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# EVALUATION OF DOPPLER FLOW PATTERNS BY ULTRASOUND IN HIGH RISK AND NORMAL PREGNANCY

Obstetrics & Gynaecology

**Dr. Rohidas P. Chavan** Professor & Head, Dept. of OBGY, SVNGMC, Yavatmal (Maharashtra)

**Dr. Sushma G. Tarak** Associate Professor, Dept. of OBGY, SVNGMC, Yavatmal (Maharashtra)

**Dr Pankti Mehta*** Junior resident, Dept. of OBGY, SVNGMC, Yavatmal (Maharashtra)*Corresponding Author

KEYWORDS

## INTRODUCTION:

In India about 20-30% pregnancies belong to high-risk category, which is responsible for 75% of perinatal morbidity and mortality.[1] Intrauterine growth restriction (IUGR) is an indicator of the increased risk of perinatal mortality and morbidity. Infants born with a birth weight < 2500 gms, IUGR prevalence is almost 33%. The incidence of IUGR is lower in developed countries (4-8%) as compared to that in developing countries (6%-30%).[2]In nearly 35%-40% of the cases, IUGR is consequence of many risk factors[3] and multiple adverse outcomes are associated with IUGR.[4]

In IUGR, the ability of the placenta to deliver adequate nutrition to the fetus through utero-placental circulation, is reduced causing in developmental problems.[5]Early identification and prediction of IUGR, rests in an ability to evaluate the maternal, placental and fetal vascular patterns effectively.[6] Evaluation of fetal well-being in high-risk pregnancies is conducted by a several methods but Colour Doppler flow velocimetry has revolutionized the diagnosis of abnormal blood flow in the foeto-placental bed. It is a non-invasive technique to study the uteroplacental fetal inoculations and it is simple, safe and reproducible. Fetal hypoxia can be assessed with the abnormal wave patterns. Colour Doppler flow velocimetry studies the blood flow in the umbilical artery and Middle cerebral artery of fetus in the high-risk pregnancies. Ductus venosus Doppler findings can assist in timing delivery of severely growth-restricted foetuses.[5]

The use of colour Doppler in high-risk pregnancies improves several perinatal outcomes. Doppler study of middle cerebral artery in combination with umbilical artery aids in prediction of adverse outcome in near-term pregnancies. [7] Doppler assessment may help in decision making and timely intervention that lowers the risk of fetal brain damage. [8]In the present study, we studied the pattern of blood flow by using colour doppler indices in our settings in second and third trimester pregnancies and compare with normal pregnancies.

## AIM AND OBJECTIVE:

1. To evaluate the doppler flow patterns by ultrasound in high-risk pregnancy
2. To compare the doppler flow patterns by ultrasound in high-risk pregnancy versus normal pregnancy.

## MATERIAL AND METHODS:

The present observational study was conducted between July 2020 to February 2022, on 116 pregnant women aged between 18 to 45 years. Women with high-risk pregnancy (with preeclampsia, IUGR, other hypertensive disorders of pregnancies, gestational DM), who are in 2nd and 3rd trimester with singleton pregnancy were included. Patients were categorized in to two groups: Group I with high-risk pregnancy and Group II with normal pregnancy. Patients detailed history and thorough physical examination was carried out along with basic investigations.

Patients were subjected to ultrasonographic examination. The equipment used was ALOKA SSD 630 with UGR 38 Doppler unit having a pulsed wave, continuous wave, HPR Doppler with dual sector transducer. Sean was performed using 2D real time ultrasound with 3.5 MHZ convex sector transducer. The umbilical artery was identified within the amniotic fluid by the appearance of parallel line echoes. Which display Pulsatility activity, pulsed Doppler was used to get Doppler signals after localizing the vessel. The maximum Doppler shift frequencies were obtained and various ratios were calculated i.e., SID RI, PI and compared with those of normal pregnant women. Visual axial plane at the level of brain stem shows the circle of Willis which is clearly visualized especially with colour Doppler, then the three branches on side (anterior, middle and poste cerebral and pulse wave Doppler is recorded.

