Clinical correlation of doppler ultrasound in pregnancy induced hypertension with special reference to perinatal outcome

Authors

1) **Hem Kanta Sarma, Professor and Head of the department of Obstetrics and Gynaecology, JMCH, Jorhat, Assam, India.**
2) **Uma Y, Postgraduate trainee, Department of Obstetrics and Gynaecology, JMCH, Jorhat, Assam, India.**
3) **Rupak Bhuyan, Associate professor, Department of Radiology, JMCH, Jorhat, Assam, India.**
4) **Pranabika Mahanta, Assistant professor, Department of Obstetrics and Gynaecology, JMCH, Jorhat, Assam, India.**

Corresponding Author: Dr. Uma Y, Postgraduate trainee, Department of Obstetrics and Gynaecology, JMCH, Jorhat, Assam, India; Email: umay0505@gmail.com

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Abstract:

Objective: To identify early high risk fetuses by changes in doppler flow velocity waveforms. **Methodology**: This was an observational, cross sectional study of 90 singleton pregnancies in the third trimester with pregnancy induced hypertension. The results of last doppler ultrasound within one week of delivery were used for analysis. Adverse perinatal outcome was studied in the form of emergency caesarean section for fetal distress, APGAR<7 at 5 mins, NICU admission, neonatal morbidity (asphyxia, meconium aspiration syndrome, sepsis) and perinatal mortality. sensitivity and specificity of various doppler parameters were calculated after comparing with standard. **Result**: Cerebroplacental ratio and umbilical artery pulsatility index had the highest sensitivity (100%) and Middle cerebral artery resistance index had the highest specificity (97%) in predicting perinatal outcome. Uterine artery doppler evaluation also gives additional information in predicting perinatal outcome**. Conclusion** – Amongst various doppler parameters cerebroplacental ratio is the best predictor of adverse perinatal outcome. Combination of various parameters is useful in decision making process mainly to decide the timing of delivery.

Keywords: Pregnancy induced hypertension, color doppler, perinatal outcome.

Hypertensive disorders during pregnancy remain the most common medical complications, leading to majority of adverse perinatal and maternal outcome despite numerous efforts have been made at early diagnosis, prevention and treatment. The incidence of various hypertensive disorders of pregnancy varies widely from 5-10% with perinatal mortality of 15-20 % in developing countries.[1,2]

Preeclampsia is associated with altered uteroplacental circulation which may in turn affect the fetal growth as well as fetal hypoxia and an inability to tolerate the in utero environment leading to intrauterine death. Doppler does correlate well with fetal compromise giving earlier warning sign of fetal distress than other tests.

The present study is undertaken considering the important role of doppler evaluation of umbilical artery, middle cerebral artery and uterine artery in detecting early fetal compromise in PIH patients, thus preventing probable neonatal morbidity and mortality by timely intervention. The aim of the present study is to clinically correlate the findings of doppler ultrasound in pregnancy induced hypertension with perinatal outcome.

Materials and methods

The study design was observational, cross sectional study. Study population included pregnancy induced hypertension cases attending obstetrics and gynecology department, Jorhat Medical College and Hospital, Jorhat from June 2020 to May 2021. Random sampling technique was used.

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Sample size being 90. Pilot study was conducted. As per records, pregnancy induced hypertension (PIH) cases admitted in O & G department in JMCH are noted to be Jan 2020 - 55, Feb 2020 – 62, March 2020- 54. Considering 60 as round figure and duration of study being 12 months, study population is obtained. Considering this study population, under 95% confidence interval, 10% absolute error, using Open Epi software, sample size is calculated as 85, round figure 90.

Inclusion criteria were singleton pregnancy, clinically diagnosed as PIH. Exclusion criteria were patients not willing to give written informed consent, multiple gestation, congenital anomalies of fetus, IUD at time of first doppler examination, coexisting medical and obstetric complications which affect the perinatal outcome and patients who could not be followed up.

