DIAGNOSTIC ACCURACY OF UTERINE ARTERY DOPPLER ULTRASOUND TO PREDICT PREECLAMPSIA IN PRIMIPAROUS FEMALES

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ABSTRACT

Objective: To determine the diagnostic accuracy of Doppler ultrasonography during second trimester of pregnancy, to predict pre-eclampsia (PE) in primigravidas.

Study Design: Cross sectional study.

Place and Duration of Study: MCH unit-II, Pakistan Institute of Medical Sciences Islamabad, from Apr 2015 to Oct 2015.

Material and Method: A total of 170 females were recruited for the study. Doppler ultrasound examination of the uterine artery (UA) was performed, using a color Doppler system. Doppler parameters including resistance index (RI) was calculated by the software supplied within the Doppler equipment. Females were labeled as positive if RI >0.7 and were labeled as negative if RI <0.7. Then females were followed till third trimester and were carefully monitored for pre-eclampsia. The data was entered on the pre-designed proforma. Collected data was entered and analyzed through SPSS version 16. A 2x2 table was generated to calculate sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of Doppler ultrasonography, taking development of PE as gold standard.

Results: The mean age of females was 27.46 ± 4.67 years. The mean gestational age at time of recruitment was 20.95 ± 0.83 weeks. The mean height, weight and BMI of females were 1.66 ± 0.07meters, 72.85 ± 10.61kg and 26.63 ± 4.04kg/m^2, respectively. There were 46 (27%) females who were obese while 124 (73%) females had normal BMI. At time of presentation of females, the RI on Doppler USG was >0.7 in 82 (48.2%) females while it was <0.7 in 88 (51.8%) females. There were 82 (48.2%) females who developed PE while 88 (51.8%) females did not develop PE at 20th week of gestation. Thus the calculated sensitivity, specificity, PPV and NPV of RI on Doppler USG were 85.4%, 86.4%, 85.4% and 86.4%. The overall diagnostic accuracy of RI was 85.9%.

Conclusion: Doppler USG is accurate enough that in future we can rely on this tool for prediction of PE in primigravidas.

Keywords: Doppler Ultrasonography, Preeclampsia.

INTRODUCTION

Preeclampsia (PE) affects 2-5% of pregnancies world-wide and is the major cause of maternal and perinatal morbidity and mortality[1,2]. In Pakistan the reported incidence of PE is 21%[3]. The precise mechanism of pre-eclampsia remains unclear, however, studies have shown that it is associated with failure of trophoblastic invasion of the maternal spiral arteries, leading to increased vascular resistance of the uterine arteries and decreased uteroplacental blood flow[4,5].

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Received: 15 Jun 2018; revised received: 21 Oct 2018; accepted: 30 Apr 2019

To identify pregnancies anticipated to end up in pre-eclampsia and eclampsia, Doppler analysis of uterine arteries is one of the non-invasive and cost effective interventions. Utero placental circulation can be measured by uterine arteries Doppler ultrasonography. Several studies have described this method as an encouraging practice to anticipate and categorize the pregnancies high risk for developing eclampsia/ pre-eclampsia later on.

Doppler examination can be performed in the first and second trimester through trans-abdominal as well as transvaginal route. In more than 95% of patients uterine arteries waveforms are easily accessible. The technique is

to recognize the uterine artery by color Doppler ultrasonography and then multiple catalogues are used to attain, evaluate and calculate various indices with the help of Pulsed-wave Doppler ultrasonography.

Cut-off value of Resistence Index (RI) >0.64 has a sensitivity of 100% and specificity of 44.0%. The positive predictive value (PPV) and negative predictive value (NPV) of Doppler ultrasonography (DUS) are 37.3% and 100% respectively[6,7]. Previous study had reported the sensitivity, specificity, PPV, NPV and diagnostic accuracy of 85.2%, 82.3%, 23.2%, 98.9% and 82.5% respectively, with RI of >7.0, proving it is a reliable tool but contrary to this some studies reported the sensitivity and specificity of 41% and 88% respectively, concluding that DUS is not a reliable predictor of pre-eclampsia[8].

Rationale behind this study is to determine the diagnostic accuracy of Doppler ultrasonography to predict the development of preeclampsia at an earlier stage of pregnancy. Thus providing us with opportunity to arrange for early monitoring and investigations to control and manage the disease accordingly. This study will remove the existing controversies about the use of this important and readily available investigation and will also help to update local guidelines and improve our knowledge and practices about the management of Pre eclampsia.

MATERIAL AND METHODS

This cross sectional study was conducted at MCH unit II, Pakistan Institute of Medical Sciences (PIMS), Islamabad, from 6 months from April 2015 to October 2015.

Sample size of 170 cases was calculated with non-probability, purposive sampling. The inclusion of this study was all primiparous booked women of age 20-35 years with gestational age of 1-12 weeks (the umbilical artery doppler was done at 20 weeks) (on USG) and singleton pregnancy (on USG).

