Research Article

A study of role of Doppler ultrasound in Pregnancy induced hypertension (PIH) and perinatal outcome

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Abstract

Background: The main purpose of providing antenatal care is to identify women at risk of complications as a result of impaired uteroplacental circulation such as Pregnancy induced hypertension (PIH) and Preclampsia. **Aim**: To describe practical application of doppler ultrasound in obstetrics with analysis of blood flow velocity waveform in PIH and to examine perinatal outcome in pregnancies with altered Doppler indices. **Material and Method**: This is a prospective study of 41 pregnant women with pregnancy induced hypertension (PIH) evaluated sonographically with colour Doppler and to be followed subsequently for any adverse perinatal outcome. **Result**: Out of 41 cases 73.1% of cases were found in 20-29 yrs age group. 26 cases had abnormal uterine artery Doppler indices accounting for 63.46%, while 15 cases had a normal Doppler indices accounting for 36.53%. Out of 41 cases, 25 cases had abnormal Middle cerebral artery. In our study 14 cases had abnormal umbilical artery Doppler indices accounting for 34.2%, while 27 cases had a normal Doppler indices accounting for 65.8%., out of 41 cases in our study 6 cases had Reversal of a wave in Ductus Venosus waveform that is in 14.6%. In this study total 5 cases (35.7%) of perinatal mortality were seen. **Conclusion**: The knowledge of uterine and umbilical artery waveform may help to improve pregnancy management and any permit identification and assessment of pregnancy induced hypertension at earliest gestation age as compared to other antepartum test modalities.

Key words: Doppler ultrasound, Pre-eclampsia, Uteroplacental flow

Introduction

Hypertensive disorder of pregnancy is one of the most common complication that effects human pregnancy. It is one of the leading cause of maternal & fetal mortality & morbidity [1]. It comprises 7-10% of all pregnancies. Pregnancy Induced Hypertension includes Gestational hypertension, Pre-eclampsia and Eclampsia. PIH has many complications. The most common complication of PIH is Intra uterine growth retardation (IUGR). perinatal deaths - including intrauterine and early neonatal deaths, hypoxic ischemic encephalopathy intraventricular hemorrhage, periventricular leukomalacia, pulmonary hemorrhage and necrotizing enterocolitis. Minor outcomes included caesarean delivery for fetal distress, APGAR score below 7 at 5 minutes, admission to neonatal intensive care unit. Others are placental infarcts, abruption. The main goals of prenatal testing are to identify fetuses at increased risk for perinatal morbidity& mortality. Early detection of disease would lead to an improved outcome, through increased surveillance and use of prophylactic therapies such as low dose aspirin [2,3]. The placenta through implantation and development modifies the uterine circulation from one of low flow and high resistance to one of high flow and low resistance. The primary defect that predisposes pregnancy to uteroplacental complication appear to be partial/complete failure of trophoblastic invasion [4]. It is therefore desirable to know the accurate changes in uteroplacental and fetal circulation to predict perinatal outcome and help in appropriate intervention. It is here that role of Color Doppler comes. Doppler ultrasound examination is a non-invasive method, which gives useful information about impaired blood flow to the fetus at risk among high risk patients several studies suggested a significant decrease in neonatal morbidity& mortality when doppler evaluation was a part of fetal surveillance [5]. The rates of preterm birth, growth retarded foetuses and perinatal death, are significantly increased in pregnancies complicated by severe preeclampsia [6], [7]. Elective preterm delivery is frequently advised for hypertensive women in an attempt to improve neonatal outcome, although this may result in higher fetal mortality and morbidity because of prematurity.

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Material and Methods

Patient selection& clinical presentation: This is a prospective study of 41 pregnant women with pregnancy induced hypertension (PIH) evaluated sonographically with colour Doppler and to be followed subsequently for any adverse perinatal outcome. The study is to be conducted in

Department of Radiodiagnosis, N.S.C.B. Medical College, Jabalpur (M.P.) over a period of 14 months from September 2011 – October 2012.

