ORIGINAL RESEARCH

Role of uterine artery doppler in pregnancy induced hypertension: A prospective study from North India

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ABSTRACT
Background: The triad of pregnancy induced hypertension (PIH), infections, and hemorrhages constitutes a significant proportion in the maternal mortality and morbidity. About 5 to 10 percent of pregnancies are complicated by the PIH. It is being observed that the sensitivity of this screening test is increased in detecting adverse perinatal outcome, if the doppler ultrasound is performed at gestational period of 23 to 26 weeks instead of 19 to 22 weeks. So, present study was conducted with an aim to evaluate the association of the deranged uterine artery velocity indices on doppler ultrasound with maternal and fetal outcomes among pregnant women with PIH.
Methods: The present prospective study was conducted among 132 singleton pregnant women (patient age: 19 to 33 years and gestational age: 25-39 weeks) with PIH in the department of Obstetrics and Gynecology in tertiary care teaching hospital of North India for 12 months (January 2021 to December 2021) after obtaining the ethical approval from the institutional ethical committee.The ultrasound examination was performed using a GENERAL ELECTRIC LOGIQ P5 ultrasound scanner machine.Chi square test was used to find association between uterine artery indices and fetal outcome and a p value of <0.05 was considered as statistically significant.
Results: The mean age of pregnant women was 24.8±3.7 years.In our study 40.8% of subjects were nulliparous, 43.9% of subjects were having parity of 1, 12.2% of subjects were having parity of 2.In our study, the doppler ultrasound was conducted among pregnant women with PIH for various indices. The uterine artery doppler ultrasound showed that 35.7% of subjects were having normal uterine artery indices, whereas 36.7% and 27.6% of subjects were having bilateral abnormal uterine artery indices and unilateral abnormal uterine dopplerrespectively.The chi-square analysis showed statistically significant association between perinatal mortality and abnormal uterine artery indices (p<0.05).
Conclusion: Doppler study for fetal surveillance in pregnancy-induced hypertension is a very useful device and abnormal uterine artery velocimetry also seems to have worse pregnancy outcomes in the present study.
Keywords: Uterine artery indices, umbilical artery indices, preeclampsia, pregnancy induced hypertension, fetal outcome

INTRODUCTION

The triad of pregnancy induced hypertension (PIH), infections, and hemorrhagesconstitutes a significant proportion in the maternal mortality and morbidity. About 5 to 10 percent of pregnancies are complicated by the PIH. As preeclampsia involves multiple organ system, it is capable of causing significant morbidity among mother and fetus; and its further progression into eclampsia causes further harm to both the mother and fetus [1].Worldwide PIH (eclampsia and preeclampsia) causes more than 14 percent of maternal mortality. Also, preeclampsia causes around 15 percent of preterm births [2,3,4].

During the 8th week ofgestation, there is initiation of invasion of decidua part of spiral arteries by trophoblast cells and the progress of complete invasion continues till 13th week of gestation. Followed by this there is initiation of invasion of myometrial part of spiral arteries by trophoblast cells and the progress of complete invasion continues till 18-19th week of gestation, although delay may extend completion of this process till 22-24th weeks of gestation [5,6].

It has been observed that among mothers with preeclampsia, there is lack of this invasion process of spiral arteries and which in turn raises the flow resistance in intervillous space. So, to indirectly monitor this invasion of spiral arteries, the uterine artery waveform is preferred approach [7.8]. Doppler study of uterine artery among non-pregnant women shows early "diastolic notch" and low "peak flow velocity". Doppler study of uterine artery among pregnant women at 18-20 weeks of gestation shows no "diastolic notch" and high "peak flow velocity". The doppler ultrasound acts as screening test for preeclampsia during 1st and 2nd trimester, where it shows deranged uterine artery velocity indices (high resistance pattern and presence of diastolic notch) [7,8].

