ORIGINAL RESEARCH

Perinatal Outcome and Pregnancy Induced Hypertension: A Better Prediction by Doppler Wave Form Study

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ABSTRACT

Introduction: Hypertension associated with pregnancy is associated with significant mortality. The aim of this study is to analyze the role of Doppler in PIH in predicting perinatal outcome.

Material and Methods: Hundred cases of women with pregnancy induced hypertension between 28-36 weeks of gestations were studied for umbilical artery (S/D ratio), uterine artery (S/D ratio) and middle cerebral artery (cerebro placental ratio). These data were correlated with perinatal outcome.

Result: 42 % patients showed abnormal Doppler out of which 28 % showed increased uterine artery S/D ratio and 23 % showed increased umbilical artery S/D ratio and 9 % patients had both umbilical and uterine artery S/D ratio increase. Statistical analysis showed that umbilical artery S/D ratio is the most sensitive (48.28%) in predicting perinatal morbidity while that of uterine artery was 44.44 %. The positive predictive value of umbilical artery was 63.64 % and that of uterine artery was 59.26 % crebroplacental ratio has direct correlation with adverse perinatal outcome.

Conclusion: Color Doppler study is a simple quick, noninvasive procedure and is found to be very useful in PIH for antepartum surveillance. Cerebroplacental ratio (MCA/UA) is a good predictor of adverse perinatal outcome and umbilical artery Doppler is more predictive than uterine artery Doppler for adverse perinatal outcome.

Keywords: early diastolic notch, end-diastolic velocity, Perinatal outcome, pulsatility index, resistance index.

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INTRODUCTION

Hypertension in pregnancy which comprises a spectrum of diseases like preeclampsia, eclampsia, gestational hypertension is responsible for significant maternal mortality, morbidity and perinatal morbidity and mortality. The incidence of various hypertensive disorder of pregnancy varies widely from 5 – 15 % throughout the globe. It accounts for a total of 7 – 10 % of prenatal mortality in developed countries and 20 % in developing countries. Doppler ultrasound has been in obstetries since 1977 to study fetoplacental circulation (umbilical) and since 1980s to study the uteroplacental (uterine) circulation and fetal circulation. Doppler ultrasound velocimetry provides a non-invasive method of measuring changes in blood flow in the uteroplacental circulation and fetoplacental circulation, thus assessing fetal wellbeing.[1]

Pregnancy induced hypertension is a high risk pregnancy from both maternal and foetal point of View. It has also been suggested that screening of low risk women is not cost effective with no significant improvement in perinatal outcome.[2]

MATERIAL AND METHOD

This prospective study was conducted between October 2014 to October 2015 over 100 women diagnosed with pregnancy induced hypertension at Rajendra Institute of Medical Sciences and Chandrama Imaging and health care. All cases were subjected to uterine and umbilical artery and middle cerebral artery Doppler along with morphology and biometry scan after fulfilling the inclusion and exclusion criteria. In every visit all patients were examined by obstetrician and physician.

Inclusion Criteria

Patients within 28 – 36 weeks of gestations diagnosed as pregnancy induced hypertension.

Exclusion Criteria

Multiple pregnancy, cardiac disease, renal disease, chronic hypertension, diabetes mellitus, vesicular mole, congenital anomalies of fetus, patient with unreliable LMP with no 1st trimester ultrasound.

Different Doppler indices are

S/D ratio i.e. $\frac{\text{Peak systolic velocity}}{\text{End diastolic velocity}}$

$$\text{Resistance index} = \frac{\text{Peak systolic} - \text{End diastolic}}{\text{Peak systolic velocity}}$$

$$\text{Pulsatility Index (PI)} = \frac{\text{Peak Systolic} - \text{End diastolic velocity}}{\text{Mean velocity}}$$

Procedure and collection of data

Study of various fetal vessels was performed using pulsed Doppler ultrasound. The following vessels were studied with the mother in a recumbent position during fetal inactivity and apnoea.

Uterine artery

The external iliac artery is visualized at pelvic side wall with color Doppler. The transducer is then angled medially towards the uterine artery. The flow velocity waveforms on the right and uterine arteries are taken, when 3 or 4 waves of equal height were seen, the image was frozen and measurements were taken, then Doppler indices were obtained directly from the machine.