Criteria for patient's selection: Inclusion Criteria: Pregnant women with pregnancy induced hypertension with more than 24 wk of pregnancy were included in the study. Acceptable reference standards for Pregnancy induced hypertension were persistently high systolic (≥ 140 mm Hg) or diastolic (≥ 90 mm Hg) blood pressure with or without proteinuria (≥ 0.3 g of protein in 24-hour urine collection, or dipstick test result of ≥ 1+ [equivalent to 30 mg/dL in single urine sample]) of new onset after 20 weeks of gestation. Exclusion Criteria: Pregnancy with severe congenital anamoly were excluded from study. In the Pregnancies with hypertension group the age of subjects ranged from 19 - 33 years with there gestational age at the time of examination varying from 25 wks to 39 wks respectively. All the subjects had their gestational age confirmed by 2-D, B mode ultrasonography by estimation of BPD (Bi-parietal diameter) , FL (Femur length) and abdominal circumference(AC) of the fetus, and then they were studied by colour Doppler. The findings at the time of first examination were taken in to consideration. Repetitive Doppler studies were performed whenever required. The subjects were followed till delivery and data at the time of delivery and final perinatal outcome was collected.

Technical consideration

1. Color Doppler ultrasound unit – A Siemens – Sonoline G – 50 B Logic 3 Expert – Ay 15 CUK – GE
2. Low frequency sectoral ultrasound transducer with a range of 3.5-5 Mhz
3. Insonation angle was taken less than 60 deg. and pre-systolic and end-diastolic velocities were defined manually after observing at least three consecutive waves.

Technique of scanning: Doppler measurements were taken with the mother in recumbent position during fetal inactivity and apnea. Gestational age of the patient was obtained using B mode 2-D 3.5-5 MHz convex probe and Doppler examination was done by pulsed Doppler method. The BPD (Bi parietal diameter), FL (Femur length) AC (Abdominal circumference) and MGA (Mean gestational age) and other relevant data were obtained initially. Then color Doppler was done.

Uterine Artery: The Uterine artery was studied by first identifying the placental site. If the placenta was unilateral, uterine artery of that side was studied. In case of central placenta, both uterine arteries were evaluated. The main branch of uterine artery is located at cervico-corporal junction. Uterine artery was examined at the level of internal os with full bladder seen crossing perpendicular to external iliac artery. Doppler velocimetry measurement performed near this location. The probe was positioned to obtain the best quality signals from uterine artery recognized by its characteristic sound and flow pattern. When the screen showed several waveforms of similar height and pattern, one image was frozen and peak systolic and end diastolic velocities were marked with cursors. The Resistive index, Pulsatility index and S/D ratio were obtained and the value was noted down.

Umbilical artery: Free - floating loop of umbilical cord was examined to evaluate Umbilical artery. Values at mid cord or placental insertion were taken as they were clinically reliable. The probe is positioned to obtain the best quality signals from umbilical artery. Care was taken not to take readings during fetal breathing for gross body movements. When the screen shows several waveforms of similar height and pattern, one image was frozen and peak systolic and end diastolic velocities were marked with cursors.

Middle cerebral artery: Middle cerebral artery was located in a transverse section of fetal skull at the level of thalami and cavum septum pellucidum. A transverse view of the fetal brain was obtained at the level of the biparietal diameter. The transducer is then moved towards the base of the skull at the level of the lesser wing of the sphenoid bone. Using color flow imaging, the middle cerebral artery can be seen as a major lateral branch of the circle of Willis, running anterolateral at the borderline between the anterior and the middle cerebral fossae. The pulsed Doppler sample gate is then placed on the middle portion of this vessel to obtain flow velocity waveforms. During the studies, care was taken to apply minimal pressure to the maternal abdomen with the transducer, as fetal head compression is associated with alterations of intracranial arterial waveform.

Ductus Venosus: The ductus venosus could be visualized either in a midsagittal longitudinal plane of the fetal trunk or in an oblique transverse plane through the upper abdomen. The sample volume was positioned at its origin from the umbilical vein, where color Doppler indicated the highest velocities. On gray scale DV is identified as a small vessel connecting UV and IVC. On C/F it is the brightest vessel showing aliasing (d/t turbulent flow) situated anterior to fetal aorta. Out come of pregnancy was studied in terms of mode of delivery, preterm or term delivery, Intra uterine growth retardation, birth weight, Apgar score, Intra uterine fetal death, and perinatal mortality.

