



Radio-Diagnosis

STUDY OF DOPPLER VELOCITY WAVEFORM IN PREGNANCY INDUCED HYPERTENSION PATIENTS AND ITS CORRELATION WITH PERINATAL OUTCOME

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ABSTRACT

Background: Pregnancy induced hypertension(PIH) poses a great risk to the maternal and child health issues. Early diagnosis, assessment of prognosis, and appropriate management at a judicious moment can change its fate in many ways.

Objective: To assess the usefulness of Doppler parameters to evaluate PIH and to predict its adverse perinatal outcome.

Methodology: 49 pregnant patients were taken after applying criteria and undergone ultrasonography and doppler with follow up subsequently.

Results: We found that total 63.26% of patients having abnormal Doppler parameters.Of these all of them had abnormal UA S/D ratio,26.53% had abnormal CPR,46.93% had abnormal UAPI and 48.97% had abnormal UA RI . So in our study most common abnormal Doppler parameter was alteration in UAS/D ratio.

Conclusion: Doppler indices from the foetal circulation can reliably predict adverse perinatal outcome in an obstetric patient population with a high prevalence of complications such as pregnancy induced hypertension.

KEYWORDS : PIH, Doppler, Umbilical artery R.I., End Diastolic flow

INTRODUCTION:

One of the most common complications that affects human pregnancy is hypertensive disorder of pregnancy. Blood pressure readings of 140/90 or higher on two different occasions, more than 6 hours apart, are normally considered pregnancy-induced hypertension. Pregnancy hypertension affects about 6-8 percent of all pregnant women. It may lead to a severe condition known as preeclampsia (also known as toxemia) that can result in foetal death, intrauterine growth retardation, and/or preterm birth. The impact of hypertension on the baby's birth weight is important. It is the leading cause of maternal and foetal mortality as well as morbidity and mortality¹. In India, the incidence of PIH was registered to be over 4% (41.2 per 1,000) in 2009². Pregnancy induced hypertension is seen in about 15% of pregnancies and is responsible for 18% of fetal and infant mortality, and 46% of infants born are Small for gestational age. Undernutrition as a result of utero-placental vascular insufficiency is the major effect on the foetus. As a consequence, blood supply in the uterine and umbilical arteries is disrupted. Normal foetal growth and development require sufficient foetal circulation. It is therefore important to recognise the condition as soon as possible and intervene as soon as possible. Prenatal testing's key objectives are to detect foetuses at higher risk for perinatal morbidity and foetal injury, as well as foetal health and weight³. For the study of uteroplacental and foetal circulation, Doppler ultrasound is a simple, non-invasive, readily available, cost-effective, and repeatable technique. It aids in the identification of at-risk fetuses and the prediction of perinatal morbidity and mortality. Doppler sonography of the umbilical and middle cerebral arteries is a useful method for identifying fetuses that are at risk of having a bad outcome⁴. Current antenatal treatment is focused on identifying fetuses with IUGR, recognising early symptoms of foetal compromise, and intervening in a timely manner to prevent adverse perinatal outcomes. Doppler velocimetry will help us treat these pregnancies and avoid high mortality and morbidity rates in these patients. It can be repeated without causing any apparent damage, with the exception of mild foetal discomfort caused by heat generation.

AIMS AND OBJECTIVES:**AIMS**

- 1 To evaluate foetal haemodynamic changes in PIH and understand its Pathophysiology
- 2 To assess selected fetal arteries and veins by color Doppler and diagnose fetoplacental vascular compromise
- 3 To assess the usefulness of Doppler parameters to predict the adverse perinatal outcome

OBJECTIVES:**The specific objectives of the study were:**

1. To obtain Middle cerebral artery PI and Umbilical artery PI by using Pulsed Doppler Ultrasound and calculate the cerebro-umbilical ratio from it.
2. To assess changes in end-diastolic flow and alteration of Doppler waveforms, qualitatively in the selected vessels (like MCA, UA)
3. To assess perinatal outcomes of the fetuses examined by following up the pregnancies up to termination.
4. To compare the Doppler abnormalities (qualitative changes in UA and altered cerebro-umbilical ratio) with the adverse perinatal outcomes to find any possible association

MATERIALS AND METHODS:**STUDY AREA:**

The study was primarily conducted in the Department of Radio diagnosis, NRS Medical College and Hospital, Kolkata in collaboration with the Dept. of Obstetrics and Gynaecology, NRS Medical College, Kolkata. Patients come here primarily from in and around Kolkata. However, patients from remote areas are also referred to our centre.