Umbilical artery (UA)

Measurements were made from free loop of cord midway between the placental and abdominal wall insertion.

Middle cerebral artery (MCA)

For MCA Doppler US, a transverse image of the fetal head was obtained at the level of sphenoid bones. Color flow imaging was used to display the circle of willis. The MCA in the near field was insonated about 1 cm distal to origin from the internal carotid artery. MCA pulsatility index ratios were considered abnormal if the value was below the 5th percentile of previously published values for gestational age.[3] The MCA/UA PI ratio (cerebroplacental ratio) is usually constant during the last 10 weeks of gestation. It is possible to use a single cut off value after 30 weeks as reported in many study.[4,5,6]

Therefore In our study a single cut off value of (1.08) was used above which velocimetry was considered normal and below which it was considered abnormal. For umbilical artery S/D ratio was used as an indicator to evaluate perinatal outcome because increase in S/D ratio is the commonest abnormal finding in PIH and IUGR. S/D ratio greater than 3 in umbilical artery and greater than 2 in uterine artery respectively was considered abnormal. Absent end diastolic velocity (AEDV) and reversed end diastolic velocity (REDV) in umbilical artery and persistent early diastolic notch in uterine artery is considered abnormal. Data regarding perinatal outcome was collected which includes

1. Mode of delivery
2. Birth weight
3. 5 minutes Apgar score of less than 7.
4. Admission to NICU, duration of stay and final outcome, number of perinatal death.

The data collected from the study was analysed using sensitivity, specificity and predictive value.

1. $\text{Sensitivity} = \frac{\text{True Positive}}{(\text{true positive} + \text{false negative})} \times 100$
2. $\text{Specificity} = \frac{\text{True negative}}{\text{True negative} + \text{false positive}} \times 100$
3. $\text{Positive predictive value} = \frac{\text{True positive}}{\text{False positive} + \text{true positive}} \times 100$
4. $\text{Negative predictive value} = \frac{\text{True negative}}{\text{True negative} + \text{false negative}} \times 100$

STATISTICAL ANALYSIS

The data was analyses statistically using SPSS version 21. Descriptive statistics were used to infer results.

RESULTS

In our study maximum patients (35 %) were between age group 25-29 years and 30 % between 20-24 years. Maximum patients, 67 % were primi. Thirty Nine Percent neonates had birth weight between 2.26 – 2.50 Kg, 20 % had between 2.76 – 3.00 Kg and 8 % had less than 2 Kg. At the time of scan 25% patients had gestational age 35 weeks, 22 % between 34 – 35 weeks, 24 % between 32-33 weeks of gestational age. At the time of delivery 52 % had 38 weeks of gestational age and 8 % were delivered at less than 34 weeks of gestational age. Mean value for the gestational age at the time of scan was 34.82, mean birth weight was 2.5013 Kg, mean value for APGAR at 5 minutes was 5.36 and mean stay in NICU was 12.57 days. Ninety Fifth percentile for umbilical artery S/D ratio was 5.74 and uterine artery was 4.64 (table-1). The S/D ratio of umbilical artery decreases with advance gestation, from 4 at 20 weeks to 2 at term. After 30 weeks S/D ratio is usually less than three. Umbilical artery doppler is set to be abnormal if the S/D ratio is above the 95th percentile for gestational age. In our study abnormal cerebroplacental ratio was associated with low birth weight (less than 2.5 Kg) in 48 babies. This is because in PIH due to placental insufficiency there is hypoxia, which causes increased blood flow in middle cerebral artery as reflex redistribution of fetal cardiac output (decrease resistance with low pulsatility index).

Study variable	No. of Subjects	Minimum	Maximum	Mean	Standard Deviations	Standard Error	95th Percentile
S/D ratio of umbilical artery	100	1.27	6.07	2.96	1.19	0.119	5.74
S/D ratio of uterine artery	100	1.24	5.06	2.2	1.02	0.010432	4.69

Table-1: Descriptive statistics of 95th percentile used for the umbilical artery and uterine artery

However, in very late stage, flow to brain also decreases and resistance increases.

