

A Prospective Study of Doppler Analysis in Pregnancy Induced Hypertension

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Abstract

Introduction: Hypertensive disorders complicating pregnancy are common and form one of the deadly triad, along with hemorrhage and infection, that contribute greatly to maternal morbidity and mortality. The incidence of various hypertensive disorder of pregnancy varies widely from 5 to 15% throughout the globe. It accounts for a total of 7-10% of perinatal mortality in developed countries and 20% in developing countries. The perinatal mortality is 5% in mild PIH and 15 to 25% in severe PIH.

Materials and Methods: The study was conducted at Rajendra Institute of Medical Sciences, Ranchi for a period of 12 months January 2018 to December 2018. Fifty hypertensive pregnant women coming to the hospital comprised the study group. The inclusion criteria was all antenatal cases diagnosed clinically having pregnancy induced hypertension beyond 28 weeks of gestation.

Results: In the present study out of the fifty pregnancy induced hypertension cases, thirty-six showed positive Doppler indices in one or all the three vessels studied. The remaining fourteen cases showed no abnormal Doppler indices in any of the three vessels studied. Out of 36 patients, 21 showed uterine artery SD ratio of >2.6 . Uterine artery RI was >0.58 in 20 cases [55%]. 55% of cases [20] showed diastolic notch in uterine artery. The CPR [cerebroplacental ratio i.e. MCA/Umbilical artery PI] was <1 in 69% of cases.

Conclusion: Pregnancy induced hypertension is associated with significant fetal morbidity and mortality. Persistence of Uterine artery early diastolic notch in third trimester is associated with severe form of hypertension and higher incidence of intrauterine growth restriction. Middle cerebral artery is less sensitive than umbilical artery. Absent end diastolic flow (AEDF) and reverse end diastolic flow (REDF) indicates severe fetal distress and is associated with 75% of perinatal mortality. Cerebroplacental ratio (CPR) of less than one is associated with significant neonatal complications, intrauterine growth retardation (IUGR) and perinatal death. Thus, color Doppler study of feto-maternal circulation in high-risk pregnancy like pregnancy induced hypertension (PIH) is valuable in prediction of adverse perinatal outcome.

Key Words: Hypertensive disorders, IUGR, Uterine artery, CPR.

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I. Introduction

Hypertensive disorders complicating pregnancy are common and form one of the deadly triad, along with hemorrhage and infection, that contribute greatly to maternal morbidity and mortality. The incidence of various hypertensive disorder of pregnancy varies widely from 5 to 15% throughout the globe.¹ It accounts for a total of 7-10% of perinatal mortality in developed countries and 20% in developing countries. The perinatal mortality is 5% in mild PIH and 15 to 25% in severe PIH.²

Satisfactory development of uteroplacental and fetoplacental circulation is necessary for a normal pregnancy outcome. Absence of its normal development can be associated with hypertension during pregnancy, which can lead to impaired circulation causing prematurity, subnormal growth (IUGR) or fetal death.³

Doppler ultrasound parameters provides a non-invasive method of measuring changes in blood flow in the uteroplacental circulation and fetoplacental circulation, thus assessing fetal well being.⁴

Management protocols for women with PIH include frequent antenatal visits with ultrasound and fetal doppler monitoring. Ultrasound biometry helps to identify a heterogeneous group of small for gestational age fetuses.⁵ With the use of Doppler velocimetry, early detection of compromised IUGR fetus is possible, which allows for timely intervention to improve perinatal outcome.² Evidence from randomized trials suggest that, if women with suspected intrauterine growth restriction and preeclampsia are offered Doppler studies of the umbilical artery, a clinically significant reduction in perinatal mortality may be expected.⁶ It has also been

suggested that screening of low risk women is not cost effective and also no significant improvement was observed in perinatal outcome.

