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RESEARCH ARTICLE

Mean PSV Ratio of Ophthalmic Artery is A Better Marker for Preeclampsia Prediction: A Cross-Sectional Analytic Study in Indian Pregnant Women

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ABSTRACT

Objective: **Study the changes in mean PSV ratio of ophthalmic artery with rise in mean arterial blood pressure and its comparison with changes in mean PI of uterine artery with rise in mean arterial blood pressure, in pregnant Indian women. The role of the ophthalmic artery means PSV ratio in the detection of pre-eclampsia.**

Method: **It is a cross-sectional analytic study. Preeclampsia may affect ophthalmic artery circulation with consequent neuro-ophthalmic manifestations. 170 patients, irrespective of parity, between the ages of 21 to 35 years included in this study. Patients in each trimester were included. Changes in the Mean PSV ratio of the ophthalmic artery recorded in both eyes, and its correlation with changes in mean arterial blood pressure, were noted. Doppler changes in the mean PI of the uterine artery with a change in mean arterial blood pressure were recorded. Then we compare the changes in mean PSV ratio of the ophthalmic artery with changes in mean PI of the uterine artery in each trimester patient. Ophthalmic artery Doppler study is done with a 5 to 13 MHz multi frequency linear probe.**

Result: **Independent t-test and Fisher's exact test are used for analysis. The mean PSV ratio of ophthalmic arteries increases with an increase in mean arterial blood pressure. This change is directly proportional to the increase in mean arterial blood pressure in all trimesters. Changes in the mean PSV ratio of the ophthalmic artery with the rise in mean arterial blood pressure were consistent in all trimesters. The mean PSV ratio of 0.55 corresponds to an MABP of 100 mmHg. Changes in the mean PI of the uterine artery were not consistent with an increase in mean arterial BP in all trimesters.**

Conclusion: **According to the results of this study mean PSV ratio of the ophthalmic artery is better than the mean uterine artery PI in the prediction of a rise in mean arterial blood pressure; p value is less than 0.05, and Pearson coefficient (r) is 0.402, suggestive of a linear relationship. We can think of the mean PSV ratio of the ophthalmic artery for screening of pre-eclampsia in the first trimester. The mean PSV ratio of the ophthalmic artery can replace the mean PI of the uterine artery in first-trimester PIH screening.**

Keywords: Mean PSV ratio, Pre-eclampsia, Uterine artery PI.

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1. Introduction

Complication due to raised BP in pregnancy is a very common problem. This contributes to maternal and fetal morbidity and mortality. Hypertension during pregnancy is a sign of underlying pathology. Which may be preexisting or appear first time in pregnancy. Pre-eclampsia is defined as the onset of hypertension and either proteinuria or other signs of end-organ dysfunction after 20 weeks of gestation in previously normotensive women. The preeclampsia feature rarely appears before 20 weeks of pregnancy, as in the case of multiple pregnancy and hydatidiform mole. In preeclampsia underlying pathology

is endothelial dysfunction and intense vasospasm. This is all due to abnormal placentation. This affects almost all the vessels, particularly those of the uterus, kidney, placental bed and brain.

Screening for preeclampsia is also carried out at around 20- and 36-week gestational age [1], [2]. The advantage of screening at the second and third trimesters is not prevention of eclampsia but detection of high-risk groups, who would benefit from timely intervention.

Markers for 20-week gestation are MAP, PLGF and serum soluble sLFT [3], [4]. At the 36-week marker is MAP, sFLT and probably ophthalmic artery doppler [5].

For the screening of preeclampsia, various protocols are followed. In the first trimester most common are uterine artery mean PI, mean arterial blood pressure and PLGF [6].

For the last few years, Doppler indices are also been used for the screening of preeclampsia. Doppler study of ophthalmic arteries can be done easily and is easy to learn. Doppler study of this vessel provides information regarding changes in intracranial circulation.

This study is planned to assess which artery Doppler is most useful in the detection of preeclampsia.

2. Objective

Study the changes in mean PSV ratio of ophthalmic artery with rise in mean arterial blood pressure and its comparison with changes in mean PI of uterine artery with rise in mean arterial blood pressure, in pregnant Indian women.