Decision regarding delivery was based on abnormal umbilical artery Doppler with MCA abnormality, absent end diastolic flow I reverse EDF in umbilical artery, worsening maternal condition with preeclampsia or eclampsia, severe oligohydramnios AFI<5, absence of growth for 2 weeks period with abnormal umbilical artery Doppler. Different parameters were be calculated by standard formulas and cut-off values for different Doppler parameters for the prediction of IUGR were kept as per refence values.[6]

The primary study variable is ratio between peak systolic velocity (A), end-diastolic peak velocity (B) of Middle cerebral artery (A/B). Secondary variables derived from colour doppler measurements were Umbilical artery: Pulsatility Index (PI), Resistive index (RI), S/D, Middle cerebral artery: PI, RI, S/D, Cerebro-umbilical artery ratios (C/U): PI, RI, S/D, Vertebral artery: RI for first visit (23-27 weeks), RI for second visit (28-32 weeks) and RI (33-37 weeks).

Data was analysed using SPSS V 21.0 package. Data was given as Mean and SD for quantitative variables and Number (Percentage %) for qualitative variables. Appropriate statistical tests were used wherever necessary. Level of Significance was taken as $P \leq 0.05$. Study was started only after IEC approval. It was carried out as per Ethical/ICMR guidelines. All data was collected and kept confidential.

## RESULTS:

In the present study, majority 48% were in age group of 21 to 30 years and 60.34%were primipara. Most common maternal complication was preeclampsia in 55.17% patients followed by8.62% had anemia and 6.03% had prior IUGR. 21.55% had no complication. Average period of gestation was 35.34±1.11 weeks. Range being 32 to 37 weeks and majority 65.5% were in range of 34 to 36 weeks.

In the present study, live birth among the study population where majority 91.38% birth were alive and only 8.62% had IUD.51.72% were delivered preterm and 48.28% were term babies.63.79% had weight <2 kg. and 2.06% were admitted in NICU. Neonatal complications were hyperbilirubinemia in 22.41% patients, 1.72% had hypocalcaemia, hypoglycemia and polycythaemia each respectively. 72.41% had no complication. Only 17.24% stayed in the hospital for more than 10 days. Neonatal mortality was 12.06%.

**Table 1: Association between UA-PI, RI and S/d ratio and Neonatal outcome**

| Neonatal outcome | Doppler Findings(Umbilical artery-PI) |
|---|---|

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| | PI <1.12 | PI >1.12 | Signi-ficance | Sensi-tivity | Speci-ficity | PPV | NPV | Accuracy |
|---|---|---|---|---|---|---|---|---|
| IUD | 0 | 10 | 0.26 | 100% | 3.7% | 8.9% | 100% | 12.07% |
| Preterm | 4 | 56 | 0.02* | 93.3% | 0% | 50% | 0% | 48.2% |
| NICU admission | 4 | 68 | 0.05* | 94.44 % | 0% | 60.7% | 0% | 58.6% |
| Complication | 2 | 30 | 0.15 | 93.75 % | 2.3% | 26.7% | 50% | 27.5% |
| Death | 2 | 12 | 0.008* | 85.71 % | 1.961 % | 10.71 % | 50% | 12.07% |
| Neonatal outcome | Doppler Finding (Umbilical artery-RI) | | | | | | | |
| | RI <0.8 | RI >0.8 | Signi-ficance | Sensi-tivity | Speci-ficity | PPV | NPV | Accuracy |
| IUD | 0 | 10 | 0.21 | 100% | 5.66 % | 9.09% | 100% | 13.79% |
| Preterm | 6 | 54 | 0.007* | 90% | 0% | 49% | 0% | 46.55% |
| NICU admission | 6 | 66 | 0.02* | 91.6% | 0% | 60% | 0% | 56.9% |
| Complication | 2 | 30 | 0.3 | 93.75 % | 4.76 % | 27.27 % | 66.67 % | 29.3% |
| Death | 2 | 12 | 0.05* | 85.71 % | 3.92 % | 10.9% | 66.6% | 13.7% |
| Neonatal outcome | Doppler Finding (Umbilical artery-S/D Ratio) | | | | | | | |
| | S/D <3.5 | S/D >3.5 | Signi-ficance | Sensi-tivity | Speci-ficity | PPV | NPV | Accuracy |
| IUD | 0 | 10 | 0.21 | 100% | 5.66 % | 9.09% | 100% | 13.79% |
| Preterm | 6 | 54 | 0.007* | 90% | 0% | 49% | 0% | 46.55% |
| NICU admission | 6 | 66 | 0.02* | 91.6% | 0% | 60% | 0% | 56.9% |
| Complication | 2 | 30 | 0.3 | 93.75 % | 4.76 % | 27.27 % | 66.67 % | 29.3% |
| Death | 2 | 12 | 0.05* | 85.71 % | 3.92 % | 10.9% | 66.6% | 13.7% |

