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Prospective Study of Uterine Artery Pulsatility Index in Three Trimesters of Pregnancy and its Correlation with Maternal Characteristics and Medical History

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ABSTRACT

Pre-eclampsia (PE) stands as a significant contributor to maternal and perinatal morbidity and mortality, exerting its impact on approximately 2-3% of all pregnancies. Numerous studies utilizing uterine artery (UtA) Doppler ultrasonography have documented that in pregnancies progressing towards PE, particularly those necessitating preterm delivery, there is a notable elevation in the pulsatility index (PI) during the successive trimesters of gestation. To evaluate usefulness and correlation of uterine artery Pulsatility index with maternal characteristic and medical history and to determine the usefulness of this parameter in early diagnosis of pregnancy outcome. Study was conducted on pregnant females coming for antenatal ultrasound at Radiology department. The study comprised 155 women with pregnancy between January 2022 and November 2022 at antenatal setup of our hospital between 11-14 weeks screening with a followup scan at 20-24 weeks and 32-34 weeks of gestation in the second and third trimesters who had high PI values with diastolic notch. The waveform from uterine artery is characterized by systolic peak, early diastolic notch which disappears after 22-24 weeks of gestation normally. PI values were calculated. The data was analysed with standard statistical test. The UtA-PI value in 1st, 2nd and 3rd trimesters of pregnancy was right (1.1-1.9) and left (0.9-1.5), right (1.0-1.8) and left (0.9-1.4), right (0.7-1.7) and left (0.7-1.3). The UtA-PI value was found higher among patients with pre-eclampsia and eclampsia, previous history of pre-eclampsia, poor foetal outcome and low birth weight baby compared to patients with good outcome. Measurement of the UtAPI in all the three trimester of pregnancy may be a useful technique for the screening of preeclampsia and eclampsia.

INTRODUCTION

Preeclampsia, classified among the gestational hypertensive disorders, emerges as a principal instigator of both maternal and perinatal mortality (comprising stillbirths and neonatal fatalities within the initial week following birth) as well as morbidity^[1-3].

Numerous uterine artery (UtA) Doppler investigations have conveyed findings indicating that within pregnancies culminating in pre-eclampsia (PE), particularly those necessitating untimely parturition, an elevation in the pulsatility index (PI) becomes evident during the sequential trimesters encompassing gestation. Nevertheless, the UtA-PI metric is reliant upon factors derived from maternal attributes and medical anamnesis, thereby necessitating the comprehensive incorporation of these covariate elements for the purpose of judicious utilization in risk stratification and screening endeavors.

In women who develop preeclampsia there is failure of trophoblast invasion of the uterine muscular wall with the result that the spiral arteries retain the muscle elastic coating and impedance to blood flow persists.

Doppler flow analyses of maternal uterine vasculature hold promise in identifying individuals predisposed to conditions such as preeclampsia. Furthermore, deviant uterine artery Doppler profiles across the triadic trimesters have exhibited correlations with subsequent perinatal adversities, including stillbirth, preterm birth and intrauterine growth restriction (IUGR).

Aims and objectives: To evaluate usefulness and correlation of uterine artery Pulsatility index with maternal characteristic and medical history and to determine the usefulness of this parameter in early diagnosis of pregnancy outcome.

MATERIALS AND METHODS

Study site: Department of Radiology, Medical College Vadodara, Vadodara.

Study duration: The study duration was between January 2021 and November 2021

Study population: Pregnant females coming to obstetrics and gynecology department of SSG Hospital, for ANC check up.

Inclusion criteria:

- Singleton pregnancy
- Gestational age from 11-14 weeks
- Known last menstrual period

Exclusion criteria:

- Hydrops fetalis
- Congenital malformation
- Twin pregnancy

Study design: Descriptive study.

Study procedure:

- In the first visit, at 11⁺⁰ to 13⁺⁶ weeks' gestation, maternal characteristics and medical history. Right and left uterine PI artery at site of crossing of uterine and external iliac artery is measured
- The patients will be followed up at 20-24 weeks and again at 32-34 weeks
- Patient with higher PI will be serially followed up till delivery
- Patient attributes encompassing maternal age, mode of conception (spontaneous or assisted conception involving ovulation-inducing agents or in-vitro fertilization), chronicles of chronic hypertension, antecedent history of pre-existing diabetes mellitus, incidences of systemic lupus erythematosus (SLE) or antiphospholipid syndrome (APS), obstetrical chronicle including parity, prior occurrences of preeclampsia in past pregnancies, gestational age at previous delivery, neonatal birth weight during the most recent pregnancy and temporal interval in years between the birth of the preceding offspring and the estimated conception date of the ongoing pregnancy. Maternal stature was measured during the initial consultation, while maternal weight was assessed during each subsequent visit
- The study was done on Philips Affinity 50 G ultrasound machine using probes of appropriate frequency
- The F forms were filled as per PC-PNDT rules and duly submitted every month