3. Materials and Methods

This is a cross-sectional analytic study. conducted at Sparsh hospital, Kannauj. Patients are recruited from the routine antenatal OPD. The duration of the study was from January 2023 to August 2024. 170 patients in any trimester were included in this study. Ethical clearance taken from the ethical committee of the hospital.

3.1. Inclusion Criteria

Pregnant women with a singleton pregnancy in any trimester were included in this study.

3.2. Exclusion Criteria

Pregnant women with any medical disorder, like diabetes, chronic hypertension. and autoimmune diseases, not included in this study. Multiple pregnancy is not included. Pregnancy due to IVF is not included. Pregnancy with stillbirth and an anomalous baby was excluded from the study. Pregnancy with any fibroid or any uterine anomaly is not included.

3.3. Procedure

A detailed general and obstetric history of every patient is taken. The patient was informed about the procedure of ophthalmic artery Doppler and its significance for their pregnancy. The procedure was done after taking verbal consent.

Patients lie down in the supine position, instructed to keep their eyes closed and eyeballs static during examination. USG Jelly is applied over the eyelid. The procedure was done with a linear probe of 6 to 13 MHZ. Both eyes were examined one by one. One reading is taken from each eye. ophthalmic artery identified on the superior and medial side of the ophthalmic nerve [7]. Reading is taken 15 cm from the optic disc. During examination, the angle of intonation was less than 20, and the Doppler sample volume was 2 mm. The duration of the examination was a few seconds. 4 to 5 Doppler waves were taken for measurement. A special present in the machine is used with a maximum mechanical index of 0.4, depth was 3 to 4 cm, and a high-pass filter was used 50 HZ filter. At the same time, an obstetric Doppler USG is also done.

The waveform of the ophthalmic artery shows two peaks in systole. The mean pulsatility index of the uterine artery and the mean PSV ratio of the ophthalmic artery were taken from both eyes for analysis.

3.4. Statistical Analysis

Qualitative data has been presented as frequencies and percentages.

Quantitative data (measurable) were first checked for normality in distribution through Shapiro Wilk.

The q-q plot was visually inspected. If normally distributed quantitative variables across two categories, an independent t-test has been used.

4. Result

10 patients in the first trimester, 9 in the second and 24 in the third trimester develop high mean arterial blood pressure. Comparison of the mean PI of the uterine artery and the mean PSV ratio of the ophthalmic artery in these patients in each group was done with normotensive patients of that group.

Table I shows the comparison of the mean PI of the uterine artery between hypertensive and normotensive patients of the first trimester.

Findings in Table II show that there are no significant changes in the mean PI of uterine arteries in the hypertensive group and normotensive group in first-trimester

TABLE I: Comparison of Mean PI of Uterine Artery

	Hypertension	Mean ut artery PI
N	No	29
	Yes	10
Missing	No	0
	Yes	0
Mean	No	1.53
	Yes	1.30
Median	No	1.42
	Yes	1.32
Standard deviation	No	0.450
	Yes	0.395
Minimum	No	0.840
	Yes	0.520
Maximum	No	2.48
	Yes	1.84

TABLE II: Independent Sample T Test

		Statistic	df	P
Mean PI	Standard's t	1.44	37	0.158

TABLE III: Comparison of Mean PSV Ratio

	Hypertensive/normotensive	Mean PSV ratio
N	No	29
	Yes	10
Missing	No	0
	Yes	0
Mean	No	0.427
	Yes	0.552
Median	No	0.430
	Yes	0.540
Standard deviation	No	0.0573
	Yes	0.0509
Minimum	No	0.290
	Yes	0.500
Maximum	No	0.530
	Yes	0.670

patients. Table III shows the comparison of the mean PSV ratio between hypertensive and normotensive patients of the first trimester.

Findings in Table IV show that there are significant changes in the mean PSV ratio of the ophthalmic artery in first-trimester patients between hypertensive and normotensive patients. p value is <0.001.

Table V shows the comparison of the mean uterine artery PI between normotensive and hypertensive patients of the second trimester.

The result in Table VI shows that there are no significant changes in the Uterine artery mean PI in hypertensive and normotensive patients, p-value is 0.232.

