

Doppler study among high risk mothers in late second trimester for predicting vulnerability of preeclampsia

Dr. Jiban Kumar Mandal¹, Dr. Meghna Mondal²

¹Department of Obstetrics & Gynaecology, Durgapur Subdivision Hospital, India

²Department of Obstetrics & Gynaecology, Bankura Sammilani Medical College & Hospital, India

Abstract

Background: Preeclampsia remains a major cause of maternal and perinatal mortality and morbidity in developing country. Although it is a heterogeneous disease, it is believed to result from impaired placentation. Pregnancies that are destined to result in normal term deliveries show increased diastolic blood flow and loss of early diastolic notch by 22-26 weeks of gestation, while pregnancies that show persistent high resistance waveform with early diastolic notches are at risk of preterm delivery due to preeclampsia, abruption & IUGR. Women who have failed to modify uterine artery blood flow by 20 weeks represent one of the highest risk group in pregnancy particularly for the development of preterm delivery, IUGR, early onset preeclampsia. It is therefore logical that many studies had focused on uterine artery Doppler as a screening test of women at risk to develop preeclampsia. Clinician could then identify women who require close antenatal surveillance and allow early referral for timely delivery, when sign and symptoms occur.

Materials and Methods: In this prospective hospital based observational study, 90 high risk mothers were selected from outpatient department. All of them were subjected to Color Doppler examination, using a 3.5-MHz transducer and medium filter. During examination patient were in supine position and fetus in quiet resting state. The flow velocity waveforms was recorded over the Uterine artery. Impedence of diastolic flow in the uterine artery waveform is manifested as a notch over the diastolic wave. The test was taken positive whenever a notch was present unilateral or bilateral. The first Doppler study of **uterine artery** was done in between 22 to 26 weeks. The cases were divided into two groups: **GROUP A:** where notching was detected. **GROUP B:** where notching was not detected. All the cases were followed up (Group A and Group B) clinically and laboratory test for complications such as Preeclampsia.

Results: Notch positive Cases at 22-26 weeks where preeclampsia did not develop were 20(27.4%). Notch positive cases where preeclampsia did developed were 13(76.5%). Association of presense of uterine artery notch at 22-26 weeks vs. preeclampsia statistically significant ($p=0.0001$).

Conclusion; The sensitivity, specificity of a diastolic notch over uterine artery at 22 to 26 weeks is fairly predictive for development of preeclampsia in later weeks of pregnancy and hence can be used as a screening test among high risk mothers.

Key word: diastolic notch, preeclampsia, antenatal surveillance

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I. Introduction

Preeclampsia remains a major cause of maternal and perinatal mortality and morbidity in the developing world¹. Although it is a heterogeneous disease, it is believed to result from impaired placentation². Pregnancies that are destined to result in normal term deliveries show increased diastolic blood flow and loss of early diastolic notch over the uterine artery waveform by 22 weeks of gestation, while pregnancies that show persistent high resistance waveforms with early diastolic notches are at risk of preterm delivery due to preeclampsia, abruption & iugr. Women who have failed to modify uterine artery blood flow by 20 weeks represent one of the highest risk group in pregnancy particularly for the development of preterm delivery, Iugr, early onset preeclampsia³. It is therefore logical that many studies had focused on uterine artery Doppler as a screening test for women at risk to develop preeclampsia. Clinician could then identify women who require close antenatal surveillance and allow early referal for timely delivery, when sign symptoms occurs³. Second trimester uterine artery pulsatility index (PI) may add more information to the prediction process of preeclampsia.⁴ There is not much difference between the abnormal pulsatility index values of the uterine artery Doppler from 16 to 19 weeks of gestations.^{5,6} Because the pathophysiology of preeclampsia is incomplete trophoblastic invasion to the spiral arteries leads to a decrease in uteroplacental circulation. It would be possible that the test becomes one of the screening methods for preeclampsia^{7,8,9}. The trophoblast normally invades the decidual portion of the spiral arteries beginning by eighth week and this invasion is usually complete by the