Due permission from institutional ethical committee of Jorhat Medical College and Hospital was taken prior to commencement of study. Informed written consent was taken from all patients. Detailed history and clinical examination was done. All these patients were subjected to various investigations like viral markers, blood grouping, complete blood count, RBS, LFT, KFT, urine albumin, serum electrolytes, coagulation profile, thyroid profile. The relevant data (history, clinical findings, and investigations) obtained was recorded in standard prepared proforma.

Detailed ultrasound examination with doppler studies was done using ultrasound system (mindray, samsung) with curvilinear probe of transducer frequency 1-7MHz. The following vessels were studied - umbilical artery, middle cerebral artery and uterine artery. The above vessels were located in standard plane. The Umbilical artery (UA) measurements were made from free loop of cord. Middle cerebral artery (MCA), we took an axial section at the level of bilateral thalami and sphenoid bone wings and visualize the MCA. Color doppler was taken from proximal third of MCA near its origin with the angle of insonation near to 0 degree. Uterine artery of placental side was considered, or the mean if there is a symmetrical placenta. Systolic flow (S) and diastolic flow (D) for the above mentioned arteries were obtained to calculate various doppler indices. Flow velocity waveforms, the resistance index (RI), pulsatility index (PI), systolic/diastolic ratio (S/D) of the above vessels were noted. Cerebroplacental ratio or MCA/UA PI ratio was also noted.

Umbilical artery (UtA) S/D ratio was considered abnormal if more than 3. Umbilical artery RI and PI were considered abnormal when it was more than the 95th percentile of the range of reference.[3] Absent and reverse end diastolic flow of umbilical artery doppler were considered abnormal. Middle cerebral artery RI and PI were considered abnormal when it was less than 5th percentile of the range of reference.[4] Cerebroplacental ratio, a single cutoff value 1.08 is used below which it is considered as abnormal. Uterine artery flow waveforms were considered abnormal with the presence of early diastolic notch and RI more than 95th percentile of the range of reference in any one uterine artery.[3]

Follow up doppler studies were performed if indicated to determine and monitor a favorable or worsening fetal wellbeing status at weekly interval. Howeveronly results of last doppler ultrasound within one week of delivery were used for analysis. Further management of cases decided to depend on clinical status of patient and doppler report. The pregnancies are terminated according to obstetric indications. Patients are followed up till delivery. Further perinatal outcome were studied.

Adverse perinatal outcome was studied in form of major adverse outcomes – perinatal mortality (still births and neonatal mortality). Minor adverse outcome – emergency cesarean section for fetal distress, NICU admission, neonatal morbidity like asphyxia, meconium aspiration syndrome, sepsis.

The newborns discharged at 48 hours following normal delivery were followed up telephonically for till 7 days postnatal age for any morbidity and mortality. Data collection continued till 90 cases were obtained.

Statistical analysis was done with the help of SPSS Software and Open Epi software. Microsoft word and excel was used to generate graphs and tables. Sensitivity, specificity was calculated for study variables after comparing with standard.

Result

The study comprised a total of 90 patients. The age of the patients in this study ranges from 17 years to 37 years of which majority belonged to the age group of 21-25 years with a mean age of 23.7. The incidence of primigravida (63.3%) was more than that of multigravida (36.6%). The study group included patients whose gestational age ranged from 28 - 42 weeks. Maximum number of patients (75.5%) belonged to 37-40 weeks with mean gestational age of 36 weeks 5 days. Out of 90 cases included in the study 35 patients had severe PIH and the remaining 55 patients had mild PIH (table 1).

Table 1: Maternal and fetal characteristics of study population (n=90)		
Characteristics	**Number**	**Percentage**
Parity		
Primi	57	63.3
Multi	33	36.6
Gestational age		
28-32 weeks	3	3.3
33-36 weeks	19	21.1
>37 weeks	68	75.5
Severity of hypertension		
Mild	55	61.1
Severe	35	38.8

Out of 90 patients, 3 babies were still born and 3 babies had neonatal mortality. 27 patients were taken for emergency LSCS with the indication of fetal distress. Total of 19 babies were admitted to NICU and among them 10 babies had neonatal morbidity like asphyxia, sepsis, meconium aspiration syndrome and 10 babies had APGAR <7 at 5 minutes (table 2).

