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To study the role of spiral, uterine artery doppler in early second trimester to predict hypertensive disorders of pregnancy

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Abstract

Aims and Objectives: To study the usefulness of uterine artery diastolic notch in second trimester for early prediction of Hypertensive disorders of pregnancy and its associations with gestational age of onset of hypertension, delivery and Low birth weight.

Methodology: This was an Observational prospective case control study performed on 184 antenatal women. The presence of a uterine artery doppler diastolic notch of >50% was assessed at 13-16th week of gestation. Spiral artery doppler was also assessed. Blood pressure at each antenatal visit was recorded and gestational age of development of hypertension and delivery was noted. Results were calculated using Statistical Program for Social Science (SPSS) version 20.0.

Results and Conclusion: Out of 39 women with notch (+), hypertension developed in 24 women (61%) thus proving that presence of a uterine artery diastolic notch is an indicator for subsequent development of hypertension (p-value < 0.0001, statistically significant). The overall sensitivity, specificity, positive and negative predictive value and accuracy of the test was 61.5%, 91.7%, 66.7% and 89.9%, 85.3%.

Keywords: Notch, pre-eclampsia, low birth weight

Introduction

Pregnancy-related hypertensive disorders continue to rank among the most important complications in obstetrics. One of the most common problems associated with pregnancy is pregnancy-induced hypertension, which affects between 10 and 12% of pregnancies worldwide. In India, the prevalence of hypertensive diseases is 15.2% nationwide, with primigravida women experiencing four times the frequency compared to multipara^[1]. For a woman who previously had normal blood pressure, after 20 weeks of gestation, is considered to have gestational hypertension if her blood pressure increases to 140 mm Hg or greater during the systolic or 90 mm Hg during diastolic or both, occurring twice with a minimum gap of 4 hours. Preeclampsia is a condition linked to newly developed hypertension that often develops before term and usually beyond 20 weeks of pregnancy. While proteinuria is frequently the first indication of preeclampsia, some women may have raised blood pressure and other preeclamptic indicators in the absence of proteinuria^[2]. The three main categories of pregnancy-induced hypertension are pre-eclampsia, eclampsia, and gestational hypertension^[3]. When trophoblasts invade the uterine spiral arteries, compliance rises significantly, allowing for a greater placental blood supply. Failure of this process results in the continuity of high resistance blood flow and early notch in the diastolic wave, which can be observed by uterine artery Doppler flow tests. As a preliminary screening tool for PIH, Doppler ultrasonography measurement of uterine artery resistance in the second trimester has been employed^[4]. Pregnancy-related hypertension increases the risk of developing eclampsia, abruptio placentae, disseminated intravascular coagulation, pulmonary oedema, blindness, cerebrovascular accidents, HELLP syndrome, growth limitation in the foetus, and foetal death^[5-6].

The use of angle-independent Doppler indices largely avoids the measurement errors associated with Doppler blood flow volume measurement and parameters like the systolic/diastolic ratio (S/D ratio), resistance index (RI), or pulsatility index (PI) have been widely used^[7-8].

History of Preeclampsia in past pregnancy, Chronic hypertension, Overt diabetes, Gestational diabetes mellitus, Thrombophilia's, Systemic lupus erythematosus, Antiphospholipid antibody syndrome, Body Mass Index exceeding 30, obesity, Obstructive sleep apnoea, Primigravida's,

mother's aged more than 35 years, assisted methods of reproduction and twin pregnancy are some of the risk determinants of pre-eclampsia. Presence of mean arterial pressure more than or equivalent to 90 mm of Hg in the second trimester, a roll over test from left lateral to supine position which raises the diastolic pressure by 20 mm of Hg, increase in serum uric acid and presence of urine albumin, Doppler ultrasound showing high pulsatility index, reversal/absent of end-diastolic flow in the umbilical artery, serum plasma associated protein A levels are a few tests used in the prognosis of pre-eclampsia [9-10].

The present analysis aims to investigate if the development of preeclampsia can be predicted by spiral artery doppler and uterine artery doppler notching obtained during the early stages of the second trimester.

Materials and Methods

This was an Observational prospective non interventional case control study conducted at Tata Motors Hospital, Jamshedpur during the period between June 2022-March 2024 after obtaining ethical clearance. Spiral and uterine artery doppler were performed on 184 antenatal women between 13-16 weeks of gestation after explaining the primary and secondary objectives and taking a written informed consent.

Inclusion criteria

- 1) Singleton pregnancy
- 2) Both primigravida and multigravida
- 3) Normotensive patients.
- 4) Women with IVF pregnancies were also included.

Exclusion criteria

1. Women with multifetal pregnancy
2. Pregnant patients with chronic hypertension.
3. Women who were lost to follow-up.
4. Patients with congenital fetal anomalies and uterine anomalies
5. Patients who had spontaneous abortions before 20 weeks of gestation.
6. Pregnancies with fetal chromosomal anomalies.
7. Pregnancies with Intrauterine fetal death.

