

ROLE OF DOPPLER ULTRASOUND IN PRE-ECLAMPSIA AND ITS 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 pre-eclampsia.

Aim: To describe practical application of Doppler ultrasound in obstetrics with analysis of blood flow velocity waveform in pre-eclampsia and to examine perinatal outcome in pregnancies with altered Doppler indices.

Material and Method: This is a prospective study of 40 pregnant women with pre-eclampsia evaluated sono-graphically with color Doppler and to be followed subsequently for any adverse perinatal outcome.

Result: Out of 40 cases 45% of cases were found in 25-29 years age group. 25 cases had abnormal uterine artery Doppler indices accounting for 62.5%, while 15 cases had a normal doppler indices accounting for 37.5%. Out of 40 cases, 24 cases had abnormal Middle cerebral artery accounting for 60%. In our study 14 cases had abnormal umbilical artery Doppler indices accounting for 35%, while 26 cases had a normal Doppler index accounting for 65%. In this study total 6 cases (15%) of perinatal mortality were seen.

Conclusion: The knowledge of Doppler arteries waveform may help to improve pregnancy outcome and any permit identification and assessment of pre-eclampsia at earliest gestational age as compared to other ante partum test modalities.

Key words: Preeclampsia, Pregnancy, Doppler ultrasound, Gestational age, Perinatal Outcome.

Introduction

Preeclampsia complicates about 3-7% of pregnancies in the Western world and remains a major cause of maternal and fetal morbidity and mortality.

(1, 2) The clinical progression of the disease is very broad and ranges from late onset (>34 weeks of gestation) mild proteinuria and hypertension to severe early onset (<34 weeks) multisystem failure in both mother and fetus.

(3, 4) The probable cause of pre-eclampsia is thought to be the abnormal utero-placental circulation resulting from the failure of second wave of trophoblastic invasion into spiral arterioles. That will result in increased resistance to flow within the uterine arteries and decreased placental perfusion. Recent studies have shown that increased resistance to uterine vessels will lead to an increased risk of progression towards preeclampsia and intrauterine growth restriction (IUGR)

(5, 6). This concept has led to the idea of using Doppler assessment of uterine artery flow velocity waveform as a screening test for predicting preeclampsia. There is indirect evidence of abnormal placentation which constitutes persistence of high impedance to flow in the uterine arteries.

As further management of the patient dynamically depends on disease severity, a comprehensive initial work-up of all potentially involved organ systems is crucial. As the disease progresses, carefully clinical and ultrasound-based follow-up remain mandatory to assess disease progression and to diagnose complications in a follow-up period in both the mother and the fetus. Even if pre-eclampsia has resolved, Care and follow-up of these patients should not stop. First of all because, former pre-eclamptic patients remain at increased risk of cardiovascular disease in later life.

(7). Secondly because a considerable proportion of these women will have subsequent pregnancies that are at risk of disease recurrence.

(8). Sometimes complications such as gestational diabetes and several other maternal conditions emerging during pregnancy, pre-eclampsia can be considered as an early warning sign and an ideal opportunity for timely prevention of later disease.

(9). 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. According to multiple studies with different results on the role of uterine artery Doppler in predicting preeclampsia and pregnancy outcomes, this study was designed to evaluate the role of uterine artery Doppler ultrasonography in predicting preeclampsia and assessed neonatal and maternal complications in pregnant women with preeclampsia, because in case of early diagnosis of fetal and neonatal complications, preventive measures can be used to improve prenatal prognosis.

(10).

Material

and

Methods

Patient selection & clinical presentation: This is a prospective study of 40 pregnant women with pre-eclampsia are evaluated Sono-graphically with Color Doppler and to be followed subsequently for any adverse perinatal outcome. The study is to be conducted in Department of Radiodiagnosis, AMCMET Medical College and L.G Hospital, Mani Nagar, Ahmadabad, over a period of 12 months from May 2020 – May 2021.