Table 2: Adverse perinatal outcome		
Outcome parameter	**Number**	**Percentage**
LSCS for fetal distress	27	30
NICU admission	19	21.1
APGAR<7 at 5 mins	10	11.1
Neonatal morbidity (asphyxia, sepsis, MAS)	10	11.1
Perinatal mortality	6	6.6

Umbilical artery PI analysis showed that patients with elevated PI had a poor perinatal outcome. Perinatal mortality was seen in 6(13.3%) patients with an elevated PI, while those with a normal PI had no perinatal mortality. 22(48.8%) patients with an elevated PI underwent LSCS for fetal distress, whereas the incidence was only 5(11.1%) in the normal PI group. 8(17.7%) of babies with elevated PI had APGAR <7 at 5 minutes. 16(35.5%) of babies in the elevated PI group required NICU admission of whom 8(17.7%) had neonatal morbidity, whereas in the normal PI group 3(6.6%) of babies required NICU care and 2(4.4%) had neonatal morbidity (table 3).

Table 3: Umbilical PI correlation with fetal outcome						
Fetal outcome	**Abnormal UA PI**		**Normal UA PI**		**Sensitivity**	**Specificity**
	N (45)	**%**	**N (45)**	**%**		
LSCS for fetal distress	22	48.8	5	11.1		
NICU admission	16	35.5	3	6.6	84%	59%
APGAR<7 at 5 mins	8	17.7	2	4.4	80%	53%
Neonatal morbidity	8	17.7	2	4.4	80%	53%
Perinatal mortality	6	13.3	0	-		

Out of 90 cases studied 2 patients had AEDF (Absent diastolic flow) and 3 patients had REDF (Reverse diastolic flow) in the umbilical arterty. Out of 2 cases with AEDF, one baby died on day 6 and other baby suffered neonatal

morbidity and discharged after 30 days of NICU care. Out of 3 cases with REDF, 2 babies were stillborn and 1 baby died on day 6. Thus REDF showing 100% perinatal mortality and AEDF with 100% neonatal morbidity. Perinatal mortality was seen in 4(19%) patients with an abnormal middle cerebral artery PI, while those with a normal PI had perinatal mortality of 2(2.8%) patients. 11(52.3%) patients with an abnormal PI underwent LSCS for fetal distress, whereas the incidence was only 16(23%) in the normal PI group. 4(19%) of babies with abnormal PI had APGAR <7 at 5 minutes. 11(52.3%) of babies in the abnormal PI group required NICU admission of whom 5(23.8%) had neonatal morbidity, whereas in the normal PI group 8(11.5%) of babies required NICU care and 5(7.5%) had neonatal morbidity (table 4).

Table 4: MCA PI with fetal outcome

Fetal outcome	Abnormal MCA PI		Normal MCA PI		Sensitivity	Specificity
	N (21)	%	N (69)	%		
LSCS for fetal distress	11	52.3	16	23		
NICU admission	11	52.3	8	11.5	58%	86%
APGAR<7 at 5 mins	4	19	6	8.6	40%	78%
Neonatal morbidity	5	23.8	5	7.5	50%	80%
Perinatal mortality	4	19	2	2.8		

Perinatal mortality was seen in 6(16.2%) patients with an abnormal CPR, while those with a normal CPR had no perinatal mortality. 20(54%) patients with an abnormal CPR underwent LSCS for fetal distress, whereas the incidence was only 7(13.2%) in the normal CPR group. 8(21.6%) of babies with abnormal CPR had APGAR <7 at 5 minutes. 16(43%) of babies in the abnormal CPR group required NICU admission of whom 8(21.6%) had neonatal morbidity, whereas in the normal CPR group 3(5.6%) of babies required NICU care and 2(3.7%) had neonatal morbidity (table 5).

