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A Study of Uterine Artery Colour Doppler at 20-24 weeks gestation as a predictor of Pregnancy Induced Hypertension and Intra Uterine Growth Restriction from Industrial Town in Western India.

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ABSTRACT

Hypertensive disorders of pregnancy are major cause of maternal and perinatal morbidity and mortality. Various studies have demonstrated an increase in impedance to blood flow in uterine artery at 20-24 weeks of gestation which resulted in preeclampsia, IUGR or both. Abnormal waveforms of uterine artery were studied to predict PIH and IUGR as a routine screening test and to find the sensitivity and specificity of colour Doppler in low risk and high risk population. 100 patients were studied. Uterine artery colour Doppler was performed at 20-24 weeks of gestation after detail history and investigations. Parameters assessed were elevated Resistance Index (RI) and presence of diastolic notch. Incidence of PIH and IUGR was significantly more in Doppler abnormal group as compared to Doppler normal group and more in high risk population. Uterine artery Doppler can predict PIH and IUGR in high risk population.

Keywords: Uterine artery, Diastolic notch, PIH, IUGR, India

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INTRODUCTION

Hypertensive disorders of pregnancy remain a major cause of maternal as well as perinatal morbidity and mortality despite recent advances in antenatal care. Pregnancy induced hypertension is a recording of blood pressure more than or equal to 140/90 mm of Hg on two occasions for more than 6 hours apart, after 20th weeks of gestation in association with proteinuria and/or oedema. Early screening for preeclampsia may allow vigilant antenatal surveillance and appropriate timing of fetal delivery in order to avoid serious sequelae to mother and newborn.

The poorly perfused or ischemic placenta may be the origin of factors which gain access to maternal vasculature and cause endothelial cell damage resulting in multi-organ dysfunction. Reduced placental perfusion in PIH and intrauterine growth retardation (IUGR) is thought to result from failure of the trophoblasts to invade into maternal spiral arteries in the 1st half of pregnancy [1]. This physiological transformation is characterized by, a gradual loss of the normal musculo-elastic structure of the arterial wall getting replaced by amorphous fibrinoid material embedded with trophoblastic cells. The physiological changes are required for a successful pregnancy without any resistance to placental blood flow through uterine artery during diastole.. In pathological pregnancy, the trophoblast cannot invade the spiral arterioles to cause these changes in arteriolar media layer. Ultimately, during diastole there will be resistance which shows diastolic notch in uterine artery. All these changes occur during first trimester and early second trimester, increasing the possibility of PIH & IUGR in latter gestational age [2].

Michael S. Kramer et al have mentioned that environmental factors like poor and crowded housing, unemployment, domestic violence in industrial workers act as 'chronic stressors' which keep the cortisol levels higher in maternal and fetal circulation resulting in impaired placentation causing PIH and IUGR in late gestation [3].

As impaired placentation is said to be the cause of PIH, its manifestation can be used as a screening test. Doppler ultrasound has been used as a tool to screen and study the utero-placental circulation. Various studies have demonstrated an increase in impedance to blood flow in uterine artery. It has also been used as a predictive test prior to the development of symptoms of preeclampsia and IUGR [4]. Present study was planned based on this background.

MATERIALS AND METHODS

This study was conducted for two years in a tertiary care centre and teaching hospital in Western India, from July 2008 to July 2010 in a cohort of 100 females.

Ethical committee permission was taken before starting the study.

Each woman gave prior written consent.

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The gestational age was calculated according to the 1st day of last menstrual period and confirmed by second trimester ultrasound performed at 16-18 weeks of pregnancy.

Doppler study of uterine artery was done at 20-24 weeks of gestation by senior sonologist. Patients were divided and grouped according to the risk factors. Group I was patients without risk factors. And group II was patients with high risk factors. The findings were analysed as per study design.

Doppler was performed with Toshiba colour Doppler diagnostic system, Corevision Pro (model SSA-350 A) using an electronic frequency, convex probe (model PVF-375AT).

First the placental position was determined, then the external iliac artery was visualized and uterine artery was identified medial to it. Flow velocity waveforms were obtained from each uterine artery, the image was frozen and peak systolic (A) , end diastolic (B) and early diastolic (C) blood flow velocities were measured in four consecutive waveforms in each uterine artery. The RI was calculated as A-B/A. The mean RI was decided. Diastolic flow variability was noted in the form of absence, notch or inversion.

Both the groups were followed subsequently for the development of preeclampsia / gestational hypertension and/or IUGR. Feto- maternal outcome was noted.