STUDY POPULATION:

Pregnant mothers between 28-36 weeks of gestation, presenting to the Gynaecology and Obstetrics Out Patient Department, or admitted Hospital, Medical College, Kolkata, who are clinically suspected to have Pregnancy induced hypertension

STUDY PERIOD:

One year (May 2019-April 2020)

SAMPLE SIZE:

A total of 49 patients were studied.

SAMPLE DESIGN:

1. All the pregnant mothers within 28-36 weeks of gestation with clinically diagnosed pregnancy induced hypertension were included in the study with written consent. PNDT protocol was strictly followed and explicitly explained to the mothers. PNDT forms were duly filled up and signed

INCLUSION CRITERIA:

1. Pregnant mothers within 28-36 weeks of gestation diagnosed as pregnancy induced hypertension

EXCLUSION CRITERIA:

1. patients with chronic hypertension ,cardiac disease ,renal disease
2. Patients with congenital anomalies of the fetus
3. patients with unreliable LMP details and not confirmed by first trimester scan
4. patients with multiple gestation

STUDY TOOL:

- 1 Ultrasonic equipment: Ultrasonography examination of the pregnant females between 28-36 weeks of gestation were done with PHILIPS HD7 machine with 3-5 MHz curvilinear probe and colour Doppler and power Doppler assessment was done
- 2 Pre-designed pro forma

STUDY DESIGN:

Hospital based observational study

STUDY TECHNIQUE:**History and clinical examination:**

- Particulars of the mother including age, religion, socio economic condition, address and phone number.
- First day of last menstrual period (LMP).
- Parity and gravida.
- Personal history – history of any addiction.
- History of past pregnancies – any history of past IUGR or foetal death, illness during past pregnancies, infertility or spontaneous abortion.
- History of present pregnancy – any illness before or during pregnancy particularly hypertension, diabetes, anaemia, hypothyroidism, renal and cardiac diseases, infections .

Selected patients were informed fully about the purpose, method, possible side effects and cost of the study (in this study, it was free) and written consent were taken from the patient .

Method proper:

Patients were kept in semi recumbent position and foetus in a quiet, resting state. Blood pressure of the patient was asked and noted down. Gestational age was calculated from any previous ultrasound examination performed in early gestation. Where any previous US report was unavailable, gestational age was calculated manually from the patient's statement of first day of last menstrual period (LMP), provided they have regular menstrual cycles. At first B-mode ultrasound study was performed for measuring foetal biophysical parameters namely the Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC) and Femur length (FL). Amniotic fluid index was also noted. Oligohydramnios was diagnosed when AFI \leq 5 cm. The maternal blood pressure was recorded from the clinical history sheet (OPD ticket or Bed Head ticket) of the patient. Doppler examination of the selected foetal vessels (UA, MCA). The site of examination of each vessels were as follows –

- a) The UA – at the middle of the umbilical cord.
- b) The MCA – transverse image of foetal head was obtained at the level of sphenoid bones. Colour flow imaging displayed the circle of Willis. The MCA was detected along the edge of the sphenoid bone.

The sample volume was selected from the proximal segment of MCA.

Flow velocity waveforms were recorded from foetal umbilical artery and middle cerebral artery. After technically satisfactory Doppler waveforms were recorded, the pulsatility index of umbilical artery and middle cerebral artery were noted and the cerebro-umbilical ratio was calculated. Two readings were recorded and the average was taken.

During the whole procedure a female attendant was present. The pregnancies were then followed up and final perinatal outcome was recorded. Abnormal Doppler study was considered, when

1. Abnormal Doppler waveform (reduced/ reversed end diastolic flow) in umbilical artery, assessed qualitatively.
2. cerebro-umbilical ratio $<$ 1.08 indicating brain sparing effect⁵.

Pregnancies were followed up to termination by personal visit to ward, labour room and Neonatal Intensive Care Unit (NICU) and phone calls to the patients/ their families.

Any adverse perinatal outcome was noted as described below:

1. Caesarean section done for fetal distress.
2. pre term delivery
3. low birth weight
- 4 whether the baby was admitted to NICU and the final outcome
- 5 Any perinatal complication like hypoxaemic ischaemic encephalopathy
- 6 Still birth or perinatal death.