thirteenth week. After this time the second stage of spiral artery invasion starts in, whereby the myometrial portion of the spiral arteries are similarly invaded by the trophoblast. This is usually completed by 18 to 19 weeks but may be delayed upto 22 to 24 weeks. In an overwhelming majority of preeclampsics, this transformation does not occur in the spiral artery bed leading to increased resistance to flow into the intervillous space. The method of choice to indirectly monitor the status of spiral artery bed is by uterine artery waveform¹⁰. Increased uterine artery velocimetry determined by doppler ultrasound in the first and middle trimester should provide indirect evidence of this process and thus serve as a predictive test for preeclampsia. Performing uterine artery doppler studies at 23- 26 weeks' gestation instead of 19- 22 weeks' gestation increases the predictive value for adverse pregnancy outcomes¹¹. The current study aims at identifying any correlation which might at all exist with late second trimester doppler indices of uterine artery, umbilical artery with subsequent development of preeclampsia in later months of pregnancy among selected pregnant population who are epidemiologically said to be at high risk. It has been estimated that more than 14% (58,000) of maternal deaths/year worldwide are due to eclampsia and preeclampsia, but in developed countries, it mainly affects fetus¹². The incidence of preterm birth due to preeclampsia is around 15%¹³.

II. Materials & Methods

This prospective hospital based observational study was carried out on patients of department of Obstetrics & Gynaecology at Bankura sammilani medical college, Bankura, west Bengal from February 2018 to July 2019. A total of 90 adult subjects were for in this study.

Study design: A prospective hospital based observational study.

Study location: This was a tertiary care teaching hospital based study done in department of Obstetrics & Gynaecology, at Bankura sammilani medical college, Bankura, West Bengal.

Study location: February 2018 to July 2019

Sample size: 90 patients.

Sample size calculation: Sample size (for each arm) = $N = (Z_{\alpha} + Z_{\beta})^2 \times (p_1q_1 + p_2q_2) / D^2$, $Z_{\alpha} = 1.96$ (two tailed) at 95% confidence interval (CI), $Z_{\beta} = 0.84$ at 80% power of test. P = proportion of mother showing the event of interest, q_1 & q_2 = complements of p_1 & p_2 = $(100 - p_1)$ & $(100 - p_2)$. D = effect size = minimum difference between the proportion to obtain optimum clinical benefit hence it is assumed to be 25, $p_1 = 48.1$ (notch present), $p_2 = 9$ (notch absent), $q_1 = 51.9$, $q_2 = 91$. After putting the value $N = (1.96 + 0.84)^2 \times (48.1 \times 51.9) + (9 \times 91) / 25^2 = 41$. So total sample size = $41 \times 2 = 82$, Considering 10% nonresponse rate, the revised sample size = 90

Subjects & selection method: The study population was drawn from consecutive high risk mothers who presented to Bankura Sammilani Medical College outpatient department. ninety such mothers were selected. All of them were subjected to Color Doppler examination, using a 3.5-MHz transducer and medium filter. During examination patient were in supine position and fetus in quiet resting state. The flow velocity waveforms was recorded over the Uterine artery. Impedence of diastolic flow in the uterine artery waveform is manifested as a notch over the diastolic wave. The test was taken positive whenever a notch was present unilateral or bilateral. The first Doppler study of **uterine artery** was done in between 22 to 26 weeks. The cases were divided into two groups: **GROUP A:** where notching was detected. **GROUP B:** where notching was not detected.

Inclusion criteria

1. Elderly Primi age >35years
2. Prior history of preeclampsia
3. Prior IUGR
4. Diabetes Melitus
5. Vascular disease
6. Prior history of preterm delivery
7. Overweight (BMI>25).

Exclusion criteria:

1. Multifetal Pregnancies
2. Pregnancy with diagnosed fetal anomalies
3. Smoking history of mother
4. Patients on treatment for hypertensive disorder
5. Patients not willing to participate.

Procedure Methodology

Ninety such mothers were selected. All of them were subjected to Color Doppler examination, using a 3.5-MHz transducer and medium filter. During examination patient were in supine position and fetus in quiet

resting state. The flow velocity waveforms was recorded over the Uterine artery. Impedence of diastolic flow in the uterine artery waveform is manifested as a notch over the diastolic wave. The test was taken positive whenever a notch was present unilateral or bilateral. The first Doppler study of **uterine artery** was done in between 22 to 26 weeks. The cases were divided into two groups: **GROUP A:** where notching was detected . **GROUP B:** where notching was not detected.