Pregnancies having fetus with congenital anomalies, women with chronic diseases i.e. DM (BSR>200gm/dl), renal disease (serum creatinine>1.2gm/dl), cardiovascular disease (medical report and ECG) were excluded from this study.

Women who had first pregnancy and had fulfilled the selection criteria were enrolled for the study from the OPD of Department of Obstetrics & Gynecology, PIMS, Islamabad. Informed consent was obtained. Demographic features like name, age, gestational age, contact were noted. Then Doppler ultrasound examination of the uterine artery (UA) was performed during 2nd trimester at 20 weeks using a color Doppler system, Philips Envisor C, with a 3.5MHz convex probe. The UA was identified and flow velocity waveforms were obtained from a free-floating loop of the cord. Recordings were made when at least three nearly identical consecutive waveforms were visible on the screen. Doppler parameters including resistance index (RI) was calculated by the software supplied within the Doppler equipment. The average value of at least two waveforms was considered as the final measurement. Females were labeled as positive if RI >0.7 and were labeled as negative if RI <0.7. Then females were followed till third trimester of gestation and were carefully monitored whether they develop pre-eclampsia or not. The data was entered on the pre-designed proforma. The females who developed PE were managed according to the hospital protocol and were followed up till delivery.

Data Analysis

Data was entered and analyzed through SPSS 16. Quantitative variables like age, gestational age, height, weight, BMI and value of RI were calculated as mean and standard deviation. Qualitative variables like BMI status (obese and normal) and pre-eclampsia were measured as frequency and percentage. A 2x2 table was generated to calculate sensitivity, specificity, PPV, NPV and diagnostic accuracy of DUS taking development of PE as gold standard.

RESULTS

In this study, we recruited 170 females during 2nd trimester of pregnancy, with the mean age of 27.46 ± 4.67 year. The age range of these females was 20-36 years. The mean gestational age at time of recruitment was 20.95 ± 0.83 weeks with the minimum gestational age of 20 weeks while maximum gestational age of 22 weeks. The mean height, weight and BMI of females were 1.66 ± 0.07 meters, 72.85 ± 10.61 kg and 26.63 ± 4.04 kg/m^2, respectively (table-I). There were 46 (27%) females who were obese while 124 (73%) females had normal BMI (figure).

Table-I: Demographic characteristics (n=170).

Demographic characteristics	Mean	SD	Minimum	Maximum
Age (years)	27.46	4.67	20	36
Height (cm)	1.66	0.07	1.41	1.77
Weight (kg)	72.85	10.61	52	91
BMI	26.63	4.04	20.1	35.5
Gestational age (weeks)	20.95	0.83	20	22

Table-II: Comparison of Resistive Index on Doppler Ultrasound and development of preeclampsia (n=170).

		Preeclampsia		Total
		Yes	No	
RI	RI>0.7	70 (85.4%)	12 (13.6%)	82 (48.2%)
	RI<0.7	12 (14.6%)	76 (86.4%)	88 (51.8%)
Total		82 (100%)	88 (100%)	170 (100%)

Table-III: Descriptive statistics of Blood pressure 20th week of gestation.

		SBP	DBP
Blood pressure (mmHg)	N	170	170
	Mean	140.29	88.35
	SD	20.34	16.31
	Minimum	110	60
	Maximum	180	110

SBP: Systolic blood pressure, DBP Diastolic blood pressure.

Out of 82 patients having RI>0.7, 70 (85.4%) developed pre eclampsia and 12 (13.6%) patients remained normal.

While amongst 88 patients having RI<9.7, 12 (14.6%) patients developed pre-eclampsia while 76 (82.4%) proceeded normally (table-III).

At the time of presentation, the RI on Doppler USG was >0.7 in 82 (48.2%) females while RI was <0.7 in 88 (51.8%) females (table-II). The mean systolic and diastolic blood pressure of females at 20th week of gestation were 140.29 ± 20.34mmHg (range=110-180mmHg) and 88.35 ± 16.31mmHg (range=60-110mmHg). There were 49 (28.8%) females who had proteinuria +1 on dipstick method, 52 (30.6%) had proteinuria +2 and 69 (40.6%) females had proteinuria +3 on dipstick method. Thus the calculated sensitivity, specificity, PPV and NPV of RI on Doppler USG were 85.4%, 86.4%, 85.4% and 86.4%. The overall diagnostic accuracy of RI was 85.9% (table-IV).

DISCUSSION

Preeclampsia (PE) refers to a syndrome characterized by the new onset of hypertension and proteinuria after 20 weeks of gestation in a previously normotensive woman[9]. PE is one of the 3 leading causes of maternal morbidity and mortality worldwide. During the past 50 years, there has been a significant reduction in the rates of preeclampsia, eclampsia and related maternal morbidity mortality, in the developed countries.