The study has shown that the odds of developing hypertensive proteinuria is 1.7 among mothers and odds of having small for gestational age (SGA) is 1.3 for fetus, where the high resistance pattern of uterine artery was observed on doppler ultrasound [7]. But it is being observed that the sensitivity of this screening test is increased in detecting adverse perinatal outcome, if the doppler ultrasound is performed at gestational period of 23 to 26 weeks instead of 19 to 22 weeks [8]. However, there is limitation of studies related to uterine artery doppler ultrasound being conducted among pregnant women with PIH for maternal and fetal outcomes, so present study was conducted with an aim to evaluate the association of the deranged uterine artery velocity indices on doppler ultrasound with maternal and fetal outcomes among pregnant women with PIH.

MATERIALS AND METHODS

The present prospective study was conducted among 132 singleton pregnant women (patient age: 19 to 33 years and gestational age: 25-39 weeks) with PIH in the department of Obstetrics and Gynecology in tertiary care teaching hospital of North India for 12 months (January 2021 to December 2021) after obtaining the ethical approval from the institutional ethical committee. The criteria to define patient with PIH was "new onset after 20 weeks of gestation" with "persistent high blood pressure" (systolic $\geq$140 mmHg or diastolic $\geq$90 mmHg) without proteinuria or with proteinuria (protein $\geq$0.3 g/dL in urine sample or urine dipstick test positive 1 or more). The informed written consent was obtained from the pregnant mothers prior to the enrollment into the study.

DATA COLLECTION

A preformed questionnaire was used for data collection to document sociodemographic (age, parity),doppler ultrasound parameters (uterine artery indices: normal/unilateral abnormal/bilateral abnormal; middle cerebral artery indices: increase diastolic flow/normal; umbilical artery indices: normal/decreased diastolic flow/absent diastolic flow/reversal of

diastolic flow; ductus venousus wave: reversal of wave/normal), and fetal outcome (birth weight (low birth weight/normal, and alive/intrauterine death).

DOPPLER ULTRASOUND

The ultrasound examination was performed using a GENERALELECTRIC LOGIQ P5 ultrasound scanner machine. An initialobstetric ultrasound scan was carried out to document obstetricparameters (including gestational age), number of foetuses to exclude multiple gestationand foetus with malformations.Doppler study was carried out with a transabdominalpulsed, curved array 3.5–5.0 MHZ transducer (Siemens - Sonoline G – 50)angle of insonationwasbelow 60°. For theuterine artery investigation, the participants were scannedin a semi‑ recumbent position with a slight lateral tilt.

The resistive index (RI), pulsatility index (PI) and S/D ratio were obtained and the value was noted down. Uterine artery flow waveforms were considered abnormal with the presence of early diastolic notch and S/D ratio of more than 2.6 in any one either right or left uterine artery.Umbilical artery S/D ratio was considered abnormal when it was more than 3 after 30 weeks' gestation.Umbilical artery (UA) RI and PI were considered abnormal when it was more than the 95th percentile of the range of reference. Absent and reverse end diastolic flow of umbilical artery doppler were considered abnormal. Middle cerebral artery (MCA) RI and PI were considered abnormal when it was more than the 95th percentile of the range of reference.Cerebroplacental ratio or MCA / UA PI ratio is useful in identifying fetuses with increased placental and/ or decreased cerebral resistance.

All pregnant women under study were carefully followed up regularly and her bloodpressure, weight gain, fundal height was measured and urinary protein analysis wasdone at each antenatal visit. The patient was followed up till delivery and the outcomewas noted with respect to the gestational age at delivery, birth weight and theperinatal events.The collected data was entered in the Microsoft (MS) Excel Spreadsheet and also, analysis of data carried out using MS Excel Spreadsheet. The qualitative variables were expressed as number and percentages. Chi square test was used to find association between uterine artery indices and fetal outcome and a p value of <0.05 was considered as statistically significant.

RESULTS

In present study a total of 98 pregnant females with PIH were included. The age group analysis showed that there were 5.1% of pregnant females were <21 years of age. Most of the study subjects were in the age group of 21-25 years (36.7%), followed by 26-30 years (33.7%). The pregnant women with age of >30 years were 24.5%. The mean age of pregnant women was 24.8±3.7 years (Figure 1).