All the cases were followed up (Group A and Group B) clinically and laboratory test for complications such as Preeclampsia.

Statistical analysis

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS (version 24.0; SPSS Inc., Chicago, IL, USA) and Graph Pad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. A chi-squared test (χ^2 test) was any statistical hypothesis test wherein the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true. Without other qualification, 'chi-squared test' often is used as short for Pearson's chi-squared test. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate. Once a *t* value is determined, a *p*-value can be found using a table of values from Student's *t*-distribution. If the calculated *p*-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favour of the alternative hypothesis. *p*-value \leq 0.05 was considered for statistically significant.

III. Result

3 (3.3%) patients had chronic hypertension, 43 (47.8%) patients had prior history of preeclampsia, 8(8.9%) patients had prior IUGR and 2(2.2%) patients had vascular disease

Table 1: DISTRIBUTION OF RISK FACTORS IN HIGH RISK GROUP

Risk factors in high risk group	Frequency	Percent
CHRONIC HYPERTENSION	3	3.3%
DIABETES MELITUS	3	3.3%
ELDERLY PRIMI	8	8.9%
INFERTILITY	3	3.3%
OVERWEIGHT	11	12.2%
PRIOR H/O BOH	6	6.7%
PRIOR H/O PRETERM	3	3.3%
PRIOR HISTORY OF PREECLAMPSIA	43	47.8%
PRIOR IUGR	8	8.9%
VASCULAR DISEASE	2	2.2%
Total	90	100.0%

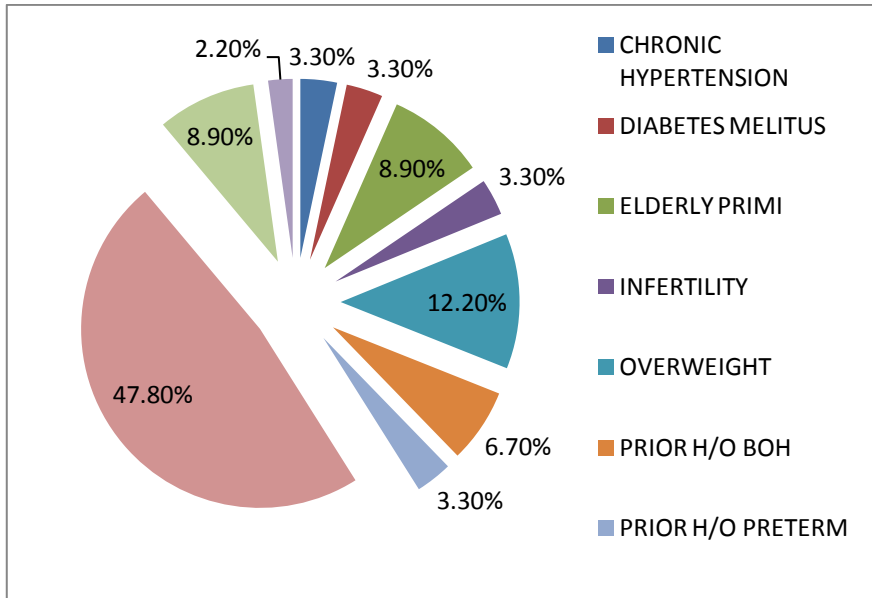
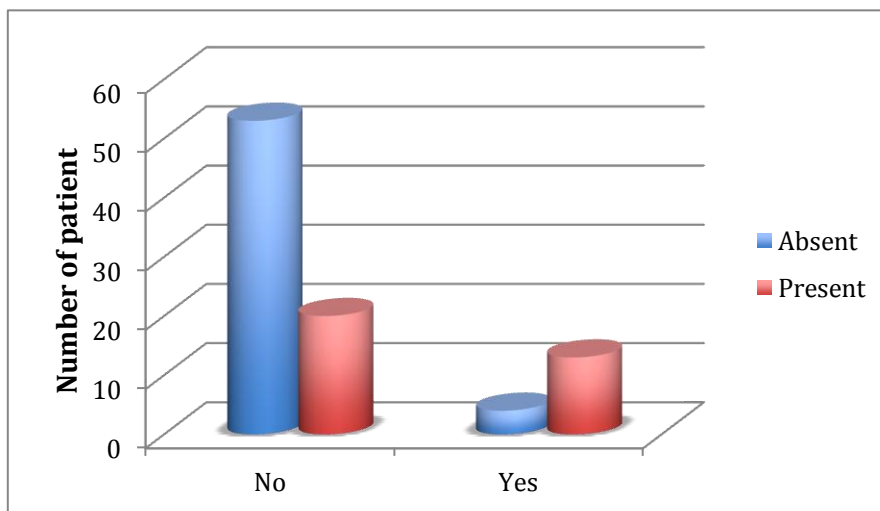


