Original Article

Prediction of Preeclampsia in Pregnant Population Using Diastolic Notch of Uterine Artery by Duplex Color Doppler Study

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Abstract

Background*: Use of Duplex Color Doppler Sonography is gaining increasing popularity for assessment of blood vessels in various disease processes around the world. The past 20 years have seen an enormous growth in both technical aspects of Doppler ultrasound and its application in obstetric and fetal medicine.* ***Objective****: This cross-sectional study was carried out to observe Doppler wave form in subjects with preeclampsia. Specific objective was to see RI and PI in different groups of study subjects from 24th to 37th weeks and find out significant difference of different Doppler indices between two groups (i.e., to calculate the proportion of subjects having early diastolic notch in two groups).* ***Materials and Methods****: Enrolling 40 subjects with preeclampsia, this study was done in the Department of Radiology & Imaging, Dhaka Medical College Hospital, Dhaka, over a period of six months from 20th June 2014 to 19th December 2014. A total number of 40 normal pregnancies were also included for comparison.* ***Results****: Majority (35% in normal and 37.5% in preeclampsia) of the respondents were found in the age group of 21−30 years. Unpaired t-test revealed no significant difference between mean age of two groups. Among normal group, mean±SD of PI and RI were 1.12±0.0846 and 0.571±0.058 respectively and in preeclamptic group mean PI and RI were 2.497±0.369 and 0.8255±0.087. There was statistically significant (by unpaired t-test) difference in mean Doppler indices between these two groups. Early diastolic notch was found in 90% subjects with preeclampsia and 5% subjects with normal pregnancy. Chi-square test showed that there was statistically significant difference regarding presence of early diastolic notch between normal regarding subjects and subjects with preeclampsia.* ***Conclusion****: From the study result it was concluded that Doppler indices with presence of early diastolic notch are reliable indicators for early detection of preeclampsia.*

Key words*: Duplex Color Doppler; Uterine Artery; Preeclampsia; Pregnant Women*

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Introduction

Among the various imaging tools in the department of Radiology & Imaging, use of Duplex Color Doppler Sonography is gaining increasing popularity for assessment of blood vessels in various disease processes around the world. The past 20 years have seen an enormous growth in both technical aspects of

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Doppler ultrasound and its application in obstetric and fetal medicine. Vessel assessment is now much easier than ever before without involvement of radiation and contrast media. Doppler ultrasound has important screening and diagnostic capabilities.[1-3] In addition Doppler ultrasound has an important contribution to the surveillance of fetus compromised by intrauterine growth retardation (IUGR) and to assess fetal structural abnormalities and complex disease processes.[1,3-5]

The uterine artery usually arises from the anterior division of the internal iliac artery and commonly anastomoses with the ovarian artery. It is the major blood supply to the uterus and enlarges significantly during pregnancy.[6]

Spectral wave of the uterine artery and vein can usually be easily obtained by using Doppler ultrasound.[2,7] Furthermore, the uterine artery notch can be made visible through this ultrasound, which is found significantly associated with higher risk of preeclampsia in general pregnant population.[8]

Several studies show Doppler ultrasound in first trimester does not have any impact on pregnancy outcome. But Doppler ultrasound in 2nd and 3rd trimester plays vital role in determining fetal outcome. Doppler wave form showing increased resistance to flow in 2nd and 3rd trimesters are associated with poor pregnancy outcome.[3] For this Continuous Wave Doppler, Pulsed Doppler, Color Flow, Powered Doppler are utilized to measure PSV, EDV, PI, RI, and S/D ratio.[4,9]

Despite recent advances in antenatal care, pre-eclampsia has remained a major cause of maternal and perinatal morbidity and mortality. Hypertension in pregnancy is responsible for 18% of fetal (>19 weeks of gestation) and infant mortality and 46% of infants born small for gestational age.[9,10] Early screening for preeclampsia may allow vigilant antenatal surveillance and appropriate timing of fetal delivery in order to avoid serious sequele. Unfortunately, various hemodynamic and biochemical measures have been found to have limited accuracy as screening measures for this condition.