Association between Doppler findings (Umbilical artery PI, RI and S/d ratio) and Neonatal outcome: Sensitivity for IUD was 100%, for preterm delivery was 93.3%, for NICU admission was 94.44%, for complication among new born was 93.75% and death among new born was 85.71%.Sensitivity for IUD was 100%, for preterm delivery was 90%, for NICU admission was 91.6%, for complication among new born was 4.76% and for death among new born was 85.71%.Sensitivity for IUD was 100%, for preterm delivery was 90%, for NICU admission was 91.6%, for complication among new-born was 93.75% and for death among new-born was 85.71%.(Table 1)

**Table 2: Association between MCA-PI, RI and S/d ratio and Neonatal outcome:**

| Neonatal outcome | Doppler Findings (Middle cerebral artery-PI) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PI <1.12 | PI >1.12 | Signi-ficance | Sensi-tivity | Speci-ficity | PPV | NPV | Accuracy |
| IUD | 0 | 10 | 0.59 | 0% | 96.23% | 0% | 91.07 % | 87.93 % |
| Preterm | 2 | 58 | 0.56 | 3.33% | 96.43% | 50% | 48.21 % | 48.28 % |
| NICU admission | 2 | 70 | 0.05* | 2.77% | 95.45% | 50% | 37.5% | 37.93 % |
| Complication | 0 | 32 | 0.1 | 0% | 95.24% | 0% | 71.43 % | 68.97 % |
| Death | 0 | 14 | 2.6 | 0% | 96.08% | 0% | 87.5% | 84.48 % |
| Neonatal outcome | Doppler Finding (Middle cerebral artery-RI) | | | | | | | |
| | RI <0.8 | RI >0.8 | Signi-ficance | Sensi-tivity | Speci-ficity | PPV | NPV | Accuracy |
| IUD | 10 | 00 | 0.39 | 100% | 00% | 8.62 % | 0% | 8.6% |
| Preterm | 60 | 0 | 0.004* | 100% | 00% | 51.72% | 0% | 51.72 % |
| NICU admission | 72 | 0 | 0.03* | 100% | 00% | 62.07% | 0% | 62.07 % |
| Complication | 32 | 0 | 0.4 | 100% | 00% | 27.5 % | 0% | 2.5% |
| Death | 14 | 0 | 0.007* | 100% | 00% | 12.07% | 0% | 12.07 % |
| Neonatal outcome | Doppler Finding (Middle cerebral artery-S/D Ratio) | | | | | | | |
| | S/D <3.5 | S/D >3.5 | Signi-ficance | Sensi-tivity | Speci-ficity | PPV | NPV | Accuracy |
| IUD | 0 | 10 | 0.39 | 100% | 3.77% | 8.92 % | 100% | 12.07 % |
| Preterm | 2 | 58 | 0.004* | 96.67 % | 3.57% | 51.79% | 50% | 51.72 % |
| NICU admission | 2 | 70 | 0.03* | 97.22 % | 4.54% | 62.5 % | 50% | 62.07 % |
| Complication | 2 | 30 | 0.2 | 93.75 % | 2.38% | 26.79% | 50% | 27.59 % |
| Death | 2 | 12 | 0.008* | 85.71 % | 1.96% | 10.71% | 50% | 12.07 % |

Association between Doppler findings (MCA-PI, RI and S/d ratio) and Neonatal outcome: Sensitivity for IUD was 0%, for preterm delivery was 3.3%, for NICU admission was 2.77%, for complication among new born was 0% and for death among new born was 0%. Sensitivity for IUD was 100%, for preterm delivery was 100%, for NICU admission was 100%, for complication among new born was 100% and for death among new born was 100%.Sensitivity for IUD was 100%, for preterm delivery was 96.67%, for NICU admission was 97.22%, for complication among new born was 93.75% and for death among new born was 85.71%. (Table 2)