Table 2: ASSOCIATION BETWEEN UTERINE ARTERY NOTCH AT 22-26 WEEKS vs. PREECLAMPSIA

PREECLAMPSIA			
Uterine artery notch AT 22-26WKS	No	Yes	TOTAL
Absent (Group B)	53	4	57
Row %	93.0	7.0	100.0
Col %	72.6	23.5	63.3
Present (Group A)	20	13	33
Row %	60.6	39.4	100.0
Col %	27.4	76.5	36.7
TOTAL	73	17	90
Row %	81.1	18.9	100.0
Col %	100.0	100.0	100.0

Chi-square value: 14.2994; **p-value:**0.0001

Notch positive Cases at 22- 26 weeks where preeclampsia did not develop were 20(27.4%). Notch positive cases where preeclampsia did developed were 13(76.5%) . Association of presense of uterine artery notch at 22-26 weeks vs. preeclampsia statistically significant (p=0.0001).



IV. Discussion

In this study women at the antenatal OPD were stratified for high risk factors before enrolling. Out of 90 enrolled mothers the high risk factors were overweight (12.2%), Prior IUGR(8.9%), diabetes mellitus(8.9%), maternal chronic hypertension and vascular disease were only a few 3% and 2% respectively.(Table 1)

Table 2 show us that on second trimester (22 to 26 weeks) doppler study : Diastolic notch over uterine artery was positive in 33 (36.7%) cases i.e **Group A** and notch negative in 57(63.5%) cases i.e **Group B**, but ultimately at the end of the study 17 mothers developed preeclampsia out of whom 13 were notch positive (i.e **true positive**) and 4 notch negative (i.e **false negative**.) Those 57 cases who were notch negative initially 53 of them had no preeclampsia hence **true negative** and out of 33 cases (Group A) who were notch positive initially 20 did not have preeclampsia and hence **false positive**. Therefore the **sensitivity** to predict preeclampsia with the presence of early notch is **76.4%**; **specificity 72.6 %**; **positive predictive value 39.3%** and **negative predictive value 92.9 %** in the current study.

Ashnafi N, Hajina K¹⁴ et al in 2011 in their study found a sensitivity of second trimester uterine artery notching for subsequent development of preeclampsia in late pregnancy as 72.2% and specificity 73.1% and positive predictive value 48.1 % and negative predictive value 88.3%. Compared to this the current study shows a very near and comparable results.

Coleman et al¹⁵ in new Zealand (in the year 2000) while studying mid trimester uterine artery Doppler waveform as a predictor of adverse pregnancy outcome among high risk women reported 40% incidence of diastolic notch. EL- Hamedji et al⁷ in 2005 in UK undertook a prospective analysis of the role of uterine artery Doppler waveform notching in the assessment of at risk pregnancies found an incidence of notching as 38% . Coleman et al¹⁵ reported a sensitivity , specificity , PPV, NPV of 62% , 89% , 47% and 94% respectively in the diagnosis of preeclampsia where the notching was noticed in bilateral uterine arteries and patient had early onset preeclampsia which led to delivery before 34 weeks ; In our study we have taken both unilateral and bilateral notching an hence the difference. None of the above mentioned authors recommended Doppler uterine artery notching a routine screening test for all pregnant women.