II. Materials And Methods

The study was conducted at Rajendra Institute of Medical Sciences, Ranchi for a period of 12 months January 2018 to December 2018. Fifty hypertensive pregnant women coming to the hospital comprised the study group. The inclusion criteria was all antenatal cases diagnosed clinically having pregnancy induced hypertension beyond 28 weeks of gestation.

The first scan was performed in each case, as soon as the patient was registered in order to avoid any influence of treatment on Doppler sonogram. The gestational age was confirmed by menstrual history and ultrasound examination and was followed by color Doppler examination.

After thorough clinical examination, the patient was explained about the non-invasive/atraumatic nature of the procedure. Synthetic ultrasound-gel was applied liberally over the abdomen to get a good acoustic coupling. The instruments used was Philips HD 11 XE Color Doppler ultrasound machine, with a convex transducer of 2 to 5 MHz frequency.

Doppler waveform was obtained after localizing the vessels by B-mode real time scanner. Pulsed Doppler was used to get the Doppler signals after localizing the vessels. Peak Systolic and End diastolic velocities were obtained manually and various ratios were calculated from each vessel. Doppler examination was done when the fetus was in apneic state to avoid the Influence of fetal respiration on Doppler signals.

Inclusion Criteria:

1. All antenatal cases, diagnosed clinically having pregnancy induced hypertension beyond 28 weeks of gestational age.
2. Antenatal cases diagnosed having intrauterine growth retardation of the fetus.

Exclusion Criteria:

1. Antenatal cases with gestational age less than 28 weeks.
2. Normal routine antenatal case.
3. Twin or Multiple pregnancy.
4. Extrauterine pregnancy.
5. Antenatal cases with intrauterine fetal death.
6. Antenatal cases with congenital anomalies of the fetus.

Identification of the various Arteries:

1. Uterine Artery: Color Doppler facilitates identification of the uterine artery substantially, Transducer should be placed 2- 3cm medial to anterior superior iliac spine, directing the ultrasound beam to the lateral wall of the uterus and slightly downward towards the pelvis somewhere around isthmus. Narrower vessel crossing two large iliac vessels is the Uterine artery.
2. We have evaluated the uterine arteries on both sides.
3. Umbilical Artery: Flow velocity waveforms (FVWs) from umbilical artery can be easily obtained, for this color flow is not usually needed, Doppler signals can be acquired from different points in cord, usually from free loop of the cord.
4. Middle Cerebral Artery (MCA): The first step in identifying MCA is to obtain an image of the head suitable for obtaining a measurement of biparietal diameter. On using color flow we can identify MCA of both sides going towards sylvian fissure.

III. Results

A total of 50 pregnant women with Pregnancy induced Hypertension with gestational age >28 weeks were included in the study. Women were between 18-35 years of age. As shown in table 1 most cases were young patients [age<20 years] and primigravida. Only two cases were >30 years of age. 40% of cases had vaginal delivery. 38% [19 cases] had elective caesarean section and 22% i.e. 11 patients had to undergo emergency caesarean section.

Doppler imaging- In the present study out of the fifty PIH cases, thirty-six showed positive Doppler indices in one or all the three vessels studied. The remaining fourteen cases showed no abnormal Doppler indices in any of the three vessels studied. Out of 36 patients, 21 showed uterine artery SD ratio of >2.6. Uterine artery RI was >0.58 in 20 cases [55%]. 55% of cases [20] showed diastolic notch in uterine artery, out of which 66% [12 cases] had unilateral diastolic notch and about 34% cases had bilateral diastolic notch. If the systolic blood pressure is greater than 140mm Hg, then resistance indices in both uterine arteries are increased. If the systolic blood pressure is less than 140 mm Hg, three separate groups may be identified those with (a) bilateral

or (b) unilateral abnormalities of the waveform within the uterine arteries and (c) those with entirely normal uterine artery flow.

Umbilical artery SD ratio was >4 in 21 cases, 3-4 in 8 cases and 2-3 in 7 cases. Umbilical artery RI was >0.70 in 72% of cases. 75% of cases showed changes in umbilical artery Doppler study whereas rest [25%] had no change.