Observations

Table 1: Distribution of PIH cases according to age

Age group(yrs)	Total cases
<20	1 2.4%
20-24	16 39.0%
25-29	14 34.1%
30-34	10 24.4%
Total	**41**

The cases under PIH were distributed under the age group of> 20, 20-24, 25-29, 30-34yrs under PIH majority of the cases came under the age group of 20-24 accounting for about 39.0% Mean age of subjects being 25.7 yrs. 34.1% cases were found in 25-29 age gp. Thus 73.1% of cases were found in 20-29 yrs age gp

Table 2: Distribution of PIH cases according to parity

Parity	Cases
0	17 (41.4%)
1	18 (43.9%)
2	5 (12.1%)
3 or more	1 (2.5%)
Total	**41 (100%)**

In this, pregnancy with hypertension group 17 (41.4%) patients were nullipara, 18 (43.9%) were primipara. Both together comprising 85.3% cases of PIH gp. Rest of 14.6% cases were multipara.

Table 3: Distribution of cases under normal and abnormal uterine artery indices

Uterine Artery	Total
Bilateral Abnormal	14 (34.1%)
Unilateral Abnormal	12 (29.3%)
Normal	15 (36.5%)
Total	**41 (100.0%)**

Under PIH cases, out of 41 cases, 26 cases had abnormal uterine artery Doppler indices accounting for 63.46%, while 15 cases had a normal Doppler indices accounting for 36.53%. Here we found that out of 26 cases of PIH showing raised Doppler indices and diastolic notch, 14 cases showed bilateral abnormality (B), either raised indices, diastolic notch or both leading to 34.1% cases of total. Whereas, 12 cases that is 29.3% cases showed unilateral Doppler abnormality

Table 4: Distribution of cases under normal and abnormal Middle cerebral artery Indices

Waveform-MCA	Total
I-Increase Diastolic Flow	25 , 60.97%
N-Normal	16, 39.03%
Total	**41, 100.00%**

In our study of PIH cases,out of 41 cases, 25 cases had abnormal Middle cerebral artery Doppler indices accounting for 60.97% cases showing increased diastolic flow with brain sparing effect While 16 cases had normal Middle cerebral artery Doppler indices accounting for 39.03% of cases.

Table 5: Distribution of cases under normal and abnormal Umbilical artery indices

Waveform – UA	Total
Normal	27 , 65.8%
Decreased diastolic flow (D)	11, 26.8%
Absent diastolic flow (A)	1, 2.4%
Reversal of diastolic flow (R)	2, 4.8%
Total	**41, 100.0%**

Under PIH cases, out of 41 cases in our study 14 cases had abnormal umbilical artery Doppler indices accounting for 34.2%, while 27 cases had a normal Doppler indices accounting for 65.8%. Here we found that out of 14 cases of PIH showing raised Doppler indices, 11 cases showed just decreased diastolic flow accounting for 26.8% of cases. While one of the case showed absent diastolic flow (A) amounting to 2.4% of cases.Two cases showed Reversal of diastolic flow (R) that is 4.8% of our cases.

Table 6: Distribution of cases with reversal of a wave in Ductus Venosus

Ductus Venosus Waveform	Total
A - Reversal of a wave	6, 14.6%
N - Normal	35, 85.37%
Total	41, 100.0%

Under PIH cases, out of 41 cases in our study 6 cases had Reversal of a wave in Ductus Venosus waveform that is in14.6%, while 35 cases had a normal Ductus Venosus Doppler waveform accounting for 85.37%.

Table 7: Correlation of birth weight with abnormal and normal uterine artery indices.

Uterine Artery	Birth Weight (In gms)				Total
	<1000	1000-1500	1500-2500	>2500	
B - Bilateral Abnormal	4 28.6%	2 14.3%	6 42.9%	2 14.3%	14 100.0%
N-Normal	0 .0%	2 13.3%	4 26.7%	9 60.0%	15 100.0%
U-Unilateral abnormal	2 16.7%	0 .0%	6 50.0%	4 33.3%	12 100.0%
Total	**6 14.6%**	**4 9.8%**	**16 39.0%**	**15 36.6%**	**41 100.0%**

In our study, out of 14 cases with bilateral uterine artery abnormality (B) maximum cases i.e. 12 cases (71.4%) were low birth wt, with 4 (28.6%) cases with birth wt. <1000gm. As compared to this only 2 cases (14.3%) of birth wt. >2500gm. $\chi 2$ Test was applied and association between B/L abnormal uterine artery and poor perinatal outcome in form of extremely Low birth wt. was found to be statistically significant , $\chi 2$ =4.97.(p value <0.05). While in normal uterine artery (N), out of 15 cases maximum cases i.e. 9 (60%) were of birth wt>2500gm (normal) with none of the cases with birth wt. <1000gm. 6 cases (40%) had wt. b/w 1000-2500gm. Out of 12 cases with unilateral uterine artery abnormality (U) 2 (16.7%) cases had birth wt. <1000gm. 6 cases (50%) were low birth wt, b/w 1500-2500gm. And 4 cases (33.3%) were of normal wt.