Increased S/D ratio in both umbilical artery and uterine artery was found in 9 % of cases out of which 8 % had IUGR and one IUD. Increased S/D ratio in umbilical artery and normal in uterine artery was also associated with IUGR. This reflects that S/D ratio of umbilical artery is direct reflection of foetoplacental perfusion. It has also been shown in a longitudinal observational study that S/D ratio of umbilical artery is more helpful than other tests of fetal well being (ex. heart rate variability and bio physical profile score) (table-3). In our study umbilical artery S/D ratio was associated with low APGAR in 22.01 %, IUGR in 35.80 %, preterm birth in 22.52 % whereas both umbilical artery and uterine artery increased S/D ratio was associated with low APGAR in 55.95%, IUGR in 78.02 %, preterm birth in 66.23 % and normal birth weight in none (table-4). This is because in PIH, there is no proper trophoblastic invasion of spiral artery in the beginning of second trimester. This results in persistence of diastolic notch and high resistance flow in PIH and increased S/D ratio in both uterine and umbilical artery. In PIH, due to placental insufficiency there is greater placental resistance, which is reflected in a decrease end diastolic component of umbilical and uterine artery and increased S/D ratio. This finally leads to increased perinatal mortality and morbidity and increased rate of preterm birth, low birth weight baby and also responsible for increased LSCS rate. In our study six patients had absent or reversed umbilical artery out of which one had IUD at 30 weeks two babies was born preterm at 34 weeks and was admitted in NICU and had an APGAR score of 4 at 5 minutes. Two babies had IUGR and another one was stillborn. In our study statistical analysis showed that umbilical artery S/D ratio is the most sensitive (48.56%) in predicting perinatal morbidity while that of uterine artery was 45.42%. The positive predictive value of umbilical artery was 64.24 % and that of uterine artery was 59.84 %. This indicates that umbilical artery Doppler is more predictive than uterine artery Doppler for adverse perinatal outcome (table-5). Yoon et al, Gramellini et al (mentioned earlier) also concluded that abnormal umbilical artery S/D ratio is a strong and independent factor for predicting adverse perinatal outcome in PIH.

MCA/UA	Birth Weight				Total
	Normal (> 2.5 kg)		Low Birth Weight (< 2.5 kg)		
	No.	%	No.	%	No.
Normal	22	55.00	18	45	40
Abnormal	12	20.00	48	80	60
Total	34		66		100

Table-2: Association of Cerebrowplacental (MCA/UA) ratio with birth weight

Uterine artery	Umbilical artery	Percentage
Normal S/D ratio	Normal S/D ratio	59
↑S/D ratio	Normal S/D ratio	18
Normal S/D ratio	↑S/D ratio	15
↑S/D ratio	↑S/D ratio	8

Table-3: Doppler wave form outcome in the study

DISCUSSION

Pregnancy induced hypertension is associated with significant perinatal morbity and mortality as well as maternal mortality and morbidity. One of the main aim of routine antenatal care is to identify the 'at risk' fetus in order to apply clinical intervention which could result in reduced perinatal morbidity and mortality. During the proliferative phase of the menstrual cycle the uterine vessels are similar to other vessels in the body. There is a prominent early diastolic notch and little or no end diastolic velocity. The S/D ratio ranges between 12.9 ± 4.4. At the end of secretary phase, the end diastolic component is usually present. The S/D ratio becomes approximately eight.

There are no further changes during first 10 weeks of pregnancy. In the beginning of the second termester there is sharp decrease in the S/D ratio between 2.6 – 3.0. This decrease resistance is first seen in the arcuate arteries. In the proximal uterine arteries the resistance remains high until the trophoblastic invasion takes place and placental circulation is fully established. The early diastolic notch disappears between

Perinatal outcome	Umbilical and uterine artery normal S/D	Umbilical artery normal uterine artery ↑ S/D	Umbilical artery ↑ uterine artery normal S/D	Both umbilical AND uterine artery ↑S/D
Mortality	NIL	NIL	NIL	33.64
Low APGAR	14.02	16.01	22.01	55.95
IUGR	26.12	27.02	35.80	78.02
PRETERM	9.98	29.92	22.52	66.53
Normal birth weight	78.96	61.97	62.92	NIL

Table–4: Perinatal outcome in correlation to normal and abnormal uterine and umbilical artery Doppler