STATISTICAL ANALYSIS:

Charts were prepared about the details of mother and foetal characteristics, obtained Doppler parameters and adverse perinatal outcomes.

Statistical analysis was performed on the obtained data to find out any correlation between the abnormal Doppler study and adverse perinatal outcome (please see subsequent discussion).

Data are shown as mean \pm SD. Chi-square analysis and Fisher's exact test were used to compare the categorical data of the 2 groups.

Variables with $P < 0.05$ were considered significant.

Analyses were performed using SPSS 17 statistical software.

SAFETY MEASURES:

Studies have shown no short or long-term adverse effects of Doppler ultrasound on the foetus, except mild foetal discomfort⁶ due to heat generation. Nonetheless, we followed safety measures like low acoustic output and minimal exposure time.

RESULTS AND ANALYSIS:

- Mean age at the time of sonological evaluation was 28.12 \pm 4.20, ranging from 19-36 yrs of age. 20(40.81%) out of these were more than 30 yrs of age, 17(34.6%) were between 25-30 yrs of age and 12(24.48%) were below 25 yrs of age.
- 31(60.78%) were primipara and 18(36.73%) were multiparous
- A total of 11 (22.4%) presented with some previous adverse perinatal history. 5(10.20%) presented with previous history of pregnancy induced hypertension, 4(8.16%) presented with previous spontaneous abortion, 2(4.08%) presented with previous perinatal death.
- Out of 49 patients, 28 (58.82%) presented with present complications. Out of these 28 presented with IUGR, 21(42%) presented with both oligohydramnios and IUGR and 7 (7.84%) had only IUGR.
- 4 (8.16%) patients belonged to 28 to 36 weeks, 16 (32.6%) patients belonged to 31-34 weeks, 29(59.1%) patients belonged to 34-36 weeks.
- A total of 31 patients showed abnormal Doppler velocity waveform.
- Out of these 31 (63.26%) had abnormal UA S/D ratio, 13(26.53%) had abnormal CPR, 23(46.93%) had abnormal UA PI and 24 (48.97%) had abnormal UARI.
- Out of these 7(14.28%) had abnormal umbilical artery waveform also. Out of these 4(8.16%) had absent diastolic flow and 3(6.12%) had reversed diastolic flow. Those with abnormal Doppler umbilical waveform all had adverse perinatal outcome.
- All the doppler parameters UAPI, UARI, UASD, CPR were found to be greater in nullipara than multipara. Out of 23 abnormal UA PI 12 (52.17%) were nulliparous whereas 11(47.8%) were multiparous. Out of 24 abnormal UA RI 14 (58.33%) were nulliparous whereas 10 (41.6%) were multiparous. Out of 31 abnormal UA S/D 18 (58.06%) were nulliparous whereas 13 (41.93%) were multiparous. Out of 13 abnormal CPR . 7 (53.8%) were abnormal whereas 6(46.15%) were multiparous.
- 31 patients with abnormal DV Doppler, 24 patients (77.41%) showed adverse perinatal outcome. 8 of them (8 out of 31 patients with abnormal DV Doppler; 32.25%) suffered IUFD/Perinatal death. All of them had abnormality in all 3 Doppler parameters. 10 babies (32.25%) were delivered with Caesarean section. 6 babies (19.35%) were admitted in NICU for more than 8 days. 2 (6.45%) had APGAR core $<$ 7 at 5 minutes. 2 (6.45%) of total patients subsequently developed HIE (FIGURE NO 8).
- Statistical correlation was done between various abnormal Doppler parameters and adverse perinatal outcome (FIGURE NO 4, 5, 6 & 7) it was found that sensitivity for UARI was 41.67%, specificity was 44.00%, the PPV was 41.67% and the NPV

was 44.0 %.for UA PI the SENSIIIVITY was 54.16%, SPECIFICITY was 60.0%, PPV was 56.5% and NPV was 57.69%.for UA S/D the sensitivity was 70.83% and specificity was 60.0%,PPV was 56.5% and NPV was 61.0%.for CPR the SENSIIIVITY was 41.67% and SPECIFICITY was 88.0%,PPV was 76.92% and NPV was 61.0%.