Procedure

GE Voluson P8 ultrasound machine was used with a transabdominal sector transducer operating at 3.5-5.0 MHz the patient was made to lie supine in order to acquire a sagittal view. The probe was positioned above the inguinal ligament in the left and right iliac region. The probe was pointed at the uterine lateral wall and downward toward the pelvis [11, 12]. The uterine artery divides from the internal iliac artery at the point where the uterine isthmus and cervix meet, entering the myometrium [13]. Cervix and internal os were identified at the sagittal view. The vessels were visualized with color flow.

At the level corresponding to the internal os, the uterine artery was identified close to the cervix. A doppler was utilized and 2 mm sampling gate with an isonation of less than 30° covered the entire vessel [14]. The presence of uterine artery diastolic notch with a fall of at least 50 cm/sec from the maximum diastolic velocity in bilateral uterine arteries was taken as notching present [15].

The spiral artery, branch of uterine artery was identified and studied at the junction of the decidua basalis and basal placental plate at the point where the flow becomes unidirectional and identified by a single color in doppler waveform [16].

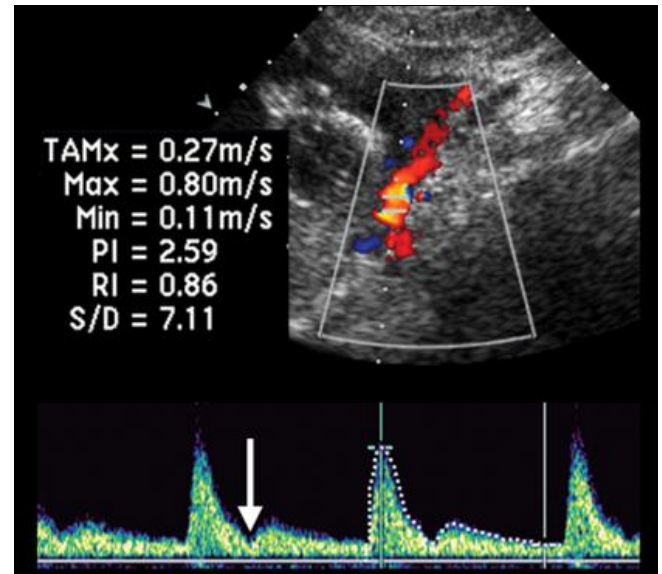


Fig 1: Color Doppler duplex USG image shows an abnormal waveform with presence of notch (arrow) in uterine artery diastolic wave

The women with pathological uterine artery notching (cases) and the women without a notch (controls) were followed up in each pre-natal visit with further measurement of blood pressure and urine albumin. Association between presence/absence of notch with a) Development of hypertension, b) Maternal age, c) Gestational age of development of hypertension, d) Delivery before and after 34 weeks of gestation and, e) Birth weight of foetus was studied.

Results

For statistical analysis data was analysed by SPSS and Graph Pad Prism version 5. Chi-square test or Fischer's exact test was used as appropriate.

Table 1: Association between Age group and presence of notch

Age in Group	Notch + VE (39)	Notch-VE (145)
< 25	15(38.5%)	47(32.4%)
25-30	15(38.5%)	65(44.8%)
>31	9 (23.1%)	33(22.8%)

We divided our study population (184) into 2 groups: Group A (case) who showed the presence of uterine artery notch (39) and Group B (control) who did not show the presence of uterine artery notch (145). In group A, 15 (38.5%) women were under the age of 25, 15 (38.5%) women were of age 25-30 years and 9 (23.1%) women were \geq 31 years of age. In group B, 47 (32.4%) women were under the age of 25, 65 (44.8%) women were of age 25-30 years and 33(22.8%) women were \geq 31 years of age.

Table 2: Association between Notch and hypertension

Blood pressure	Notch + (39)	Notch (145)
Normotensive	15(38.5%)	133(91.7%)
Hypertension	24(61.5%)	12(8.3%)

In Group A, out of 39 women with presence of notch, 24(61.5%) women developed hypertension whereas 15(38.5%) did not develop hypertension. In Group B, out of 145 women without presence of notch, 12(8.3%) women developed hypertension whereas 133(91.7%) did not develop hypertension.

Table 3: Association between notch and gestational age of developing hypertension

Gestational age of developing hypertension	Notch + (24)	Notch (12)
20-28	2(8.3%)	2(16.7%)
28-34	12(50%)	8(66.7%)
>34	10(41.6%)	2(16.7%)

Table 4: Association between notch and Gestational age at which antenatal women delivered and birth weight (kgs).

Notch	Gestational age of developing hypertension		Birth weight	
	<34 weeks	>34 weeks	<2.5 kg	>2.5 kg
Present	1	38	7	32
Absent	5	140	23	122

The association of age group 25-30 years was statistically significant with the presence of uterine artery notch (p value = 0.0329). The presence of notch and subsequent development of hypertension was also statistically significant (p-value: < 0.0001)

The association of presence of notch and development of hypertension between 28-34 weeks of gestation was statistically significant (p-value < 0.0001). The association of notch with gestational age at delivery and birth weight was not statically significant.

Our test showed an overall sensitivity of 61.5%, specificity of 91.7%, PPV of 66.7%, NPV of 89.9% and accuracy of 85.3%.