Table 5: CPR correlation with fetal outcome

Fetal outcome	Abnormal CPR		Normal CPR		Sensitivity	Specificity
	N (37)	%	N (53)	%		
LSCS for fetal distress	20	54	7	13.2		
NICU admission	16	43	3	5.6	84%	70%
APGAR<7 at 5 mins	8	21.6	2	3.7	80%	64%
Neonatal morbidity	8	21.6	2	3.7	80%	64%
Perinatal mortality	6	16.2	0	-		

Perinatal mortality was seen in 4(22.2%) patients with an abnormal uterine artery (Ut A) RI, while those with a normal RI had perinatal mortality of 2(2.7%) patients. 12(66.6%) patients with abnormal RI underwent LSCS for fetal distress whereas the incidence was only 15(20.8%) in normal RI group. 7(38.8%) baby with abnormal RI had APGAR <7 at 5 minutes. 11(61.1%) of babies in the abnormal RI group required NICU admission with 6(33.3%) cases neonatal morbidity, whereas in the normal RI group 8(11.1%) of babies required NICU care and 4(5.5%) had neonatal morbidity (table 6).

Table 6: Uterine RI with fetal outcome

Fetal outcome	Abnormal Ut A RI		Normal Ut A RI		Sensitivity	Specificity
	N (18)	%	N (72)	%		
LSCS for fetal distress	12	66.6	15	20.8		
NICU admission	11	61.1	8	11.1	57.8%	90.1%
APGAR<7 at 5 mins	7	38.8	3	4.1	70%	86%
Neonatal morbidity	6	33.3	4	5.5	60%	85%
Perinatal mortality	4	22.2	2	2.7		

Discussion

The role of doppler ultrasound to understand the uteroplacental and fetoplacental circulation in pregnancy induced hypertension is well studied by various researchers. In a normal pregnancy, there is a low resistance in

uteroplacental and fetoplacental circulation. Pregnancy induced hypertension is associated with defective trophoblastic invasion which further leads to abnormal placental vascular flow. Doppler studies help in detecting the abnormal vascular resistance patterns in compromised fetuses so that timely intervention can be done.

The mean age of the mother in present study is 23.7 years. In similar studies by Smitha et al [5] and Ozeren et al [6], they reported mean age as 23.4 and 27.6 years respectively. In the present study 63.3% of the patients were primigravidas where as in the studies by Mohd Khalid et al [7] and Lakhkar BN et al [8] 77.7% and 60.3% patients were primigravida respectively. The average gestational age at the time of delivery was found to be 36.51 weeks, whereas in the studies by Ozeren et al [6] and Mohd Khalid et al [7] it was 36.63 and 37.44 respectively. The average birth weight in present study is 2630 grams, whereas in the studies by Ozeren et al [6], Mohd Khalid et al [7] and Lakhkar BN et al [8] it is reported as 2356 grams, 2440 grams and 1798.70 grams respectively.

The umbilical artery doppler is an index of resistance to flow in the fetoplacental circulation and has a strong correlation with the presence or absence of fetal hypoxia and acidosis. In cases of placental vascular insufficiency diastolic flow decreases causing the umbilical artery S/D ratio to increase to values 2SD or higher above the mean for the gestational age. With progression of placental vascular insufficiency there will be AEDF followed by REDF which is an ominous sign indicating the presence of fetal hypoxia and need to deliver the fetus. Umbilical artery doppler is considered abnormal if the values are above the 95th percentile for the gestational age. In present study UA S/D ratio showed a sensitivity and specificity of 63% and 69% in predicting adverse perinatal outcome whereas sensitivity and specificity in the study Ozeren et al [6] was 88% and 97%, Lakhkar BN et al [8] was 66.6% and 45.4%, Kofinas et al [13] was 71% and 93% respectively. The sensitivity and specificity of umbilical artery PI in prediction of adverse perinatal outcome of present study was 84% and 59% whereas in studies done by Smitha et al [5] was 90.26% and 80.57%, Lakhkar BN et al [8] was 50% and 59% and Yoon et al [10] was 89% and 86% and are comparable. Fetuses with absent and reverse end diastolic flow was at a significantly increased risk for delivery at low gestation, IUGR, low birth weight and perinatal deaths. In the present study both babies with AEDF were admitted to NICU and one baby died on day 6 resulting in mortality of 50%. But out of 3 babies with REDF, one required NICU admission and died on day 5 and the remaining two were stillborn resulting into mortality rate of 100% comparable with studies done by Smitha et al [5], AEDF had mortality rate of 27.78% and REDF had mortality rate of 100%.