Table 8: Perinatal mortality in relation to abnormal uterine artery indices

Uterine Artery	Outcome		Total
	LB	IUD+END	
B - Bilateral Abnormal	9 64.3%	5 35.7%	14 100.0%
N-Normal	15 100.0%	0 .0%	15 100.0%
U-Unilateral abnormal	10 83.3%	2 16.7%	12 100.0%
Total	**34, 82.9%**	**7, 17.1%**	**41, 100.0%**

In our study, out of 14 cases with bilateral uterine artery abnormality (B) there was Intrauterine death(I) in 3 cases., 1case had birth asphyxia and was admitted to NICU but died on postnatal day 3.Another case developed severe neonatal jaundice and died on postnatal day 10i.e. Early neonatal death in 2 cases (E) leading to total 5 cases (35.7%) of perinatal mortality.(3I+2E) While in normal uterine artery (N), out of 15 cases there was no mortality. $\chi 2$ Test was applied and association between B/L abnormal uterine artery and perinatal mortality was found to be statistically significant , $\chi 2 = 6.47$.(p value <0.05) Out of 12 cases with unilateral uterine artery abnormality (U) there were 2 IUD (16.7% of cases) and 10 live births (83.3%)

Discussion

Pregnancy induced hypertension is prone to develop Intra uterine growth retardation and other catastrophic fetal outcomes and thus proper monitoring is essential. Pregnancy induced hypertension and small for gestational age are both pathological conditions strongly related to development and function of uteroplacental and fetoplacental circulations. Uteroplacental and fetoplacental insufficiency are the primary cause of I.U.G.R. and other catastrophic events related to pregnancy induced hypertension and -can be identified using uterine artery and umbilical artery Doppler velocimetry.In our study uterine artery, umbilical artery, middle cerebral artery and ductus venosus are studied with special emphasis on jeopardized fetus, so that timing of delivery can be decided, so that the purpose of i.e. to improve perinatal outcome can be achieved. In Pregnancy induced hypertension there is inadequate invasion of spiral arteries leading to increased resistances in spiral arteries. This leads to increased impedance of blood flow in uterine arteries Fleischer A, Schulman H, Farmakides G et al 1986 [8]. The findings in our study are consistent with above.In our study of uterine artery Doppler velocimetry among 41 case group, 15 (36.53%) subjects had normal flow pattern in uterine artery and 26 (63.46%) had abnormal flow pattern with raised indices and diastolic notches. Out of 26 cases of PIH showing raised Doppler indices and diastolic notch, 14 cases showed bilateral abnormality (B), either raised indices, diastolic notch or both leading to (34.1%) cases of total. Our findings were consistent with Mohd Khalid et al (2011)[9] to determine the role of Color Doppler Sonography in evaluation of fetal outcome in 58 antenatal females (22 normotensive, 36 hypertensive) in their third trimester of pregnancy. Arteries evaluated included – bilateral uterine arteries, umbilical artery, fetal middle cerebral and fetal aorta. In this study, 34(94.44%) out of 36 hypertensive patients showed abnormal uterine artery flow.U/L Uterine artery involved in 12 cases (33.3%). B/L uterine artery was involved in 22 (61.11%) cases. Axt-Fliedner Ret al (2004)[10] in a Prospective study to assess the role of uterine artery color Doppler waveform analysis in the prediction of adverse pregnancy outcome such as preeclampsia, intrauterine growth retardation, placental abruption or a combination of outcome parameters in risk pregnancies (n=52). According Jackson MR et al [11], patients with uterine artery notches and high resistance flow had significantly higher rates of fetal growth retardation and caesarean delivery because of fetal distress and had significantly bad pregnancy outcome. In our study of umbilical artery among 41 case group, 14 (34.2%), cases had abnormal umbilical artery Doppler indices while 27 (65.8%) cases had a normal Doppler indices. In our study of middle cerebral artery Doppler velocimetry among 41 case group, 25 (60.97%) had abnormal Middle cerebral artery. Doppler showing increased diastolic flow with brain sparing effect (I) while 16 (39.03%) cases had normal Middle cerebral artery Doppler indices. Similar findings were seen in study by B.N. Lakhkar et al in (2003)[12] prospectively examined 58 singleton pregnancies beyond 30 weeks of gestation complicated by intrauterine growth restriction and severe pre-eclampsia with Doppler. In this 35(60.3%) were primipara and 23(39.7%) were multipara. 36 (62%) had caesarean and 22(37.8%) had vaginal delivery. Thirty-six patients of the 58 included in the study population had at least one major or minor adverse outcome. Chan et al[13] studied 71 high-risk fetuses with weekly UA and MCA Doppler US examinations until delivery. In 15.5% (11 of 71) of fetuses, there was perinatal mortality or major morbidity, including major intracranial hemorrhage, periventricular leukomalacia, necrotizing enterocolitis, and major neurologic handicap (follow-up data in 24 cases and up to only 2 years of age). By using the last Doppler US result for analysis, the UA/MCA resistance index ratio, compared with the UA systolic-to-diastolic ratio, was more sensitive (75% vs 64%) but less specific (60% vs 74%). UA Doppler US was a better predictor for each of the individual adverse outcomes when separate analyses were performed. C.J. Bhatt, J Arora in 2003[14] studied total of 100 cases of PIH between 28 - 36 wks of gestation over a period of 2 years. for studying uterine, umbilical & fetal middle cerebral arteries. . S/ D ratio of greater than 3 & 2.6 in umbilical & uterine arteries respectively were considered abnormal Out of 100, 11 % cases out of these have both uterine and umbilical arteries as abnormal, 56% had abnormal S/D ratio in umbilical artery and/or uterine artery 60% of these patients delivered IUGR babies. In patients with absent end diastolic velocity (AEDV) & reversed end diastolic velocity (REDV) perinatal mortality was 50% & 50% had IUGR babies. The fetuses with compromised circulation showed increased diastolic flow in fetal MCA suggestive of brain sparing effect. In our study of Ductus venous velocimetry of 41 case group, 35 (85.37%) have normal flow whereas 6 (14.6%) had abnormal flow with Reversal of ‘a’ wave in Ductus Venosus Waveform (A) Turan OM et al (2011)[15] in One hundred and seventy-seven study participants underwent a total of 1069 examinations. Days of duration of absent/reversed UA end-diastolic velocity (UA-AREDV), low middle cerebral artery PI (brain sparing), ductus venosus