Preeclampsia is characterized by an imbalance between prostacyclin and thromboxane production[5] as well as failure of the second wave trophoblastic invasion of the endometrio-myometrial vasculature. The result is abnormal uteroplacental blood flow, and this has led to the idea of using Doppler assessment of uterine artery velocity waveforms as a method of screening for this antenatal complication.[6] An abnormal test result is represented by either an abnormal flow velocity ratio (systolic to diastolic velocity [S/D] ratio, diastolic to systolic velocity [D/S] ratio) or resistance index or the presence of an early diastolic notch.[11-13]

Study was carried out for early diagnosis of preeclampsia (PET) by measuring uterine artery pulsatility index (PI) at 11 weeks to 13 weeks 6 days' gestation. A more effective method of screening for PET is provided by uterine artery Doppler velocimetry at 22 weeks' gestation either alone or in combination with maternal history, with detection rates of 52% and 57%, respectively. Indeed, Doppler is particularly effective in screening for severe PET that necessitates iatrogenic delivery before 34 weeks, with a detection rate of 85% for a false-positive rate of 10%.[14]

Identification of women at high risk for PET during the second trimester could potentially improve pregnancy outcome because intensive maternal and fetal monitoring in such patients would lead to an earlier diagnosis of the clinical signs of the disease and the associated fetal growth restriction and avoid the development of serious complications through such interventions as the administration of antihypertensive medication and early delivery.

No previous study regarding the Doppler sonography of uterine artery had been carried out in our country on preeclamptic mothers. So this present study was carried out to observe Doppler wave form in subjects with preeclampsia. However, the wide variation in scanning techniques, Doppler measurement parameters and study protocols have resulted in conflicting results.[15]

Pregnancies affected by the complications of impaired placentation such as pregnancy induced hypertension had been shown to demonstrate increased impedance in the spiral artery.[4] In subjects with preeclampsia arterial resistance is increased.[1,10,13,15-17] This results in increase in PSV and decrease in EDV. Aardema et al[17] observed that a striking difference between PI values for PIH/PE with and without poor pregnancy outcome.

Uterine artery PI in the 22nd week was increased significantly in pregnancies which developed early-onset (before 35 weeks) PIH/PE with a poor pregnancy outcome. Coleman et al[18] had seen that RI value was ≥0.7 in subjects with preeclampsia. North et al[19] found that majority of the preeclamptic women had early diastolic notch in their uterine artery Doppler.

If we can sonologically help the pregnant women in the early detection and management of pre-eclampsia this study will help reduce the mortality from this widely prevalent problem in our country and as well as will help the policy makers to design national health measures guided against this fatal entity.

Materials and Methods

This cross-sectional study was carried out to observe Doppler wave form in subjects with preeclampsia among 40 subjects. Sampling technique was purposive. A total number of 40 normal pregnancies were included for comparison. This study was conducted in the Department of Radiology & Imaging, Dhaka Medical College Hospital, Dhaka. Study period was six months (from May 20, 2012 to November 19, 2012). Research protocol was approved by Bangladesh College of Physicians and Surgeons (BCPS). Ethical clearance was obtained from Ethical Review Board.

Subjects with clinically diagnosed case of pre-eclampsia from 24th to 37th weeks of gestation with singleton pregnancy were included. Normal singleton pregnancies from 24th to 37th weeks of gestation were compared. Subjects with multiple pregnancies, IUGR, history of DM were excluded.

Doppler indices of uterine artery were measured by researcher herself first and subsequently assessed by two consultant radiologists of the department who did not know the patient's history to eliminate observation bias. The objective of the study was discussed in details with the patients or their attendants before their decision to enroll themselves into the study.

Clinical examination and laboratory tests were done and data were collected. Demographic information was prospectively recorded and substantiated by means of inspection of medical record. Age of the subjects, medical and clinical history were recorded. No preparation was required before examination. Patient lied supine. Uterine artery was examined with 3−5 MHz curvilinear transducer in Siemens Sonoline 8000. The Doppler velocimetry measurements of the uterine artery were taken at the point just distally to the crossover with the iliac artery, before uterine artery division into arcuate arteries. The Doppler indices of uterine artery taken as outcome variables are PSV, EDV, PI, RI and early diastolic notch.

Data were collected from primary source starting from the clinical history to laboratory investigations and recorded in a pre-designed structured data collection sheets. The results are presented in tables and figures. Data entry and analysis were done using SPSS version 19.0. Output of data and graphical representation was done using Microsoft Office chart and Microsoft Word.

Results

In this study total number of subjects was 80.The age range was from 18 to 42 years in normal subjects and 18 to 43 years in subjects with preeclampsia. Majority (35% in normal and 37.5% in preeclampsia) of the respondents were found in the age group of 21−30 years, 32.5% and 22.5% subjects were found below 20 years in normal and preeclampsia groups. No significant difference between mean ages between two groups was found (Fig 1).

Pulsatility index (*PI*) *of the study subjects*

Among normal group, mean (±SD) PI was 1.12 (±0.0846). PI ranged from 0.942 to 1.245. Mean PI was 2.497 with SD 0.369 in preeclampsia group. PI ranged from 2.193 to 2.866 in this group. There was statistically significant difference between mean PI of these two groups (Fig 2).