Females with abnormal Doppler findings were followed up till 6 weeks postpartum.

Inclusion criteria

Low risk group is Group I,

- Included all normotensive primigravidae between 20-24 weeks of gestation without any risk factors such as teenage pregnancy, elderly primigravida, grand multipara, patients with past history of PIH, IUGR or Intra Uterine Death (IUD) and patients with multiple gestations.

High risk group is Group II, which included –

- All normotensive teenager (<18 years), elderly (>35 years) primigravida and grand multipara (>gravid 3) who were in the 20-24 weeks of gestation.
- Normotensive multipara between 20-24 weeks with past history of PIH, IUGR or IUD.
- All patients with multiple gestations between 20-24 weeks.

Exclusion criteria

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- Patients with essential hypertension.
- Patients denied being included in this study.

RESULTS

Total 100 patients were included in the study. Out of them 10 females had lost for follow up. Group I- 46, was primigravida without risk factor – low risk group, Group II- 44, was patients with risk factors- high risk group. Both the groups were studied and data was analysed and depicted, for total number of 90 patients in following tables.

Table 1: Distribution of patients according to age.

	< 18 Years	18-25 Years	25-35 Years	35-45 Years
Low Risk Total (n=46)	-	25	21	-
High Risk Total (n=44)	4	18	20	2

Table 1 show that maximum number of patients was in an age group between 18 to 35 years.

Table 2: The Doppler abnormality in both groups

	High Risk (n=44)		Low Risk (n=46)	
	Abnormal	Normal	Abnormal	Normal
RI>0.58	10	34	6	40
Diastolic Notch	4	40	2	44

Table 2 indicates significantly that abnormal uterine artery waveform was present in 22.27% patients and 40% of them had shown diastolic notch in uterine artery in a high risk group. In a low risk group the incidence was 6.96% and 33.33% respectively.

Table 3: Patients who developed hypertension during pregnancy in both groups

	High Risk (n=44)		Low Risk (n=46)	
	Hypertension	No Hypertension	Hypertension	No Hypertension
Doppler Abnormal	6	8	4	4
Doppler Normal	3	27	2	36

Z= 2.52

Table 3 show that there is a development of abnormal uterine artery waveform in 99.6% patients in a high risk group, which is significant.

Table 4: Distribution according to type of hypertension in both groups

	High Risk		Low Risk	
	Abnormal Doppler	Normal Doppler	Abnormal Doppler	Normal Doppler
Gestational HT	2 (20%)	2 (6.9%)	2 (33.3%)	1 (2.7%)
Preeclampsia	4 (33.3%)	1 (3.57%)	2 (33.3%)	1 (2.7%)
No Hypertension	8	27	4	36

Table 4 depicts development of preeclampsia in 33.3 % patients who had abnormal waveforms of the uterine artery, in both, high as well as low risk group. Similarly incidence of gestational hypertension was high in both groups in patients with abnormal waveform.

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Table 5: Patients who developed IUGR in both groups				
	High Risk		Low Risk	
	< 2.5 kg	> 2.5 kg	< 2.5 kg	> 2.5 kg
Doppler abnormal	3 (21.43%)	11 (78.57%)	1 (12.50%)	7 (87.50%)
Doppler normal	2 (6.67%)	28 (93.33%)	2 (5.26%)	36 (94.74%)

Z=1.38

Table 5 indicates significant relation between abnormal waveform and development of subsequent IUGR. Showing prevalence of IUGR in 90% patients with abnormal Doppler.

Table 6: Sensitivity and specificity of second trimester colour Doppler				
Studies by diff. Study groups	Sensitivity	Specificity	PPV	NPV
Olivier Irion et al (1998)	26%	88%	7%	2.07%
Jacobson et al (1990)	44%	-	33.3%	-
Bower et al (1993)	82%	86%	11%	99%
Present study	66.67%	90%	50%	97.94%

Table 6 shows the specificity of our study is correlating well with other study groups. Sensitivity is also nearly correlating.

DISCUSSION

Uterine artery flow velocity increases resulting in reduction of RI, in the first half of pregnancy during trophoblastic invasion. Flow velocity should remain higher than a threshold value until delivery to have a good pregnancy outcome. Patients lacking in attainment of this threshold value can develop PIH and/ or (IUGR).