PE is characterized by abnormal placenta formation, which results in inadequate utero-placental blood flow. This has led to the idea of

using Doppler ultrasonography to assess the velocity of uterine artery blood flow as part of routine ultrasound screening[10,11]. Low end-diastolic velocities and an early diastolic notch characterize the waveforms of uterine artery blood flow in women who are not pregnant or are in their first trimester. Persistence of a diastolic notch (beyond 24 weeks gestation) or abnormal flow velocity ratios have been associated with inadequate trophoblast invasion[12]. Accurate prediction PE is crucial to allow

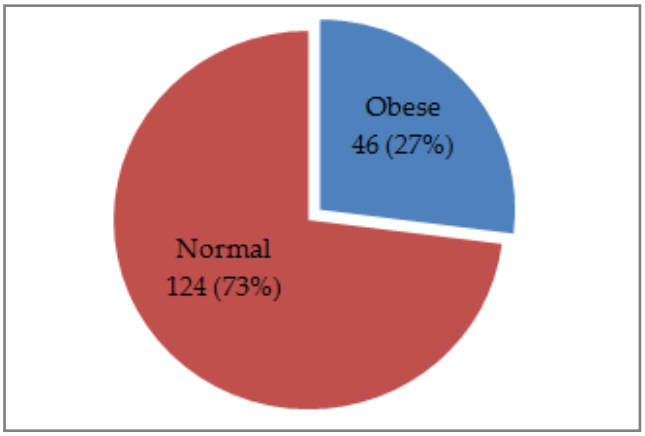

Figure: Distribution of females according to their BMI.

judicious allocation of resources for monitoring and preventive treatment to improve maternal and perinatal outcomes[12,13]. However, studies investigating the predictive accuracy of uterine artery Doppler indices have revealed considerably varied results. Thus, it is questionable whether uterine artery Doppler USG should be used as a predictive test. That's why we planned to conduct this study and included 170 females during 1st trimester with the mean age of 27.46 ± 4.67 year (age range = 20-36 years). The mean gestational age at time of recruitment was 20.95 ± 0.83 weeks.

In our study, at time of presentation of females, the RI on Doppler USG was >0.7 in 82 (48.2%) females while RI was <0.7 in 88 (51.8%) females. There were 82 (48.2%) females who developed PE while 88 (51.8%) females did not develop PE at 20th week of gestation. Thus the calculated sensitivity, specificity, PPV and NPV of RI on Doppler USG were 85.4%, 86.4%, 85.4% and 86.4%. The overall diagnostic accuracy of RI was 85.9%.

Myatt *et al*, showed that the Doppler USG has sensitivity 43% and specificity 67% for prediction of PE overall. He concluded that the data shows poor sensitivity of second-trimester Doppler ultrasound measurements for prediction of PE overall in a well-characterized, low-risk, nulliparous population. The technique has utility in identifying poor trophoblast invasion of spiral arteries of a magnitude that severely compromises uteroplacental blood flow and gives early-onset disease[14].

Table-IV: Sensitivity, specificity, PPV & NPV of uterine artery doppler USG to predict preeclampsia.

Sensitivity	85.4%
Specificity	86.4%
PPV	85.4%
NPV	86.4%
Diagnostic Accuracy	85.9%

Melchiorre and his colleagues described that the presence of bilateral notches on the Doppler waveform was shown to be significantly increased in our cohort of women with PE. However, the presence of bilateral notches in the first-trimester uterine artery waveform was a relatively poor predictor of PE because of the high prevalence of this finding in normal pregnancies (45%). This resulted in a high sensitivity for preterm pre-eclampsia (76%), but a relatively low specificity (55%)[15].

This finding is consistent with previous studies which concluded that early bilateral notching alone is unlikely to be useful in screening for pregnancy complications[16,17]. It is possible that the presence of bilateral notching used in conjunction with other biomarkers may prove acceptable in screening for PE.

Albaiges *et al* showed that the sensitivity in increased PI or bilateral notches in the second trimester, in predicting PE was 45% whereas for PE requiring delivery before 34 weeks the sensitivity was 90%[18]. Albaiges *et al* in another study had shown that the sensitivity and

specificity of RI were 90.5% and 73.3%, respectively[19]. Finally Papageorgiou *et al*, reported that the sensitivities for PE requiring delivery before 36, 34 and 32 weeks were 70%, 81% and 90% respectively[20].

Antsaklis and Daskalakis[21] have described that Uterine artery Doppler screening meets all the requirements for a worthwhile screening program in prediction of PE. The sensitivity for predicting severe PE was between 80 and 90% for a false positive rate of 5 to 7%. The detection rate could be better if we would set a higher screen-positive rate. In terms of performance, uterine artery screening at 20 to 24 weeks of gestation is superior to first trimester screening, and appears to fulfill all the requirements for a worthwhile screening test[21]. Antsaklis *et al* found the sensitivity and specificity of screening for PE to be 81% and 87% at 20 weeks, and 7% and 95% at 24 weeks' gestation[22].

CONCLUSION

Doppler USG is accurate enough that in future we can rely on this tool for prediction of PE in primigravidas.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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