Criteria for patient's selection:

Inclusion Criteria

Inclusion criteria include consent to participate in the study, history of previous preeclampsia, IUGR, and IUFD; family h/o preeclampsia or IUGR in mother or sister; nulliparity, mother's age (less than 35-year-old), or mother's age less than 18 years, abortion history, infertility history, chronic hypertension, diabetes, renal disease.

Exclusion Criteria: Pregnancies with structural or chromosomal fetus mal formations, no feasibility to undergo the Doppler US test (obesity, oligohydramnios, etc.) were excluded from the study.

In the Pregnancies with pre-eclampsia group the age of subjects ranged from 20- 34 years with their 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 color 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

1. Color Doppler ultrasound unit – GE– Logic P5.
2. Low frequency sectoral ultrasound transducer with a range of 4CMHz.
3. Intonation angle was taken less than 60 deg. and pre-systolic and end-diastolic velocities were defined manually after observing at least three consecutive waves

consideration:

Technique of scanning:

Doppler measurements were taken with the mother in supine position. Gestational age of the patient was obtained using B mode 2-D 4C 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.

Measurements

On admission, all women underwent blood and urine work up according to current recommendations. Doppler examination was performed on hospital admission.

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 best quality signals from umbilical artery. When screen shows several waveforms of similar height and pattern, one image was frozen and values of peak velocities and end diastolic velocities was noted down.

UTERINE ARTERY:

Uterine Artery Doppler was carried out by identifying the vessel in an oblique scan with the sample volume distal to the crossing with the external iliac artery. Main branch of uterine artery is located at cervical-corporeal junction. Uterine artery was examined at level of internal so with full bladder seen crossing perpendicular to external iliac artery. Doppler velocimetry measurement performed near this location. Plasticity indexes (PIs) of the left and right arteries were measured and the mean PI was calculated. Resistive index and S/D ratio were obtained and value was noted down.

MIDDLE CEREBRAL ARTERY:

Middle Cerebral Artery Doppler was recorded in a transverse view of the foetal brain, with the Doppler gate placed on the vessel about 1 cm distal to the circle of Willis. In all these vessels, the pulsed Doppler gate was placed over the whole width of the vessel once it had been ensured that the angle was 30°. Angle correction was then applied and the signal updated until 3 similar consecutive waveforms were obtained.

The Umbilical artery, Uterine Artery and Middle cerebral Artery Doppler investigation on admission and the last Umbilical Artery, Uterine Artery and Middle Cerebral Artery Doppler investigation within 1 week before delivery were considered for the analysis. Early PE was defined

as that diagnosed before 32.0 weeks. Severe PE was defined as a blood pressure of 160/110 mm Hg on 2 or more determinations, proteinuria of 6.5 g/24 h or the presence of maternal complications, including eclampsia and other neurological manifestations, HELLP syndrome (lactate dehydrogenase 1600 IU/l, aspartate transaminase 162 IU/l, platelet count <100,000), acute renal failure defined as creatinine 1.2g/dl, subcapsular hepatic hematoma, pulmonary edema and the presence of disseminated intravascular disease. Small-for-gestational age (SGA) was defined as a birth weight 10th centime according to local customized curves. Adverse perinatal outcome was defined as the presence of at least one of the following: foetal or neonatal demise, acidosis at birth (UA pH 7.10 and base excess 112mEq/l), 5-min Agar score 7 and admission to the neonatal intensive unit for more than 10 days.

Management

Magnesium sulphate prophylaxis was administered to all women with severe PE, as well as first and second-line antihypertensive therapy with labetalol and hydra-lazine, respectively, when blood pressure was persistently 160/110mmHg. Corticosteroid therapy for foetal lung maturity was administered to all pregnancies less than 34 weeks of gestational age. During admission, maternal blood pressure was recorded several times per day and laboratory testing at least twice a week. Foetal assessment was performed by daily foetal heart rate monitoring and Doppler atleast every 3 days. Indications for delivery where severe PE beyond 32 weeks once pulmonary maturation was completed, uncontrollable blood pressure, maternal complications (defined above), abruption placental or declarative foetal heart rate (15 decelerations of more than 30beats/min from basal line in 30 min). Women without severity criteria [7] were discharged and outpatient management with weekly foetal and maternal assessment was performed. In cases with mild PE, delivery was induced after 37 weeks.