Figure 1: Age group characteristics among pregnant women with PIH (N=98).
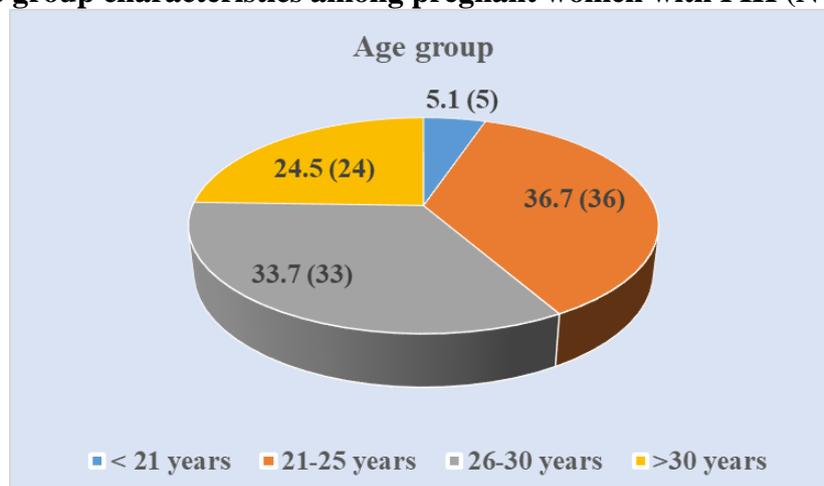
In our study 40.8% of subjects were nulliparous, 43.9% of subjects were having parity of 1, 12.2% of subjects were having parity of 2. Only 3.1% of subjects were having parity of 3 or more (Figure 2).

Figure 2: Parity characteristics among pregnant women with PIH (N=98).
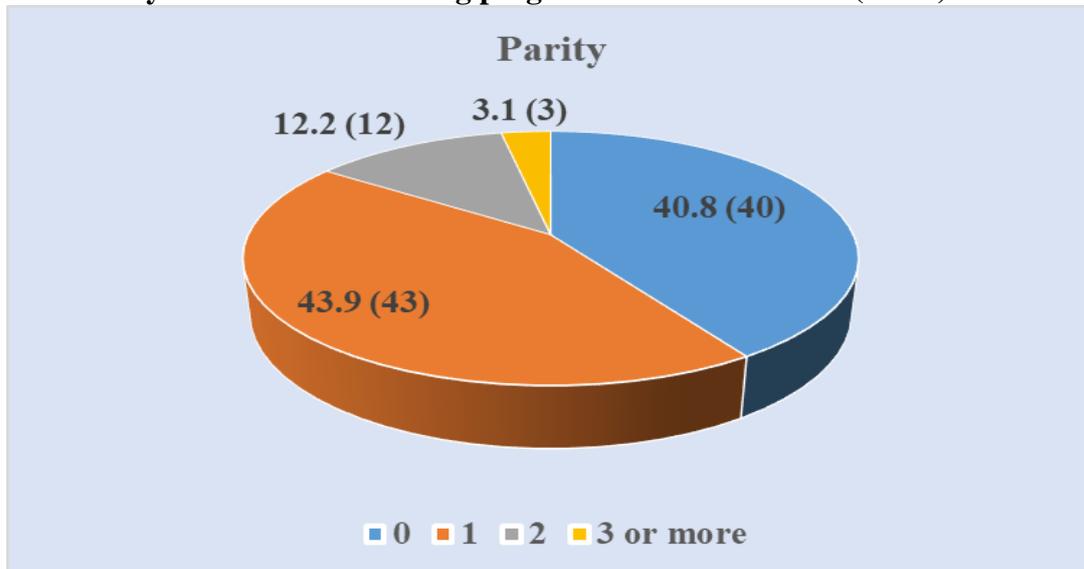
In our study, the doppler ultrasound was conducted among pregnant women with PIH for various indices. The uterine artery doppler ultrasound showed that 35.7% of subjects were having normal uterine artery indices (including no diastolic notch), whereas 36.7% and 27.6% of subjects were having bilateral abnormal uterine artery indices (including diastolic notch) and unilateral abnormal uterine doppler (either diastolic notch or abnormal uterine indices) respectively.The middle cerebral artery indices in doppler ultrasound among pregnant women showed increased diastolic flow (including brain sparing effect) among 63.3% of subjects. The umbilical artery doppler ultrasound showed that 64.3% of subjects were having normal umbilical artery indices, whereas 36.7% and 27.6%, 5.1% and 3.1% of subjects were having decreased diastolic flow, reversal of diastolic flow and absent diastolic flow in umbilical artery doppler respectively (Figure 3).