V. Conclusion

The sensitivity, specificity of a diastolic notch over uterine artery at 22 to 26 weeks is fairly predictive for development of preeclampsia in later weeks of pregnancy and hence can be used as a screening test among high risk mothers.

Reference

- [1]. Antsaklis A et al. Uterine artery Doppler in the prediction of preeclampsia and adverse pregnancy outcome. Donald School Journal of Ultrasound in Obstetrics and Gynaecology. April-June 2012;4(2):117-122.
- [2]. Barbieri C. Doppler ultrasound in high risk pregnancies. Department of ObstetGynecolof the Center for Integral Attention to Women's Health. [Last accessed on 2010 Oct 6]
- [3]. Barati M, Shahbazian N, Ahmadi N, Masihi S. Diagnostic evaluation of uterine artery Doppler sonography for the prediction of adverse pregnancy outcomes. J Res Med Sci.2014 Jun;19(6): 515-519.
- [4]. Toal M, Keating S, Machin G, Dodd J, Adamson SL, Windrim RC, et al. Determinants of adverse perinatal outcome in high — risk women with abnormal uterine artery Doppler images. Am J Obstet Gynecol. 2008;198:330.e1–330.
- [5]. Gómez O, Figueras F, Fernández S, Bennasar M, Martínez JM, Puerto B, et al. Reference ranges for uterine artery mean pulsatility index at 11–41 weeks of gestation. Ultrasound Obstet Gynecol. 2008;32:128–32.
- [6]. Sritippayawan S, Phupong V. Risk Assessment of Pre-eclampsia in Advanced Maternal Age by Uterine Arteries Doppler at 17-21 Weeks of Gestation. J Med Assoc Thai. 2007;90:1281–6.
- [7]. EL- Hamedji, S. Shillito, N.A. Simpson, J.J. Walker Prospective analysis of the role of uterine artery Doppler waveform notching in the assessment of at risk pregnancies. Hypertens Pregnancy, 24 (2005), pp. 137-145
- [8]. R. AxtFliedner, A. Schwarze, I. Nelles, C. Altgassen, M. Friedrich, W. Schmidt, et al. The value of uterine artery Doppler ultrasound in the prediction of severe complication in a risk population. Arch GynecolObstet, 271 (2005), pp. 53-58
- [9]. M.J. Nagtegaal, S. van Rijswijk, S. Mc Gavin, G. Dekker Use of uterine Doppler in a Australian level II maternity hospital Aust N ObstetGynecol, 45 (2005)
- [10]. Roberts, J. M. (1998).Pregnancy related Hypertension in Maternal Fetal Medicine, (Creasy, R.K and Resnik., eds.), page 883-872.4th Edition.W .B. Saunders, Philadelphia.
- [11]. Schwarze A, Nelles I et al. Doppler ultrasound of the uterine artery in the prediction of severe complications during low risk pregnancies. British Journal of Obstetrics and Gynecology,2000 February; 107(2):196-208. PMID: 15185101
- [12]. WHO, 2004. Betesda, MD. Global burden of disease for the year 2001 by World Bank region, for use in disease control priorities in developing countries, National Institutes of Health: WHO. Make every mother and child count. World Health Report, 2005, Geneva: World Health Organisation, 2005. 2ndEdition.
- [13]. Roberts, J. M. (1998).Pregnancy related Hypertension in Maternal Fetal Medicine, (Creasy, R.K and Resnik., eds.), page 883-872.4th Edition.W .B. Saunders, Philadelphia.
- [14]. Asnafi N et al, Mid trimester uterine artery Doppler ultrasound as a predictor of adverse obstetric outcome in high risk pregnancy. Taiwan J Obstet Gynecol. 2011 March;50(1):29-32. doi: 10.1016/j.tjog.2009.08.002. PMID:21482371
- [15]. M. A Coleman, L. M McCowan , R. A north Mid trimester uterine artery as a predictor of adverse pregnancy outcome in high risk women . Ultrasound ObstetGynaecol, 15(2000), pp.7-12.