We have compared the incidence of hypertensive disorders in Doppler normal & Doppler abnormal group in low and high risk population as shown in table 3. Incidence of hypertensive disorders in the present study was comparable with the previous studies by Campbell et al and Jacobson et al [5]. The incidence of PIH and IUGR is higher in Doppler abnormal group in low as well as high risk population. It can be commented that relative risk of developing PIH in low risk group who had shown Doppler abnormality, is higher as compared to Doppler normal in the same group, whereas incidence is doubled in high risk group with Doppler abnormality as compared to Doppler normal.

P. López-Jaramillo and J.P. Casas have mentioned the incidence of pre-eclampsia in general population as 7% and in industrialized low socio-economic status women as 42%. According to their study, higher free radical levels in these may be the cause of this higher incidence [6]. In our study, done in 90 patients from industrial area, incidence of PIH was 24.44% and that of IUGR was 20%. Presence of chronic stressors and under-nutrition were the possible contributing factors.

The period of gestation at which Doppler was done is 20-24 weeks in the present study. It was different in all previous studies except Jacobson et al (1990) & Steel et al (1990) who had done Doppler at same gestation [7,8]. Campbell et al (1986) conducted Doppler at 16-18 weeks gestation, Bower et al (1993) conducted Doppler at 18-22 weeks.

Doppler abnormality, seen at 20-24 weeks of gestation, in both the groups is charted in Table 2. RI more than 0.58 was used as cut off; various previous studies have shown that mean RI at 20 weeks gestation is 0.54-0.56. The definition of abnormal Doppler was different in all the previous studies. Campbell et al and Jacobson et al had taken RI >0.58 as abnormal. Newnham et al had studied uterine artery S/D ratio in relation with various pregnancy outcomes [9]. McCallum W.D, Williams C.S, Napel S et al and Brian J Trudinger, Warwick B.G, Colleen M.C et al had studied uterine blood flow velocity & its effect on gestational hypertension / fetal growth [10, 11]. Bower et al had measured significance of high RI with or without diastolic notch in relation with prediction of PIH and IUGR [12] Irion et al had studied 3 parameters (A: C ratio > 2.5, A: B ratio >90^{th} percentile, RI >0.58) in relation with prediction of PIH, small for gestational age and spontaneous preterm delivery. He proved that A: B ratio (peak systolic over end diastolic ratio) > 90^{th} percentile was the best criterion which showed the highest association of pre-eclampsia [13]. F.Y. Chan studied various indices at 20, 28 & 36 weeks of gestation and concluded that RI> 90^{TH} percentile with presence of diastolic notch was the best criterion to predict PIH [14].

Słowakiewicz K, Perenc M and Sieroszewski P in 2010 studied uterine artery in first, second & third trimesters for prediction of PIH and IUGR and reported that abnormal uterine artery wave forms are associated with PIH and IUGR [15].In the study done by Agrawal Prerana, incidence of PIH with IUGR was 52.9 % and incidence of only IUGR was 47.1 % in the patients showing persistent diastolic notch [16]. In our study incidence of PIH was 45.45 % in patients with abnormal waveform. Prevalence of IUGR in our study group was 90% in patients with abnormal colour Doppler as shown in table 5. Comparison between the types of hypertension in both the groups is done in Table 4. The diastolic notch was defined as being present or absent in the present study. The relative risk of developing preeclampsia in Doppler abnormal group with present diastolic notch was more in high risk population as compared to low risk population. The incidence of Doppler abnormalities in our study was comparable with previous studies by Olivier Irion & Bower et al., as shown in table 5. Sensitivity and specificity of second trimester Doppler for the prediction of hypertensive disorders in pregnancy is shown in Table 6, which are comparable in past and present study.

Stampalija T, Gyte GML and Alfirevic Z, have reported in 2010 that, in their study group, they performed a second trimester Doppler showing the results that it is not much of benefit in low risk group and benefit in high risk group needs further studies. They performed, one-stage color Doppler screening program at 23 weeks and identified most women who subsequently developed severe pre-eclampsia and/or fetal growth restriction [17].

Thus it can be commented from above discussions that results in the present study are comparable with past studies in patients with both the groups.

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CONCLUSION

Maintenance of adequate blood flow through uterine artery is an important issue to prevent hypertensive disorders of pregnancy. Presence of diastolic notch in uterine artery colour Doppler at 20-24 wks of gestation indicates inadequate invasion of myometrial arterioles by trophoblast in early pregnancy leading to PIH and/or IUGR latter. Present study and review of literature concludes that uterine artery Doppler need not be done in all antenatal women for prediction. It has a definite place in high risk patients to prevent or reduce maternal as well as perinatal morbidity and mortality.

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