- It reveals that, the sensitivity and NPV of UA S/D abnormality is (61.10%, 70.83% respectively). However, the specificity and PPV of C/U ratio is (88.0%,76.92% respectively). It indicates that, with a normal C/U ratio, adverse perinatal outcome can be ruled out with even more certainty.

DISCUSSION:

Classification of the hypertensive syndromes of pregnancy is based on the two main manifestations of PE: hypertension and proteinuria, and so rigorous measurement of BP and proteinuria is of particular importance. According to the guidelines of the Canadian and British Hypertension Societies, BP in a pregnant woman should be measured as follows:

The patient should be seated at 45° with the arm at the level of the chest;

An appropriate-sized cuff should be used;

A manual sphygmomanometer should be used. Automated devices tend to underestimate systolic and diastolic pressure by 5–15mmHg in pregnancy.

The suitability of such devices for women with suspected or confirmed PE has only been tested in a small number of models and their use should be limited to assessment of BP variation in low-risk patients⁷.

In high-risk cases a mercury sphygmomanometer is indicated;

Phase 5 Korotkoff sounds should be used to indicate diastolic Bp⁸;

Ambulatory BP monitoring in normotensive or mildly hypertensive pregnant women has not been assessed in randomized clinical trials, and its value in terms of maternal and fetal outcomes is unknown.

Gestational hypertension is defined as systolic BP \geq 140mmHg and/or diastolic BP \geq 90mmHg on at least two occasions after the 20th week of pregnancy in a previously normotensive woman. The interval between BP measurements should be a minimum of 4–6hours and a maximum of seven days.Diastolic BP is a better predictor of adverse pregnancy outcomes than systolic BP; a diastolic BP of 90mmHg is the level above which perinatal morbidity is increased in non-proteinuric hypertension.Severe hypertension is defined as systolic BP \geq 160mmHg or diastolic BP \geq 110mmHg and measurement should be repeated after 15min to confirm the diagnosis. These cutoffs were selected on the basis of evidence of a significantly increased risk of stroke in pregnant women with BP above these levels⁹.

Risk factors

/Maternal causes e.g. :

- Obesity
- Age 35 years or more.
- Past history of D.M,Hypertension and Renal diseases.
- Adolescent pregnancy.
- New paternity.
- Thrombophilias (anti-phospholipid syndrome, protein C/S deficiency, factor V Leiden)

2/Pregnancy:-

- Multiple gestation (twins or triplets, etc.)

• Placental abnormalities:

1. Hyperplacentalosis: Excessive exposure to chorionic villi.
2. Placental ischemia.

3/Family history :-

- Family history of pre-eclampsia.
- Possibility of African American

Etiopathological factors for pre-eclampsia

- 1 Failure to trophoblast invasion (abnormal placentation)

- 2 Vascular endothelial damage
- 3 Inflammatory mediator (cytokines)
- 4 Immunological intolerance between maternal and fetal tissues
- 5 Coagulation abnormalities
- 6 Increased oxygen free radicals
- 7 (polygenic disorders)
- 8 Dietary deficiency or excess

In growth-retarded foetuses and foetuses developing intra-uterine distress, the umbilical artery blood velocity waveform usually changes in a progressive manner as

- reduction in end diastolic flow : increasing RI values, PI values and S:D ratios
- absent end diastolic flow (AEDF) : RI = 1
- reversal of end diastolic flow (REDF) (figure no 3)

- Flow velocity waveforms from the umbilical cord have a characteristic saw-tooth appearance of arterial flow in one direction and continuous umbilical venous blood flow in the other¹⁰. In the **normal** situation the fetal MCA has a **high** resistance flow which means there is minimal antegrade flow in fetal diastole. In **pathological states** this can turn into a **low** resistance flow mainly as a result of the fetal head sparing theory.(figure no 1 & 2)

The umbilical artery waveform is distinguished by absent EDF and pulsatile flow throughout the umbilical vein during the first trimester. With advancing gestation, umbilical arterial Doppler waveforms show a gradual increase in the end diastolic velocity and a decrease in the impedance indices. The pulsatility index (PI) of the umbilical artery decreases from 2.0 in the early second trimester to 1.5 in the early third trimester, and finally to 1 .

As the pregnancy progresses, the blood velocity increases, and this increase is linked to a decrease in PI.