Figure3: Color doppler characteristics of pregnant women with PIH (N=98).
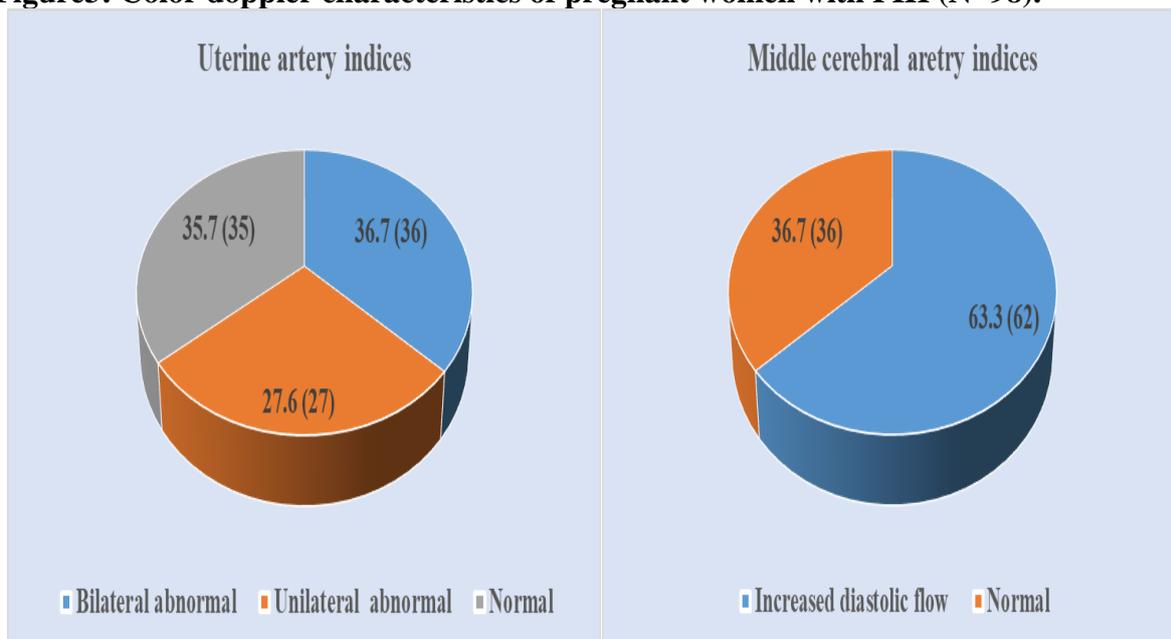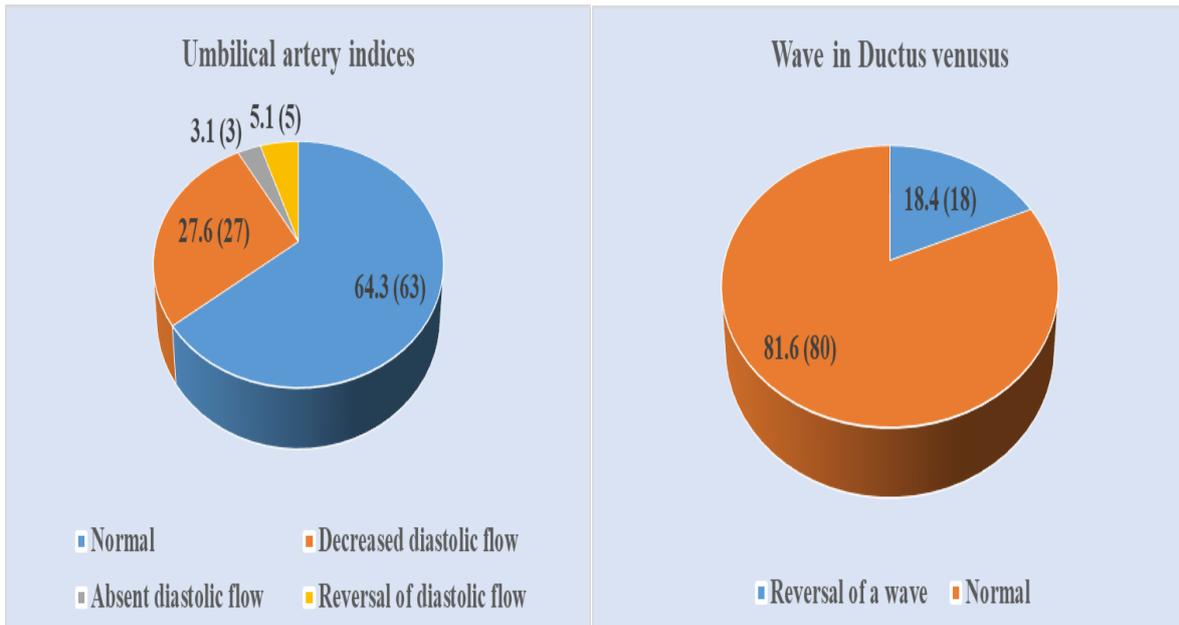
The pregnant women werefollowed up postpartum till early neonatal phase and it was observed that there were 87.8% live births (including early neonatal mortality of 5.1%) and 12.2% of fetus were having IUD. So, a total 17.3% of perinatal mortality was observed in our study. Among live births, only 37.2% of newborn were having normal birth weight, whereas 14.0%, 9.3% and 39.5% of newborns were having ELBW, VLBW and LBW respectively (Table 1).