It has high impedance low flow circulation and is a more sensitive parameter of fetal oxygenation status than umbilical blood flow. In the present study, the specificity of MCA S/D ratio in detecting adverse perinatal outcome are 91%. Lakhkar BN et al [8] in his study concluded that S/D ratio of MCA/UA is the most sensitive and specific index in predicting perinatal adverse outcome.

Cerebroplacental ratio (CPR) is the ratio of the MCA to UA pulsatility index. CPR compares the resistance to blood flow in the umbilical artery and the MCA. It measures the proportion of flow supplying the brain and the placenta. The CPR is a possibly better predictor of adverse outcome than the ratio in either of the vessels on their own. In the present study, abnormal cerebroplacental ratio was found in 90.4% of the babies admitted to NICU. The sensitivity and specificity of cerebroplacental ratio in predicting adverse perinatal outcome in the present study was 84% and 70% and by different studies Ozeren et al [6] was 81% and 89%, Gramellini et al [9] was 68% and 98.4% and Fong et al [11] was 51.3% and 80.6%. In the similar study by Rozeta Shahinaj et al[12], they found high sensitivity of MCA/UA PI ratio in predicting still birth.

Kofinas et al[13] in his study yielded a sensitivity of 66% and specificity of 64% for uterine artery S/D. But when it was combined with umbilical artery S/D sensitivity increased to 75% and specificity increased to 100%. Frusca et al [14] in a retrospective study on 344 hypertensive pregnant women found abnormal uterine velocimetry was associated with worse pregnancy outcome. Mohd Khalid et al [7] in their study found that 94.44% hypertensive women showed abnormal uterine artery doppler of which 32.25% had intrauterine growth restriction and one had intrauterine death as fetal outcome. In the present study uterine artery RI had specificity of 90.1% in predicting abnormal perinatal outcome. In the present study, uterine artery notch had a sensitivity and specificity of 26% and 92% respectively. However, in combination with other uterine artery doppler indices it is a good indicator for prediction of adverse perinatal outcome. Hazra et al[15] in his study found that in patients with uterine artery early diastolic notch, 13% babies were still born and 25% neonates required NICU admissions.

The limitations of this study were less duration, small sample size, study being conducted at a tertiary care government hospital where high numbers of complicated referral cases are received.

Conclusion

Multi vessel color doppler ultrasound studies are important monitoring tools in patients with PIH to identify compromised fetuses in utero and to take timely appropriate action. In the present study, the findings of AEDF and REDF were associated with significant perinatal morbidity and mortality. All babies with AEDF required NICU admission whereas 100% babies with a REDF had succumbed to death. Hence AEDF and REDF are ominous sign in doppler study and prompt action for intervention is necessary in these cases. Considering cerebroplacental ratio is better than UA PI and MCA PI alone. Because CPR incorporates data not only on the placental side but also the fetal response. Additional uterine artery doppler evaluation is also helpful in predicting adverse pregnancy outcome. Considering all parameters in predicting adverse perinatal outcome, combination of various parameters can be useful in decision making process especially to decide the timing of delivery. Management depends on overall evaluation of the maternal and fetal condition individualized to each patient.

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