.016	1	0.000		

a. 0cells (.0%)have an expected count of lessthan5.Theminimumexpectedcountis11.14

b. Computedonlyfora2x2table

c. *Statistically Significant

Table 3: Preeclampsia, and Notching in the Second-trimester Women (Sensitivity, Specificity, 95% CI)

Variables	Estimated Value	95%ConfidenceInterval	
		Lower Limit	Upper Limit
Sensitivity	0.791667	0.645963	0.890442
Specificity	0.90099	0.849161	0.936976
If Positive tests- (Probability will be)			
Positive	0.232	0.182155	0.290263
Negative	0.768	0.709737	0.817845
If Positive tests- (Probability is)			
True Positive	0.655172	0.517957	0.771798
False Positive	0.344828	0.228202	0.482043
If Negative tests- (Probability is)			
True Negative	0.947917	0.903557	0.973316
False Negative	0.052083	0.026684	0.096443
likelihood (Ratios): [C]= (conventional)	[W]=weighted (by prevalence)		
Positive[C]	7.995833	5.146593	12.42246
Negative[C]	0.231227	0.133069	0.401791
Positive[W]	1.9	1.272497	2.836943
Negative[W]	0.054945	0.030034	0.100518

Table 4: Association of Preeclampsia, and PI in the Second-trimester Women

PI (n=250)		Preeclampsia -Absent	Preeclampsia -Present	Total
Negative (n=174)	Count	144	30	174
	Expected Count	140.6	33.4	174
	% within PI	82.80%	17.20%	100.00%
	% within Preeclampsia	71.30%	62.50%	69.60%
	% of Total	57.60%	12.00%	69.60%
Positive (n=76)	Count	58	18	76
	Expected Count	61.4	14.6	76
	% within PI	76.30%	23.70%	100.00%
	% within Preeclampsia	28.70%	37.50%	30.40%
	% of Total	23.20%	7.20%	30.40%
Total (n=250)	Count	202	48	250
	Expected Count	202	48	250
	% within PI	80.80%	19.20%	100.00%
	% within Preeclampsia	100.00%	100.00%	100.00%
	% of Total	80.80%	19.20%	100.00%

Table 5: Pearson Chi-square-Preeclampsia, and PI in the Second-trimester Women

Fisher's Exact Test /Pearson Chi-square					
Chi-Square Tests	Value	df	Asymp. Significant (2-sided)	Fisher's Exact Sig.(2-sided)	Fisher's Exact Sig.(1-sided)
Pearson Chi-square	1.415[a]	1	.234		
Continuity Correction	1.031	1	.310		
Likelihood Ratio	1.375	1	.241	0.295	0.155
Linear-by-Linear Association	1.410	1	.235		

Table 6: Preeclampsia, and PI in the Second-trimester Women (Sensitivity, Specificity, 95% CI)

Variables	Estimated Value	95%ConfidenceInterval	
		Lower Limit	Upper Limit
Sensitivity	0.375	0.243214	0.526663
Specificity	0.712871	0.644382	0.773103
If Positive tests- (Probability will be)			
Positive	0.304	0.248437	0.365702
Negative	0.696	0.634298	0.751563
If Positive tests- (Probability is)			
True Positive	0.236842	0.149988	0.350704
False Positive	0.763158	0.649296	0.850012
If Negative tests- (Probability is)			
True Negative	0.827586	0.76138	0.878929
False Negative	0.172414	0.121071	0.23862
likelihood(Ratios): [C]=(conventional)	[W]=weighted(by prevalence)		
Positive[C]	1.306034	0.853873	1.997635
Negative[C]	0.876736	0.701463	1.095805
Positive[W]	0.310345	0.20339	0.473542
Negative[W]	0.208333	0.150094	0.289171

DISCUSSION

In our present study, we found there was a significant association between notching and preeclampsia in second-trimester women of our study participants, the sensitivity of notching in 2nd trimester was 79% (95% CI between 64% and 89%) while specificity was 90% (95% CI between 84% and 93%). The positive predictive value was 65%, the negative predictive value was 94% ($\chi 2$=104.433, p-value-<0.000), and % within notching was 94.8%, and the % within preeclampsia was 90.1% with an overall percentage of 72.8%.Mariana NA et al study reported in their 24-week study participants that an are-diastolic notch at the 24-week mark has a 72.7% sensitivity and a 95.4% specificity to predict pre-eclampsia (p-value is 0.022), and Li M et al reported 95.5% of specificity, and 79% sensitivity p-value-<0.001.[14,15]

In the significant association between notching and preeclampsia in second-trimester women of our study participants, we found the false positive was 0.344828 (95%.CI-0.22-0.48), and false negative-0.052083 (95%.CI-0.02-0.09), with the Positive Predictive Value (PPV) was 65%. The Negative Predictive Value (NPV) was 94% ($\chi 2$=104.433, p-value-<0.000). Poon LC et al conducted a study on33 602 pregnancies and reported the false-positive percentage was 10%.[16] The researcher Capriglione S et al reported in the association of notching, and preeclampsia in the first trimester women, the PPV was 65%, NPV was 70%, and Álvarez SC et al reported there were four key performance indicators: sensitivity (32.1%), specificity (98.4%), positive predictive value (PPV) (94.4%), and negative predictive value (NPV) (63.3%).[17,18]

In our current study, we found an insignificant association between PI and preeclampsia in second-

trimester women, but among the 250 cases, the overall percentage of the % within PI was 100.0%. the overall percentage of the % within preeclampsia was 100.0%. While not statistically significant ($\chi2$=1.41, p=0.23), PI was over the cut off in 23.7% of patients with preeclampsia and below the cut off in 82.8% of patients without preeclampsia, and the PI's sensitivity was 37% (95% CI between 24% and 52%) and its specificity was 71% (95% CI between 64% and 77%). There was an 83% negative predictive value and a 23% positive predictive value. Sotiriadis A et al reported that the uterine artery PI determined by transabdominal ultrasonography at 23 weeks has a p-value of 1.44, which is the 95th percentile, and according to Cavoretto PI et al reports, the uterine artery PI normal Doppler values in the first, second, and third trimesters are 1.84 ± 0.55, 1.07 ± 0.38, and 0.78 ± 0.23, respectively.[19,20]

CONCLUSION

We found a substantial correlation between notching and preeclampsia in second-trimester women who participated in our study. The sensitivity of notching in the second trimester was 79% (95% CI between 64% and 89%), while the specificity was 90% (95% CI between 84% and 93%). 65% of the data had a positive predictive value and 94% had a negative predictive value ($\chi2$=104.433, p-value <0.000). A non-significance association was found between PI and preeclampsia. Doppler is a significant tool in identifying and predicting preeclampsia in high-risk pregnant women.

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