Resistive index (*RI*) *of the study subjects*

Among normal group, mean (±SD) RI was 0.571 (±0.058). RI ranged from 0.513 to 0.629. Mean RI was 0.825 and SD was 0.087 in preeclampsia group. RI ranged from 0.738 to 0.912 in this group. There was statistically significant difference between mean RI of these two groups (Fig 3).

Distribution of the study subjects according to presence of early diastolic notch

Early diastolic notch was found in 36 (90%) subjects with preeclampsia while in only 2 (5%) subjects with normal pregnancy. Chi-square test showed that

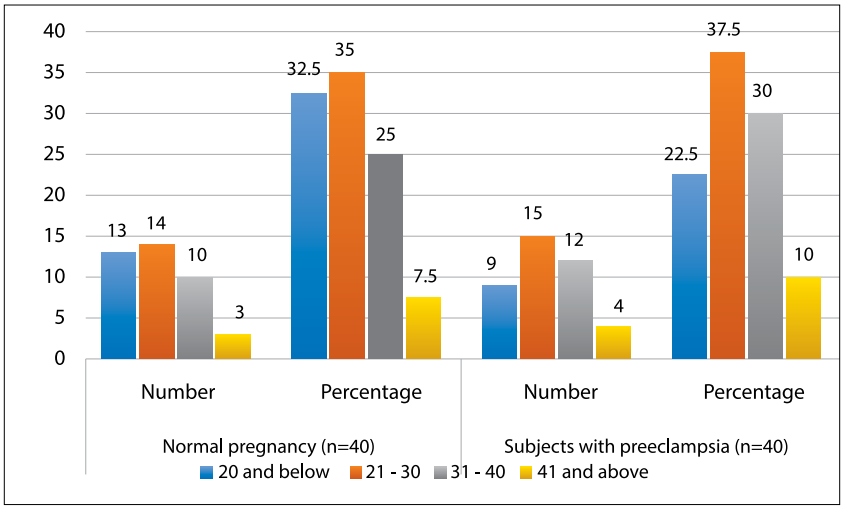

Fig 1. Bar diagram showing age distribution of the study subjects

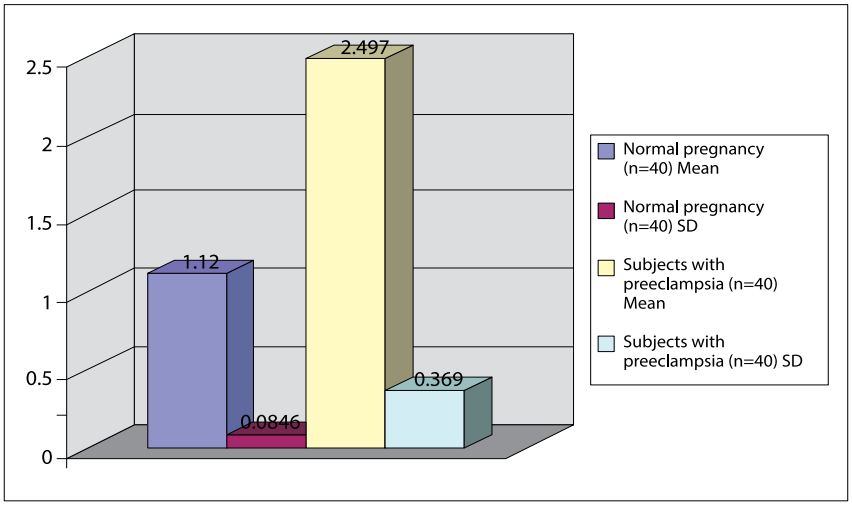

Fig 2. Bar diagram showing pulsatility index of the study subjects

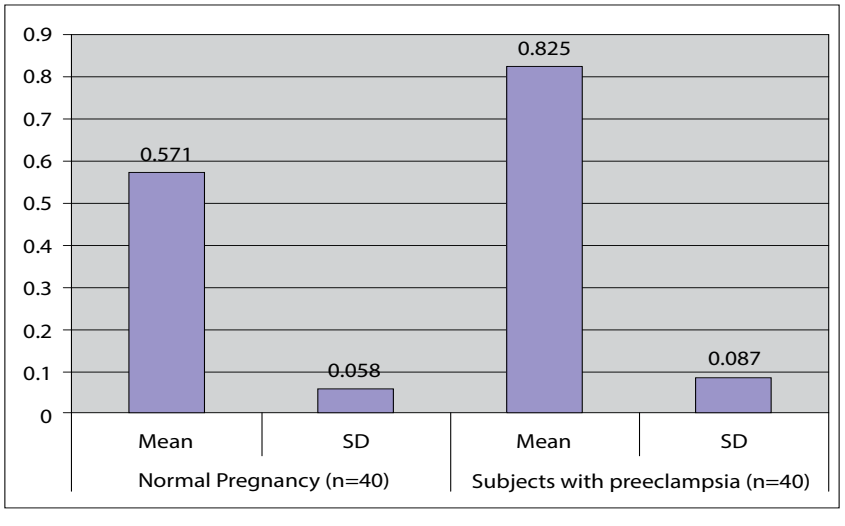

Fig 3. Bar diagram showing resistive index of the study subjects

Table I: Distribution of the study subjects according to presence of early diastolic notch