TABLE IV: Independent Sample T-Test

		Statistic	df	P
Mean PSV ratio	Student's t	−6.11	37	<0.001

TABLE V: Comparison of Mean Uterine Artery PI

	Hypertensive/normotensive patient	Mean UT artery PI
N	No	48
	Yes	9
Missing	No	0
	Yes	0
Mean	No	1.09
	Yes	1.23
Median	No	1.00
	Yes	1.2
Standard deviation	No	0.310
	Yes	0.418
Minimum	No	0.570
	Yes	0.780
Maximum	No	2.00
	Yes	1.96

TABLE VI: Independent Sample T-Test

		Statistic	df	p
Mean PI of UT artery	Students	−1.21	55.0	0.232

TABLE VII: Comparison of Mean PSV Ratio

	Hypertensive and normotensive patients	Mean PSV of ophthalmic artery
N	No	48
	Yes	09
Missing	No	0
	Yes	0
Mean	No	0.400
	Yes	0.498
Median	No	0.400
	Yes	0.510
Standard deviation	No	0.0506
	Yes	0.0449
Minimum	No	0.250
	Yes	0.430
Maximum	No	0.480
	Yes	0.550

Table VII shows the comparison of the mean PSV ratio of the ophthalmic artery between hypertensive and normotensive patients of the second trimester.

The result in Table VIII shows that there are statistically significant changes in the mean PSV ratio of hypertensive patients as compared to normotensive patients in the second trimester.

Table IX demonstrates a comparison of the mean PI of the uterine artery between hypertensive patients and normotensive patients of the third trimester.

The result in Table X shows that there are no statistically significant changes in mean uterine artery PI of hypertensive patients as compared to normotensive patients.

TABLE VIII: Independent Sample T-Test

		Statistic	df	p
Mean PSV ratio	Student t	−5.39	55	<0.001

TABLE IX: Comparison of the Mean PI of the Uterine Artery

	Hypertensive and normotensive patients	Mean PI of uterine artery
N	No	44
	Yes	24
Missing	No	0
	Yes	0
Mean	No	0.837
	Yes	0.958
Median	No	0.735
	Yes	0.900
Standard deviation	No	0.293
	Yes	0.395
Minimum	No	0.380
	Yes	0.450
Maximum	No	1.68
	Yes	2.10

TABLE X: Independent Sample T-Test

		Statistic	df	p
Mean Utt artery PI	Student's t	1.43	66	0.156

TABLE XI: Comparison of Mean PSV Ratio of the Ophthalmic Artery

	Hypertensive and normotensive pts	Mean ut artery PI
N	No	24
	Yes	44
Missing	No	0
	Yes	0
Mean	No	0.428
	Yes	0.515
Median	No	0.430
	Yes	0.515
Standard deviation	No	0.0564
	Yes	0.0443
Minimum	No	0.320
	Yes	0.430
Maximum	No	0.560
	Yes	0.590

TABLE XII: Independent Sample T Test

		Statistic	df	p
Mean PSV of ophthalmic artery	Student's t	6.53	66	<0.001

Table XI shows the comparison of the mean PSV ratio of the ophthalmic artery between hypertensive patients and normotensive patients of the third trimester.

Table XII shows that there are statistically significant changes in the ophthalmic artery mean PSV ratio in hypertensive patients as compared to normotensive patients. P-value is <0.001.

Table XIII shows a correlation matrix between the mean PSV ratio of the ophthalmic artery, the mean PI of the uterine artery and the mean arterial blood pressure.

R value of mean PSV ratio is 0.402, and P value is <0.001. A moderate positive correlation is present between PSV ratio and mean arterial blood pressure, since the Pearson coefficient is (r) is between 0.40 and 0.59, suggesting a linear relationship.

Table XIII shows that the mean PSV ratio of the ophthalmic artery is a better predictor of the rise in mean arterial blood pressure than mean uterine PI.

5. Discussion

5.1. *Principal Findings of this Study*

This study is carried out on pregnant patients in all 3 trimesters and a comparison is made between the mean uterine PI and the mean PSV ratio of the ophthalmic artery with change in mean arterial blood pressure.