The physiological variations and anatomical complexities of the uteroplacental vascular tree make it difficult to obtain accurate and reproducible measurements using continuous wave Doppler. In later pregnancy between 37 to 40 weeks, maternal position may also alter flow patterns, with umbilical artery RI being higher in supine position than in decubitus. Furthermore, variations in uterine artery, maternal heart rate and exercise also significantly alter the waveform.

The CPR [cerebroplacental ratio i.e. MCA/Umbilical artery PI] was <1 in 69% of cases.

S.No	Age group (years)	No of cases
1	<20	31
2	21-25	14
3	26-30	03
4	31-35	02
5	Total	50

Table 1: Age Distribution of cases

SD Ration	No of cases	Percentage
<2.6	15	41.66
>2.6	21	58.34
Total	36	100

Table 2: Uterine Artery SD Ratio

Resistance Index	No of cases	Percentage
<0.58	16	44.45
>0.58	20	55.55
Total	36	100

Table 3: Uterine Artery Resistance Index

Diastolic Notch	No of cases	Percentage
No of cases with notch	20	55.55
No of cases without notch	16	45.45
Total	36	100

Table 4: uterine Artery Diastolic Notch

Incidence	No of cases	Percentage
Unilateral Diastolic Notch	12	60.00
Bilateral Diastolic notch	08	40.00
Total	20	100

Table 5: Incidence of Uterine Artery Diastolic Notch

	No of cases	Percentage
No. of cases with one uterine artery Doppler positive	21	44.00
No. of cases with both right and left uterine artery Doppler positive	15	36.00
No. of cases with normal uterine artery Doppler	14	20.00
Total	50	100.00

Table 6: Significance of Bilateral Notch in Uterine Artery

Umbilical Artery SD Ratio	No of cases
<1	00
1-2	00
2-3	07
3-4	08
>4	21
Total	36

Table 7: Umbilical Artery SD Ratio

Umbilical Artery RI	No of cases	Percentage
<0.70	10	27.77
>0.70	26	72.33
Total	36	100

Table 8: Umbilical Artery Resistance Index

Sensitivity	No of cases	Percentage
No. of cases with positive umbilical artery Doppler	27	75.00
No. of cases with negative umbilical artery Doppler	09	25.00
Total	36	100.00

Table 9: Umbilical artery percentage sensitivity

Parameters	Jane A Bates (%)	Present Study (%)
Abnormal umbilical artery SD ratio	76.00	57.14
Abnormal Fetal Doppler	62	42.85

Table 10: Sensitivity of Umbilical Artery Vs other Vessels

Parameters	No of cases	Percentage
Ratio of MCA/UA PI<1	25/36	69.45

Table 11: MCA Criteria for Cerebral Redistribution

Parameters	No of cases	Percentage
Uterine Artery	21/36	58.33
Umbilical Artery	27/36	75.00
Fetal MCA	11/36	30.55

Table 12: Sensitivity of Various Vessels Studied

Mode of Delivery	No of cases
Vaginal	20
Elective Caesarean-section	19
Emergency Caesarean –section	11
Total	50

Table 13: Mode of Delivery

IV. Discussion

Pregnancy induced hypertension is a common complication during pregnancy. Introduction of Doppler ultrasound in obstetrics allows us to study the changes in uteroplacental and fetal circulation in adverse conditions like PIH. By serial Doppler studies, we can follow the sequence of changes in response to fetal hypoxemia.⁷

In our study, we have included fifty clinically diagnosed PIH cases. None of the case is elderly primi. Of these cases, thirty-six cases (72%) were found Doppler positive for IUGR. The remaining fourteen (28%) does not show any evidence of IUGR on any single Doppler parameter. Campbette et al, 1983 observed that

patients with abnormal utero-placental waveforms had a higher incidence of hypertension than those with normal wave patterns.⁸