Discussion

The validity of uterine artery doppler parameters has been utilized in various studies to predict adverse antenatal outcome [17]. In our study population of 184, 39 women showed the presence of uterine artery notch, of which 24(61.5%) women developed hypertension. The age group of 25-30 yrs was most associated with notching. Out of the women with notch, hypertension developed in 12 (50%) between 28-34 weeks of gestation.

Muara Panusunan Lubis *et al.* [18] conducted a study on 70 antenatal women. 35 women in this study showed the presence of notch while 35 women did not have any evidence of notching. The number of pregnant women < 35 years were 62(77.5%) which was similar to our study. Maud D. van Zij *et al.* [19] conducted a study on 6996 women. Women having a bilateral notch were substantially younger than women with a unilateral notch or with absence of a notch (30.6 vs 30.8 and 31.8 years for unilateral and no notch. JAG Alves *et al.* [20] did a uterine artery ultrasound on 6579 antenatal women and significant complication was seen in 57% of women with bilateral notches. The number of women < 35 years of age were 5881(89.3%), higher than our study.

Soheley Sultana *et al.* [21] performed USG on 40 subjects in Dhaka over a period of 6 months. Early diastolic notch was present in (36) 90% women who later developed preeclampsia. Thawalwong Ratanasiri *et al.* [22]. analyzed the presence of diastolic notch in the uterine artery in 378 antenatal women. Out of these, 51 women had uterine artery notching. 11 subjects (22%) later developed pre-eclampsia which was significantly less than our performed study. Uludag S *et al.* [23] did a study on 80 women with levels of MSAFP during weeks 15-18 of pregnancy along with bilateral uterine artery notch at 20 weeks of gestation. 17 cases (75%) showed the presence of notch.

Wu JN *et al.* [24] did a study on 31,291 women. 1781 (118) women eventually preeclampsia after 24 weeks of gestation the scan with an incidence of 5.7%. Shagufta T *et al.* [25] reported a

study on 160 women. Mean gestational age at which pre-eclampsia developed was 33.12±2.54 weeks. Barati *et al.* [26] reported in their study that 17% patients developed preeclampsia before 32 weeks period of gestation with abnormal uterine artery indices. Parra-Cordero M *et al.* [27] made a predictive algorithm on 5367 women with transvaginal Doppler between, 11 to 13±6 weeks.

The gestational age of Delivery at < 37 weeks was seen in 17% women with late onset pre-eclampsia. In the study done by Pettit *et al.* [28], with the case group (n = 696), demonstrated that the early commencement of preeclampsia had a period of gestation of delivery at 33 weeks in contrast to late-onset of preeclampsia and a higher incidence of caesarean section (70%) in these women. José P *et al.* [29] performed a study on 629 subjects. The outcomes were published as per the range of gestational age (less than 34 weeks and between 34 to 37 weeks) maternal and neonatal consequences, as per the time of birth, needing immediate delivery. Before 34-week period of gestation, the neonatal outcomes were considerably inferior when prompt delivery was done.

Between 34 to 37 weeks, women who underwent expectant management-eclampsia progressed to severe form. Trudinger *et al.* [30] described uteroplacental insufficiency as changes in doppler waveforms in 12 normal and 91 complicated pregnancies from 20 weeks of pregnancy. Decrease in blood flow during diastole in the uterine artery was associated with intrauterine growth restriction and pre-eclampsia. Fleischer *et al.* [31] analyzed uterine artery Doppler in antenatal women in second and third trimesters in the United States of America. A notch in the waveform resulted in stillbirth, pre-term delivery and intrauterine growth restriction. A uterine artery notch was associated with a higher frequency of Pre-eclampsia, preterm birth, and intrauterine growth restriction according to a study done by Konchak *et al.* [32]. A bilateral end-diastolic notch is associated with reduction in perfusion at the site of placentation. This resulted in uteroplacental insufficiency according to the study by Espinoza *et al.* [33] and ultimately intrauterine growth restriction. It was found that the presence of bilateral end-diastolic notch would be useful to predict the incidence of preterm delivery by 31.4% sensitivity and 58% AUC according to Van Zijl *et al.* [34]

Silviaawor *et al.* [35] concluded in her study that 9% of participants who showed the presence of an end-diastolic notch (11.0% bilateral) had a prevalence of 5.7% of (39 out of 687) neonatal birth weight < 2.5 kg at term.

As per the above studies, it is hence seen that uterine artery notch when used with other indicators like P.I, R.I, S/D Ratio gives a better prediction of the development of pre-eclampsia when done in the first half of the second trimester.

Notching can be due other causes of uteroplacental insufficiency like Diabetes mellitus, TORCH infections etc which need to be identified. Another limitation of this study was that women with multifetal gestation were not included, who are at more risk of developing hypertension.

Conclusion

Since Doppler ultrasound accurately predicts high resistance in uteroplacental circulation, the results depicted in our study suggest that uterine artery diastolic notch can be used as a reliable index to predict hypertensive disorder of pregnancy. Uterine artery diastolic notch along with other parameters like P.I and R.I in the spiral arteries doppler can be used for increased accuracy.

Conflict of Interest

Not available

Financial Support

Not available

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