Measurement of uterine artery PI: The mother is placed in supine position and deep probe is placed gently over medial to crossing of uterine artery and external iliac artery and uterine artery waveforms were obtained at <60 degree inclination (ideally between 15-20 degree) and 1.5 mm sample gate. The waveform from uterine artery is characterized by systolic peak, early diastolic notch which disappears after 22-24 weeks of gestation. PI values were calculated (Fig. 1 and 2).

Statistical analysis: All data was analyzed using Descriptive statistics (frequency, percentage, mean, SD), Chi Square test. A p<0.05 was considered significant. Data acquired was entered in excel sheet and analyzed and data collected tabulated and presented in percentages.

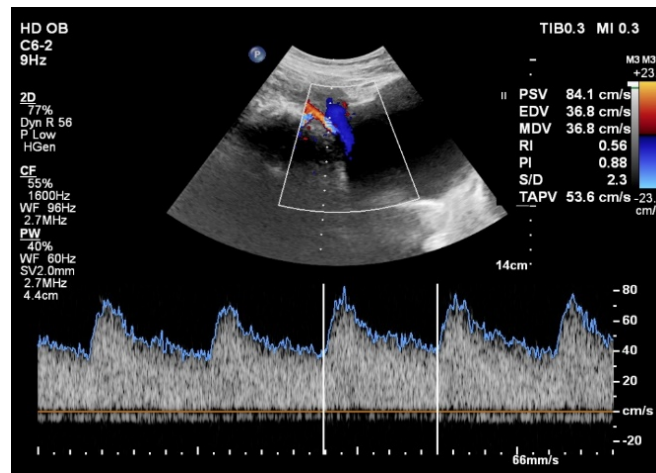


Fig. 1: Normal uterine artery doppler

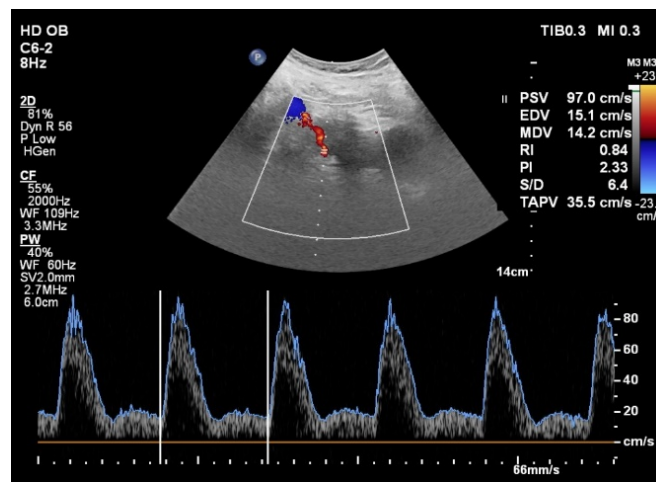


Fig. 2: Abnormal uterine artery doppler with high PI and early diastolic notch

Association of Uterine artery PI and maternal characteristics was tested by Chi square test.

Unpaired 't' test was used to compare sensitivity of Doppler velocimetry of uterine artery.

RESULTS AND DISCUSSIONS

Uterine artery Doppler waveforms hold the capacity to discern women afflicted by obstetric complications attributed to irregular placentation, given that Doppler ultrasonography serves as an efficacious modality for gauging uterine artery blood flow velocities. An anomalous velocity waveform is typified by heightened resistance to flow and/or an untimely diastolic notch (Table 1).

In present study, the UtA-PI value was found higher among patient with pre-eclampsia compared to patient with good outcome and the difference was found statistically significant in all the three trimesters ($p < 0.05$) (Table 2).

Alterations in uterine artery hemodynamic patterns occurring between the first and second trimesters exhibited associations with gestational hypertension and fetal growth restriction (Table 3)^[4].