In the first trimester patients there are no statistically significant changes in the mean PI of the uterine artery in hypertensive patients in comparison to normotensive patients.

Changes in mean PSV ratio are statistically significant between hypertensive and normotensive patients of the first trimester, p-value is <0.001. There is an increase in the mean PSV ratio with an increase in mean arterial blood pressure.

The result of the second trimester shows that there are no statistically significant changes in mean arterial PI with the increase in mean arterial blood pressure in hypertensive patients as compared to normotensive patients.

There is an increase in the mean PSV ratio of ophthalmic arteries with the rise in mean arterial blood pressure of hypertensive patients in comparison to normotensive patients of the second trimester. This change is statistically significant p value is <0.001.

In the third trimester, changes in mean uterine PI in hypertensive groups are not statistically significant in comparison to changes in normotensive patients, p-value is 0.156.

Changes in mean PSV ratio with an increase in mean arterial blood pressure are significant in hypertensive patients of this group in comparison to normotensive patients. An increase in mean PSV is directly proportional to an increase in mean arterial blood pressure.

This finding is consistent in all trimester patients.

There is a rise in uterine artery mean PI in hypertensive group patients, but this rise is not statistically significant. This is true for all trimester patients.

5.2. *Comparison with Other Studies*

The ophthalmic artery is anatomically and embryologically similar to the intracranial vasculature and is easily accessible. Doppler assessment of this vessel provides information about less accessible intracranial circulation. There is much evidence present in the literature that there is a decrease in impedance to flow and an increase in velocity of blood in ophthalmic arteries with the rise in blood pressure [6]. This outcome is also shown by the result of our study.

TABLE XIII: Correlation Matrix

		Mean PSV ratio of ophthalmic artery	Mean PI of uterine artery	Mean arterial BP
Mean PSV ratio ophthalmic artery	Pearson's r	–	–	–
	P-value			
Mean PI of uterine artery	Pearson's r	−0.070	–	–
	P-value	0.374		
Mean BP	Pearson's r	0.402	0.080	
	P-value	<0.001	0.310	

Some studies show that these changes precede the onset of pre-eclampsia 2 [8], [9].

The result of an observational study done on 2287 singleton pregnancies shows that the mean PSV ratio is the only ophthalmic artery index that provides useful information regarding pre-eclampsia [8].

The Results of a study done by Sapantzoglou *et al*. concluded that ophthalmic arteries could potentially improve the detection rate of pre-eclampsia. According to their study, the mean PSV ratio was the best marker [5].

A study done by Singh concluded in their study that the mean PSV of the ophthalmic artery is the best predictor for detection of preeclampsia in any trimester [7]. In these studies, they studied all the Doppler indices of the uterine artery. The results of our study also support that the mean PSV ratio of ophthalmic arteries shows consistent changes with the rise in mean arterial blood pressure.

On this basis, we can say that the mean PSV of the ophthalmic artery can be used in the detection of preeclampsia in the second and third trimesters. At present, in first trimester preeclampsia screening, mean arterial blood pressure, mean PI of uterine artery and PLGF are used. After analyzing the results of this study and comparisons with other studies, PSV of ophthalmic arteries can replace uterine artery PI in the screening of PET in the first trimester.

6. Conclusion

According to the results of this study, the mean PSV ratio of ophthalmic arteries is better than the mean uterine artery PI in the detection of a rise in mean arterial blood pressure. Changes in mean PSV ratio are consistent with an increase in mean arterial blood pressure in all three trimesters. Changes in uterine arteries are not consistent and are also not statistically significant.

We can think of the mean PSV ratio of the ophthalmic artery for screening of pre-eclampsia in the first trimester. The mean PSV ratio of the ophthalmic artery can replace the mean PI of the uterine artery in first-trimester PIH screening.

To validate the results of this study, large sample studies from multiple centers are required.

6.1. Strengths and Limitations

We included patients in all trimesters of pregnancy. Compare the mean PI of the uterine artery with the mean PSV ratio of the ophthalmic artery in all trimesters. The sample size is small. Multiple pregnancies and patients with medical disorders are not included. Only Indian pregnant women were included in the study.

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Conflict of Interest

Author declares that there is no conflict of interest.

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