Vessels	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Uterine artery	45.42 %	83.45 %	59.84 %	73.23 %
Umbilical artery	48.56 %	88.60 %	64.24 %	79.01 %
Both umbilical and uterine artery	24.78 %	96.99 %	89.92 %	53.98 %

Table–5: Efficacy of Doppler parameter in predicting adverse perinatal outcome

Author	Indicator	Sensitivity	Specificity	PPV	NPV
Atkinson et al 1994	S/D Ratio	18 %	91 %	13 %	94 %
Beattie and Darman et al 1989	S/D ratio	40 %	84 %		

Table-6: Previous study for perinatal outcome in PIH (umbilical artery doppler waveform study)

20- 26 weeks due to morphological changes in the spiral arteries. In the fourth stage S/D ratio remains stable throughout at a value less than 2.6.

Diastolic component of the Doppler waveform is thus transformed during normal pregnancy from one low peak velocity and an early diastolic notch to one of high flow and no diastolic notch by 18-20 weeks. This marked decrease in vascular impedance and the disappearance of early diastolic notch is due to trophoblastic invasion of the spiral arteries. Pregnancy with abnormal out come (PIH/IUGR) are characterized by

(a) Low diastolic flow
(b) High resistive index that persist throughout the pregnancies.

In normal pregnancy, the three indices, S/D, PI and RI decreases with advancing gestation[7] in umbilical artery. But in PIH and IUGR first there is decreased diastolic flow in the umbilical artery due to increase in the resistance that occurs in small arteries and arterioles of the tertiary villi. Thus raises the S/D ratio; PI and RI of umbilical artery. As the placental insufficiency worsens, the diastolic flow decreases, then become absent, and later reverses. The prevalence of perinatal death in fetuses with absent or reversed end diastolic flow velocity is reported to be over 40 %[8] Yoon et al[9] demonstrated in their study that absent umbilical artery waveform is a strong and independent predictor of adverse perinatal outcome. In our study umbilical artery S/D ratio, uterine artery S/D ratio, MCA/UA PI ratio, doppler indices are included that reflects foetoplacental and uteroplacental circulation and perfusion of cerebral vascular beds for identifying compromised fetuses. It is difficult to define normal and abnormal umbilical flow velocity before 28-30 weeks, except the absent end diastolic velocity after 20 weeks. Therefore we studied the doppler indices of umbilical artery after 28 weeks in agreement with Gramellini (mentioned earlier).

Fetal MCA is a low resistance circulation throughout pregnancy and accounts for 7 % of fetal cardiac output.[10] The MCA impedance varies during gestation according to Mari et al[11] with a parabolic pattern during pregnancy significantly after delivery. Increase in diastolic flow with decreased pulsatility index shows the brain sparing effect taking place in compromised fetuses. Arbeille et al. found that the cerebral placental ratio is constant during especially after 30 weeks and suggested one as the cut off value; all values less than one are abnormal

In this analysis of adverse perinatal outcome results of K. W. Fong et al[12] can be compared with this results. The values of umbilical artery sensitivity and specificity in this study (48.56 % and 88.60 %) is comparable to that of K. W. Fong et al (44.7 % and 86.6 %).

Limitation

1. The Doppler indices are affected by following:
2. Fetal breathing movement
3. Foetal heart rate

Location of measurement/ Location of gating for sample volume

S/D ratio, PI and RI shows higher values when recorded near the fetal abdominal part of the umbilical artery compared to the placental end. The use of PI is preferred when diastolic flow is absent, S/D ratio is not measureable and RI tends to be one. Therefore, PI is preferred in cases where there is reduction, absence or reversal of diastolic flow as PI will not be biased. Interobserver and intraobserver variations are also cause of errors.

CONCLUSION

Doppler wave form study is a good noninvasive test to know foetal condition and thus to know time of intervention in pregnancy induced hypertension. This will help in reducing perinatal morbidity and mortabiliy. Also there is need to study more and more about physiological changes and changes during deasease process (PIH/IUGR) in fetoplacental and uteroplacental circulation. As well as there is need to include more Doppler indices and to get a standardized cut off value to compare the results. The color Doppler is a simple, quick, non invasive procedure and is found to be the most accurate among the other tests for antepartum surveillance.

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