Table 1: Fetal outcome among pregnant women with PIH.

Fetal outcome	Number	%
Birth weight* (n=86)#		
Normal (>2500 gms)	32	37.2
ELBW (<1000 gms)	12	14.0
VLBW (1000-1500gms)	8	9.3
LBW (1501-2500 gms)	34	39.5
Perinatal mortality (n=98)		
Intrauterine death (IUD)	12	12.2
Early neonatal death	5	5.1
No	81	82.7

*LBW: Low birth weight, VLBW: Very low birth weight, ELBW: Extremely low birth weight, # Excluding IUD

Among 25.9% of newborn with low birth weight were having normal uterine artery indices, whereas 27.8% and 46.3% of newborn with low birth weight were having abnormal unilateral and bilateral uterine artery indices respectively and the chi-square analysis showed statistically significant association between low birth weight and abnormal uterine artery indices ($p<0.05$). Among 29.4% and 70.6% of newborn with perinatal mortalitybelonged to pregnant mothers with abnormal unilateral and bilateral uterine artery indices respectively, and there was no perinatal mortality observed among pregnant mother with normal uterine indices, and the chi-square analysis showed statistically significant association between perinatal mortality and abnormal uterine artery indices ($p<0.05$).

Table 2: Association of fetal outcome with the uterine artery indices.

Fetal outcome	Abnormal uterine artery indices n (%)			Test of significance
	Normal	**Unilateral**	**Bilateral**	
Birth weight (n=86)#	**(n=35)**	**(n=22)**	**(n=29)**	$\chi^2=14.9$,

Normal birth weight (n=32)	21 (65.6)	7 (21.9)	4 (12.5)	df=2, p=0.0006
Low birth weight (n=54)	14 (25.9)	15 (27.8)	25 (46.3)	
Perinatal mortality (n=98)	**(n=35)**	**(n=27)**	**(n=36)**	χ^2=20.4, df=2, p<0.0001
Yes (n=17)	0 (0.0)	5 (29.4)	12 (70.6)	
No (n=81)	35 (43.2)	22 (27.2)	14 (17.3)	

Excluding IUD

DISCUSSION

PIH is a common cause of feto-maternal mortality affecting10% of pregnant women and is associated with 22% perinataldeaths. Doppler studies in high-risk pregnancies are morebeneficial in the management of perinatal and neonatal outcomes [9].