(DV) and umbilical vein Doppler abnormalities were related to stillbirth, major neonatal morbidity and intact survival. The duration of an absent/reversed a-wave in the DV (DV-RAV) was significantly higher in stillbirths (median, 6 days) compared with intact survivors and those with major morbidity (median, 0 days for both; P = 0.006 and P = 0.001, respectively). Baschat AA, et al [16] Patients with suspected intrauterine growth restriction (IUGR) underwent uniform fetal assessment including umbilical artery (UA), ductus venosus (DV) and umbilical vein (UV) Doppler. Absent or reversed UA end-diastolic velocity (UA-AREDV), absence or reversal of atrial systolic blood flow velocity in the DV (DV-RAV) and pulsatile flow in the umbilical vein (P-UV) were examined for their efficacy to predict critical outcomes (stillbirth, neonatal death, perinatal death, acidemia and birth asphyxia) before 37 weeks' gestation Overall, DV-RAV or P-UV offered the best prediction of acidemia and neonatal and perinatal death irrespective of the UA waveform. In fetuses with UA-AREDV, prediction of asphyxia and stillbirth was significantly enhanced by venous Doppler. Prediction of critical perinatal outcomes is improved when venous and umbilical artery qualitative waveform analysis is combined. The incorporation of venous Doppler into fetal surveillance is therefore strongly suggested for all preterm IUGR foetuses.

Conclusion

Doppler ultrasound offers the ability to screen cases of pregnancy induce hypertension early in gestation with a reproducible noninvasive haemodynamic testing mechanism. Doppler indices from the fetal circulation can reliably predict adverse perinatal outcome in an obstetric patient in high risk population like PIH population. The knowledge of uterine and umbilical artery waveform may help to improve pregnancy management and any permit identification and assessment of pregnancy induced hypertension at earliest gestation age as compared to other antepartum test modalities. Early identification creates possibility of early intervention and therapy. The Doppler patterns follow a longitudinal trend with early changes in the umbilical artery followed by middle cerebral artery and other peripheral arteries. Venous changes follow the arterial pattern and occur in severely compromised fetus. Doppler investigation plays an important role in monitoring the redistributing growth restricted fetus and thereby may help to determine the optimal time for delivery.

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