- Most sensitive(70.83%) Doppler parameter was altered UA S/D ratio and most specific(88.0%) parameter was CPR . In the study by Lakhhar Rajgopal and Gopalachari most sensitive index was UA S/D (66.66%) and most specific was CPR (75%).
- Lastly, it is to be emphasised that, in the patients having UA Doppler abnormality alone (2 cases), altered C/U ratio alone (5 cases) and UA S/D abnormality alone (6 cases), only 4.08%, 10.20 % and 22.24% patients respectively, had adverse perinatal outcome. Whereas, in the patients having more than one Doppler parameter alteration, almost 100% cases ultimately had some adversity in their perinatal outcome. It indicates the supremacy of combined Doppler parameter abnormalities over single parameters to predict adverse perinatal outcome.

CONCLUSIONS:

1. Altered UA,S/D ,RI, PI and C/U ratio all are good predictors of adverse perinatal outcome.
2. Altered C/U ratio has even more specificity than UA Doppler. It also has statistically significant association with individual parameters for adverse outcome. Thus it can be used as a useful parameter.
3. UA reversed or absent flow has high possibility of yielding adverse perinatal outcome.
4. Combination of multiple Doppler parameters is an even more sensitive parameter than any index alone, to predict adverse outcome.

Case no 1

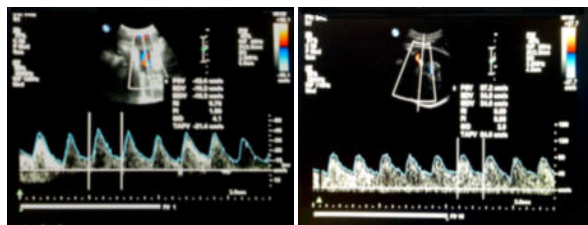


Fig no 1 & 2 : Reduced UA EDF, with brain sparing effect, causing altered C/U Ratio.

Case no 2



Fig no 3 : Reversed EDF in UA

Table no 1 shows the sensitivity, specificity, positive and negative predictive values

	UA RI	UA PI	UA S/D	CPR
SENSITIVITY	41.67%	54.16%	70.83%	41.67%
SPECIFICITY	44.00%	60.00%	60.00%	88.00%
PPV	41.67%	56.50%	54.83%	76.92%
NPV	44.00%	57.69%	61.10%	61.00%

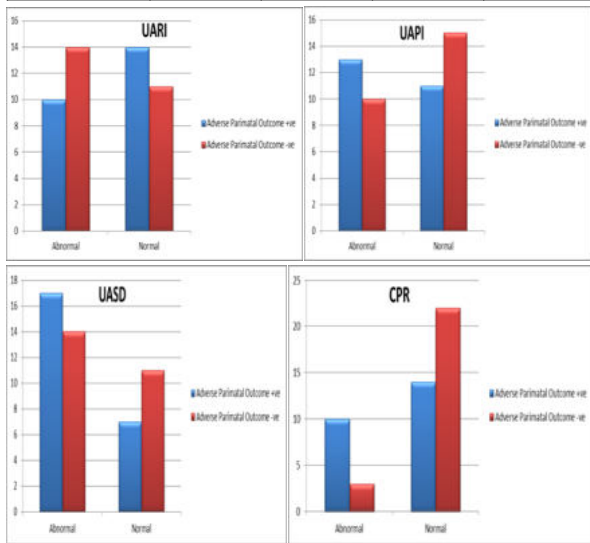


Figure No 4,5,6& 7 : Statistical Correlation Between UA RI, UA PI, UA S/D,CPR And Adverse Perinatal Outcome

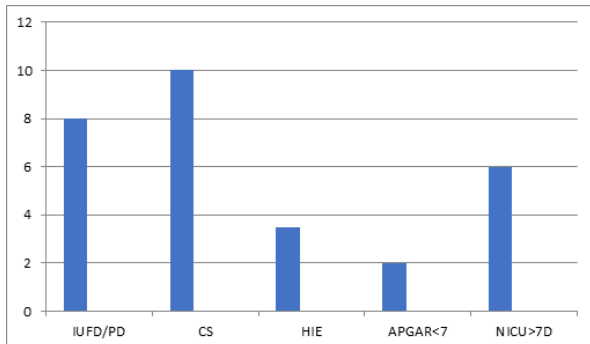


Figure No 8 : Correlation Between Different Perinatal Outcome.

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