Many authors have linked preterm delivery with that of abnormal uteroplacental. Flow velocity waveforms (FVWs). Ducy et al (1987) studied 70 cases of hypertensive pregnancies with abnormal FVW, out of which 70.5% had preterm deliveries.⁹

Elective C-sections were performed in 38% and emergency C-sections were performed in 22% of whole group. In the present study, out of 30 C-sections performed, 70% were in the abnormal Doppler group indicating timely intervention to decrease perinatal mortality and morbidity. 42.2% had elective and 28.8% had emergency C-section. Low birth weight (LBW) babies are more commonly associated with abnormal FVWs.¹⁰

Uterine Artery: Normal value of systolic to diastolic ratio is 2.6 in third trimester. Increased values are seen in cases of growth retardation. More than 50% of cases show elevated systolic to diastolic ratio in the present study. Thaler et al (1992) evaluated 140 hypertensive pregnant women, out of them 27.8% had uterine artery early diastolic notching.

In the present study, out of the Doppler positive cases, 20 (55.55%) cases had uterine artery early diastolic notching. The upper limit for normal RI value in third trimester was considered 0.58. Increased RI values indicate that there is increased risk of IUGR. In our study more than fifty percent of cases show abnormal RI. A diastolic notch is defined as “a decrease in maximal flow velocity below the maximum diastolic velocities occurring just after the systolic wave”. In non-pregnant state uterine artery is a high resistance vessel. Low diastolic flow and early diastolic notching is a normal feature of the non-pregnant uterine circulation. During the second trimester, the trophoblast invades the myometrium converting the high resistance flow pattern into that of low resistance pattern characterized by increase in diastolic flow and disappearance of the notch. Persistence of notch after 28 weeks of gestation is an indicator of PIH/IUGR or both, Persistence of notch indicates unilateral vasospasm. Disappearance of notch will happen first in uterine artery which is directly under the placenta.

In the present study, number of cases with diastolic notch is approximating the same without the notch. The number of cases showing unilateral and bilateral notches forms 55.55% of total number of cases. Umbilical artery SD ratio was >4 in 21 cases, 3-4 in 8 cases. Umbilical artery RI was >0.70 in 72% of cases. 75% of cases showed changes in umbilical artery Doppler study whereas rest [25%] had no change.

The physiological variations and anatomical complexities of the uteroplacental vascular tree make it difficult to obtain accurate and reproducible measurements using continuous wave Doppler, with inter-observer variations ranging from 3.9 to 17%. In later pregnancy between 37 to 40 weeks, maternal position may also alter flow patterns, with umbilical artery RI being higher in supine position than in decubitus, Furthermore, variations in uterine artery, maternal heart rate and exercise also significantly alter the waveform.

Most of the antihypertensive drugs appear to have no effect on fetomaternal Blood flow. However, nifedipine appears to produce a reduction in umbilical artery resistance.

V. Conclusion

Pregnancy induced hypertension is associated with significant fetal morbidity and mortality. Normally, there is progressive fall of vascular resistance in uterine, placental and umbilical arteries as gestational age increases. This will result in high end-diastolic blood flow in all these blood vessels. Persistence of Uterine artery early diastolic notch in third trimester is associated with severe form of hypertension and higher incidence of intrauterine growth restriction. Middle cerebral artery is less sensitive than umbilical artery. Absent end diastolic flow (AEDF) and reverse end diastolic flow (REDF) in umbilical artery indicates severe fetal distress and is associated with 75% of perinatal mortality. Cerebroplacental ratio (CPR) of less than one is associated with significant neonatal complications, intrauterine growth retardation (IUGR) and perinatal death. So to conclude, color Doppler study of feto-maternal circulation in high-risk pregnancy like pregnancy induced hypertension (PIH) is valuable in prediction of adverse perinatal outcome. However, its routine use in all cases does not seem to be cost effective.

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