Observations:

Table1: Distribution of cases of pre-eclampsia according to age

Age group(yrs)	Total cases
20-24	6 15%
25-29	18 45.0%
30-34	16 40%
Total	40

The cases under pre-eclampsia were distributed under the age group of 20-24, 25-29, and 30-34 years under pre-eclampsia. Majority of the cases came under the age group of 25-29 accounting for about 45.0%. Mean age of subjects being 25.7 yrs. 40% cases were found in 30-34 age groups.

Table 2: Distribution of Pre-eclampsia cases according to parity

Parity	Cases
0	16 (40%)
1	18 (45%)
2	5 (12.5%)

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3 or more	1 (2.5%)
Total	40 (100%)

In our study pre-eclampsia group, 16 (40%) patients were nullipara, 18 (45%) were primipara. Both together comprising 85% cases of Pre-eclampsia group. Rest of 15% cases were multipara.

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

Uterine Artery	Total
Normal	15 (37.5%)
Unilateral Abnormal	11 (27.5%)
Bilateral Abnormal	14 (35%)
Total	40 (100.0%))

Under pre-eclampsia cases, out of 40 cases, 25 cases had abnormal uterine artery Doppler indices accounting for 62.5%, while 15 cases had a normal Doppler index accounting for 37.5%. Here we found that out of 25 cases of Pre-eclampsia showing raised Doppler indices and diastolic notch, 14 cases showed bilateral abnormality (B), either raised indices, diastolic notch or both leading to 35% cases of total. Whereas, 11 cases that is 27.5% cases showed unilateral Doppler abnormality

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

Waveform-MCA	Total
N-Normal	16 40%
I-Increase Diastolic Flow	24 60%
Total	40 100.00 %

In our study of Pre-eclampsia cases, out of 40 cases, 24 cases had abnormal Middle cerebral artery Doppler indices accounting for 60% cases showing increased diastolic flow with brain sparing effect While 16 cases had normal Middle cerebral artery Doppler indices accounting for 40% of cases.

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

Waveform – UA	Total
Normal	26 65%

Decreased diastolic flow (D)	11 27.5%
Absent diastolic flow (A)	2 5%
Reversal of diastolic flow (R)	1 2.5%
Total	40 100.0 %

Under Pre-eclampsia cases, out of 40 cases in our study 14 cases had abnormal umbilical artery Doppler indices accounting for 35%, while 26 cases had a normal Doppler index accounting for 65%. Here we found that out of 14 cases of pre-eclampsia showing raised Doppler indices, 11 cases showed just decreased diastolic flow accounting for 27.5% of cases. While two of the case showed absent diastolic flow (A) amounting to 5% of cases. One case showed Reversal of diastolic flow (R) that is 2.5% of our cases.

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

Uterine Artery	Outcome		Total
	LB	IUD+EN D	
N-Normal	15 37.5 %	0	15 37.5%
B-Bilateral Abnormal	9 22.5 %	5 12.5%	14 35%
U-Unilateral abnormal	10 25%	1 2.5%	11 27.5%
Total	34 85%	6 15%	40 100.0 %

In our study, out of 14 cases with bilateral uterine artery abnormality (B) there was 9 cases shows low birth weight accounting for 22.5% and 5 cases shows Intrauterine death (IUD) accounting for 12.5%. While out of 11 cases of unilateral uterine artery abnormality (U) there was 10 cases shows low birth weight accounting for 25% and 1 case shows Intrauterine death (IUD) accounting for 2.5%. While in normal uterine artery (N), out of 15 cases there is no perinatal mortality.