A retrospective study conducted a comprehensive analysis of UtA-PI outcomes in a cohort of 5,887 gravid women during the latter stages of the second and third trimesters^[2]. Findings demonstrated an elevated propensity for the manifestation of gestational

Table 1: Distribution of patients according to UtA-PI

Pregnancy weeks	Uterine artery	UtA-PI	
		Mean	SD
11-14	Right	1.53	0.41
	Left	1.24	0.34
22-24	Right	1.40	0.44
	Left	1.15	0.31
32-34	Right	1.23	0.50
	Left	1.01	0.39

SD: Standard deviation

Table 2: Comparison of UtA-PI with Gravida

		Gravida				
		Primi (n = 51)		Multi (n = 104)		
Pregnancy weeks	UtA-PI	Mean	SD	Mean	SD	p-value
11-14	Right	1.62	0.42	1.49	0.41	0.060
	left	1.24	0.34	1.24	0.34	0.960
22-24	Right	1.46	0.36	1.37	0.47	0.266
	left	1.18	0.30	1.14	0.31	0.403
32-34	Right	1.28	0.42	1.21	0.53	0.458
	left	1.02	0.37	1.01	0.40	0.803

SD: Standard deviation

Table 3: Comparison of UtA-PI with pregnancy outcome

		Pregnancy outcome						
		Normal (n = 107)		Pre-eclampsia (n = 41)		Eclampsia (n = 7)		
Pregnancy weeks	UtA-PI	Mean	SD	Mean	SD	Mean	SD	p-value
11-14	Right	1.45	0.35	1.68	0.49	1.89	0.46	0.001
	left	1.15	0.29	1.42	0.32	1.53	0.53	0.0001
22-24	Right	1.25	0.33	1.77	0.46	1.60	0.32	0.0001
	left	1.05	0.25	1.38	0.28	1.34	0.51	0.0001
32-34	Right	1.05	0.33	1.68	0.58	1.41	0.31	0.0001
	left	0.87	0.25	1.36	0.45	1.16	0.51	0.0001

SD: Standard deviation

Table 4: Comparison of UtA-PI with Foetal Outcome

		Foetal outcomes				
		Good (n = 98)		Poor (n = 57)		
Pregnancy weeks	UtA-PI	Mean	SD	Mean	SD	p-value
11-14	Right	1.51	0.38	1.57	0.47	0.4000
	left	1.22	0.34	1.27	0.34	0.4760
22-24	Right	1.28	0.34	1.61	0.50	0.0001
	left	1.10	0.31	1.24	0.30	0.0080
32-34	Right	1.07	0.34	1.51	0.59	0.0001
	left	0.90	0.30	1.22	0.45	0.0001

SD: Standard deviation

Table 5: Comparison of UtA-PI with Foetal Birth Weight

		Foetal birth weight				p-value
		LBW (n = 33)		Normal (n = 122)		
Pregnancy weeks	UtA-PI	Mean	SD	Mean	SD	
11-14	Right	1.63	0.54	1.51	0.37	0.1470
	left	1.28	0.31	1.23	0.34	0.4070
22-24	Right	1.79	0.54	1.30	0.34	0.0001
	left	1.25	0.31	1.13	0.30	0.0380
32-34	Right	1.72	0.64	1.10	0.35	0.0001
	left	1.35	0.47	0.92	0.31	0.0001

SD: Standard deviation

hypertension in patients characterized by sustained increments in UtA-PI values in contrast to those devoid of such elevations (Table 4)^[5].

Foetal outcome was good (term baby) in 63.2% of the patients, 27.7% of the patients had preterm baby, 2.6% of the patients had post term baby and IUGR was occurred in 6.5% of the patients (Table 5).

The UtA-PI value was found higher among patient with poor foetal outcome (preterm, post term and IUGR) compared to patient with good foetal outcome (term). The difference was found statistically significant in the second and third trimesters ($p < 0.05$).

Jamal *et al.*^[6] ascertained that escalated uterine artery pulsatility index (UtAPI) measurements during the second and third trimesters of pregnancy exhibited a concomitant augmented susceptibility to adverse pregnancy outcomes.

Within the investigation conducted by Guzmán *et al.*^[3], the presence of aberrant uterine artery pulsatility index (UtAPI) values during the initial and third trimesters displayed a notable statistical distinction and was correlated with the occurrence of early-onset preeclampsia (PE).

The UtA-PI value was found higher among patient with low birth weight baby compared to patient with normal birth weight baby. The difference was found statistically significant in the second and third trimesters ($p < 0.05$).

CONCLUSION

Early recognition of women of preeclampsia will help in identifying high risk women who may benefit from early prophylaxis and enhanced surveillance. Abnormal uterine artery Doppler studies in all the

three trimester have been associated with subsequent adverse pregnancy outcomes including preeclampsia, fetal growth restriction and perinatal mortality. In conclusion, the measurement of the UtAPI in all the three trimester of pregnancy may be a useful technique for the screening of preeclampsia and eclampsia. Further studies are recommended to validate the predictive and prognostic ability of UtAPI in each trimester regarding adverse pregnancy outcomes in combination with other PE predictors.

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