Early diastolic notch	Frequency	Percentage	p value
Normal pregnancy (n=40)	2	5	0.001
Subjects with preeclampsia (n=40)	36	90	

there was statistically significant difference regarding presence of early diastolic notch between two groups (Table I).

Discussion

Pre-eclampsia (PET), which affects about 2% of pregnancies, is a major cause of perinatal and maternal morbidity and mortality.[1-3] Routine antenatal care has evolved with the aim of identifying women at high risk for subsequent development of PET. The likelihood of developing PET is increased by a number of factors in the maternal history, including Afro-Caribbean race, nulliparity, high body mass index (BMI) and personal or family history of PET.[5] However, screening by maternal history may detect only about 30% of those who will develop PET with false positive rate of 10%.[6] A more effective method of screening for PET is provided by uterine artery Doppler velocimetry at 22−24 weeks' gestation either alone or in combination with maternal history, with detection rates of 52% and 57%, respectively.[4,5,10] Doppler is particularly effective in screening for severe PET that necessitates iatrogenic delivery before 34 weeks, with a detection rate of 85% with false positive rate of 10%.[11] Identification of women at high risk for PET during the second trimester could potentially improve pregnancy outcome.

This cross-sectional study was carried out to observe Doppler wave form in subjects with preeclampsia among 40 preeclamptic and 40 normal pregnant subjects. The age ranged from 18 to 42 years in normal subjects and 18 to 43 years in subjects with preeclampsia. This age range of the pregnant women is common in Bangladesh. Majority (35% in normal and 37.5% in preeclampsia) of the respondents were found in the age group of 21−30 years.

Pregnancies affected by the complications of impaired placentation such as pregnancy-induced hypertension had been shown to demonstrate increased impedance in the spiral artery.[4] This was reflected in our study in which mean ± SD PI was 1.12 ± 0.0846 among subjects with normal pregnancy and mean PI was 2.497 ± 0.369 in preeclampsia group. There was statistically significant difference between mean PI of these two groups. Aardema et al[17] found the similar study result. They observed a striking difference between PI values for PIH/PE with and without poor pregnancy outcome. Uterine artery PI in the 22nd week increased significantly in pregnancies which developed early-onset (before 35 weeks) PIH/PE with a poor pregnancy outcome.

The spiral artery, the major continuation of the uterine artery undergoes trophoblastic invasion during pregnancy. This physiological process is characterized by loss of the musculoelastic properties and its conversion to the uteroplacental arteries, which allows an increased blood flow to the placenta and the fetus. This process commences in the first and ends in early second trimester.[8] Second trimester Doppler is usually performed between 20th and 24th weeks of pregnancy, when it is expected that the physiologic process would be completed. The impairment or complete absence of the physiological process is associated with increased vascular resistance to blood flow and ultimately affects blood flow into the placenta.[9-11]This phenomenon was reflected in the present study. In present study, mean (±SD) RI was 0.571 (±0.058) cm/sec in normal subjects while it increased in case of preeclampsia. Mean RI was 0.825 and SD was 0.087 in preeclampsia group. In a comparable study by Coleman et al[18] it was observed that RI value was ≥0.7 in subjects with preeclampsia. It was seen that early diastolic notch was found in 36 (90%) subjects with preeclampsia. Early diastolic notch in normal group was observed in Doppler wave form in 2 (5%) subjects. North et al[19] found that majority of the preeclamptic women had early diastolic notch in their uterine artery Doppler. Harrington et al[15] performed two mid-pregnancy screening studies of antenatal population in the last three years to assess the use of Doppler velocimetry in predicting the subsequent development of PIH. There was a significant association between an abnormal RI and the subsequent development of PIH. There was

presence of a pre-diastolic notch as well as an elevated RI in preeclamptic subjects.

From the present study it was observed that mean±SD of PI was 2.49±0.369 and mean±SD of RI was 0.825±0.087. There was statistically significant difference between mean PI and RI of preeclamptic and normal subjects. The present study revealed that early diastolic notch was found in 36 (90%) subjects with preeclampsia. So, these Doppler indices with presence of early diastolic notch are reliable indicators for early detection of preeclampsia.

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