In present study a total of 98 pregnant females with PIH were included and their mean age of was 24.8±3.7 years. The age group analysis showed that there were 5.1% of pregnant females were <21 years of age. Most of the study subjects were in the age group of 21-25 years (36.7%), followed by 26-30 years (33.7%). The pregnant women with age of >30 years were 24.5%. In the studies by Smitha et al., and Ozeren et al., the mean age of study participants was 23.4 years and 27.6 years respectively [10,11].

In our study 40.8% of subjects were nulliparous, 43.9% of subjects were having parity of 1, 12.2% of subjects were having parity of 2. Only 3.1% of subjects were having parity of 3 or more. In the study by Khalid et al., (60.3%) and Lakhkar et al., (77.7%) more than half of pregnant women with PIH were primigravida [12,13].

In our study, the doppler ultrasound was conducted among pregnant women with PIH for various indices. The uterine artery doppler ultrasound showed that 35.7% of subjects were having normal uterine artery indices (including no diastolic notch), whereas 36.7% and 27.6% of subjects were having bilateral abnormal uterine artery indices (including diastolic notch) and unilateral abnormal uterine doppler (either diastolic notch or abnormal uterine indices) respectively. But in contrast to our study, the study by Khalid et al., showed that 94.4% of pregnant women with PIH were having abnormal uterine artery doppler (33.3% as unilateral abnormal uterine doppler and 61.1% as bilateral abnormal uterine artery indices) [12]. The study by Bhatt et al., showed 56.0% of pregnant women with PIH were having abnormal uterine artery doppler [9].

In our study, the middle cerebral artery indices in doppler ultrasound among pregnant women showed increased diastolic flow (including brain sparing effect) among 63.3% of subjects.The umbilical artery doppler ultrasound showed that 64.3% of subjects were having normal umbilical artery indices, whereas 36.7% and 27.6%, 5.1% and 3.1% of subjects were having decreased diastolic flow, reversal of diastolic flow and absent diastolic flow in umbilical artery doppler respectively. The similar findings were observed in the studies by Lakhkar et al., and Frusca et al., and Epsinoza et al., [13,14,15]. Study by Bhatt et al., showed that the fetus with reversal of diastolic flow and absent diastolic flow in umbilical artery doppler was associated intrauterine growth retardation [IUGR] (OR:2.0) and perinatal mortality (OR:2.0) [9].

In our study, among 25.9% of newborn with low birth weight were having normal uterine artery indices, whereas 27.8% and 46.3% of newborn with low birth weight were having abnormal unilateral and bilateral uterine artery indices respectively and the chi-square analysis showed statistically significant association between low birth weight and abnormal uterine artery indices (p<0.05). The studies by Turan et al., and Messawa et al., havealso shownthe similar findings [16,17].

Among 29.4% and 70.6% of newborn with perinatal mortalitybelonged to pregnant mothers with abnormal unilateral and bilateral uterine artery indices respectively, and there was no perinatal mortality observed among pregnant mother with normal uterine indices, and the chi-

square analysis showed statistically significant association between perinatal mortality and abnormal uterine artery indices (p<0.05). Similar findings were observed in the study by Axt-Fliedner et al., [18]. In a study by Chan et al., 15.5% of fetus born to mother with PIH having abnormal uterine indices were having perinatal mortality or major morbidity [19]. Study by Bhatt et al., showed that the prevalence of intrauterine growth retardation (IUGR) or low birth weight among fetusborn to mother with PIH having abnormal uterine indices was 60.0% [9].

Also, Liberati et al., showed the presence of a diastolic notch in the placentaluterine artery increased sensitivity (31.7%) for IUGR[20]. Sieroszewski et al., observed the sensitivity of the notchin 20-24 week in the uterine artery velocimetry for theprediction of IUGR was 68% [21]. The study by Baschat et al., has shown that the prediction of critical perinatal outcomes is improved when venous and umbilical artery qualitative waveform analysis is combined [22].

CONCLUSION
Doppler study for fetal surveillance in pregnancy-inducedhypertension is a very useful device and abnormal uterine artery velocimetry also seems to haveworse pregnancy outcomes in the present study. The knowledge of uterine and umbilical artery waveform mayhelp to improve pregnancy management and any permitidentification and assessment of pregnancy inducedhypertension at earliest gestation age as compared to otherantepartum test modalities.

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