Discussion:

Pre-eclampsia is prone to develop in pregnancy induced hypertension and other serious fetal outcomes which require proper monitoring. Pre-eclampsia is strongly related to development and function of uteroplacental and fetoplacental circulations. Uteroplacental and fetoplacental insufficiency are the primary cause of pre-eclampsia and events related to pre-eclampsia can be identified using uterine artery and umbilical artery Doppler velocimetry. In this study, uterine artery, umbilical artery, middle cerebral artery and ductus venosus are studied with details assessment of fetus, so that timing of delivery can be decided, so that the purpose of perinatal outcome can be achieved. In Pre-eclampsia resistance to spiral arteries occurs due to inadequate invasion. This leads to increased impedance of blood flow in uterine arteries. Fleischer A,

Schulman H, Farmakides G et al 1986 [11]. In our study findings are similar as mentioned above. In this study of uterine artery Doppler velocimetry among 40 case group, 15 (37.5%) subjects had normal flow pattern in uterine artery and 25 (62.5%) had abnormal flow pattern with raised indices and diastolic notches. Out of 25 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 (35%) cases of total. Our findings were similar with Mohd Khalid et al (2011) [12] to determine the role of Color Doppler Sonography in evaluation of foetal outcome in 58 antenatal females (22 normotensive, 36 hypertensive) in their third trimester of pregnancy. Arterial study included – bilateral uterine arteries, umbilical artery, and foetal middle cerebral and foetal aorta. In this study, 25(62.5%) out of 40 hypertensive patients showed abnormal uterine artery flow. U/L Uterine artery involved in 11 cases (27.5%). B/L uterine artery was involved in 14 (35%) cases. Axt-Fliedner Ret al [13] 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 [14], 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 40 case group, 14 (35%), cases had abnormal umbilical artery Doppler indices while 26 (65%) cases had a normal Doppler index. In our study of middle cerebral artery Doppler velocimetry among 40patients' group, 24 (60%) had abnormal Middle cerebral artery. Doppler showing increased diastolic flow with brain sparing effect while 16 (40%) cases had normal Middle cerebral artery Doppler indices. Similar findings were seen in study by B.N. Lakhkar et al in [15] prospectively examined 58 single ton pregnancies beyond 30 weeks of gestation complicated by intrauterine growth restriction and severe pre-eclampsia with Doppler. In this 18(45%) were primipara and 16(40%) were multipara. 22 (55%) had caesarean and 18(45%) had vaginal delivery. Twenty-six patients of the 40 included in the study population had at least one major or minor adverse outcome. Chan et al [16] studied 71 high-risk fetuses with weekly UA and MCA Doppler US examinations until delivery. In 15% (6 of 40 patients) 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 but less specific. 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[17] 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 40, 11 % cases out of these have both uterine and umbilical arteries as abnormal in patients with absent end diastolic velocity (AEDV) & reversed end diastolic velocity (REDV) perinatal mortality was 75% &25% had pre-eclampsia. The fetuses with compromised circulation showed increased diastolic flow in fetal MCA suggestive of brain sparing effect.

Conclusion:

General Doppler Ultrasound result, as well as N from uterine vessel, RI from umbilical artery, and PI from umbilical and middle cerebral arteries in their individual form, may be considered as tools to determine hemodynamic repercussion caused by Preeclampsia. Pre-eclampsia remains a major cause of maternal and foetal morbidity and mortality. By assessing risk factors for the development of preeclampsia, closer monitoring in the high-risk population is possible. Once diagnosed, the difference between mild and severe preeclampsia has to be made, always considering the two patients, mother as well as fetus. As there is still no accurate therapy besides delivery of the placenta, the follow-up and necessity for delivery depend both on the maternal condition

(Clinical and biochemical) as on foetal well-being, assessed by non-stress test and ultrasound (foetal growth, amniotic fluid and Doppler evaluation). The combination of those results will lead to the decision if an immediate delivery is necessary, or if expectant management with close monitoring of maternal and foetal condition is possible. Further follow-up of the patient remains mandatory, in subsequent pregnancies (higher risk of recurrence of preeclampsia) as later in life, due to the higher risk of developing cardio- and cerebrovascular disease.

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