Association between Doppler findings (PI MCA/UMB) and Neonatal outcome: Sensitivity for IUD was 100%, for preterm delivery was 93.3%, for NICU admission was 94.44%, for complication among new born was 93.75% and for death among new born was 85.71%.Sensitivity for IUD was 100%, for preterm delivery was 93.3%, for NICU admission was 94.44%, for complication among new born was 93.75% and for death among new born was 85.71%. (Table 3)

**Table 3: Association between Doppler findings (PI MCA/UMB)and Neonatal outcome:**

| Neonatal outcome | Doppler Findings (PI MCA/UMB) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PI | PI MCA/UMB >1 | Signi-ficance | Sensi-tivity | Speci-ficity | PPV | NPV | Accuracy |
| IUD | 10 | 0 | 0.26 | 100% | 3.7% | 8.9% | 100 % | 12.07% |
| Preterm | 56 | 4 | 0.02* | 93.3 | 0% | 50% | 0% | 48.2% |
| NICU admission | 68 | 4 | 0.05* | 94.44 % | 0% | 60.7% | 0% | 58.6% |
| Complication | 30 | 2 | 0.15 | 93.75 % | 2.3% | 26.7% | 50% | 27.5% |
| Death | 12 | 2 | 0.008 * | 85.71 % | 1.96% | 10.71 % | 50% | 12.07% |
| Neonatal outcome | Doppler Finding (S/D ratio of MCA/UMB) | | | | | | | |
| | S/D | S/D MCA/UMB >1 | Signi-ficance | Sensi-tivity | Speci-ficity | PPV | NPV | Accuracy |
| IUD | 10 | 0 | 0.26 | 100% | 3.7% | 8.9% | 100 % | 12.07% |
| Preterm | 56 | 4 | 0.02* | 93.3 % | 0% | 50% | 0% | 48.2% |
| NICU admission | 68 | 4 | 0.05* | 94.44 % | 0% | 60.7% | 0% | 58.6% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Complication | 30 | 2 | 0.15 | 93.75% | 2.3% | 26.7% | 50% | 27.5% |
| Death | 12 | 2 | 0.008* | 85.71% | 1.96% | 10.71% | 50% | 12.07% |

**Table 4. Comparison of Efficacy (Sensitivity) of PI, RI and S/D ratio in predicting adverse perinatal outcome:**

| Parameters | | IUD | Preterm | NICU admission | Complication | Death |
|---|---|---|---|---|---|---|
| PI | UA | 100% | 93.33% | 94.44% | 93.75% | 85.71% |
| | MCA | 0% | 3.33% | 2.7% | 0% | 0% |
| RI | UA | 100% | 90% | 91.67% | 93.75% | 85.71% |
| | MCA | 100% | 100% | 100% | 100% | 100% |
| S/D ratio | UA | 100% | 90% | 91.67% | 93.75% | 85.71% |
| | MCA | 100% | 96.67% | 97.22% | 93.75% | 85.71% |
| MCA/UMB PI | 100% | 93.33% | 94.44% | 93.75% | 85.71% | |
| MCA/UMB S/D | 100% | 93.33% | 94.44% | 93.75% | 85.71% | |

Comparison of Efficacy (Sensitivity) of PI, RI and S/D ratio in predicting adverse perinatal outcome: Sensitivity of PI velocimetry of MCA is less sensitive to umbilical artery in predicting IUD, preterm birth, NICU admission, neonatal complications and neonatal death. Sensitivity of RI velocimetry of MCA is superior to umbilical artery in predicting IUD, preterm birth, NICU admission, neonatal complications and neonatal death. Sensitivity of S/D velocimetry of MCA is superior to umbilical artery in predicting IUD, preterm birth, NICU admission, neonatal complications and neonatal death. Sensitivity of PI ratio of MCA/UMBA is same as compared to S/D ratio of MCA/UMB in predicting IUD, preterm birth, NICU admission, neonatal complications and neonatal death.(Table 4)

## DISCUSSION:

Colour Doppler study is a non-invasive method which helps us in studying hemodynamic in utero. Investigation of the uterine and umbilical arteries gives information on the perfusion of the uteroplacental and fetoplacental circulations, respectively, while Doppler studies of selected fetal organs are valuable in detecting the hemodynamic rearrangements which occur in response to the fetal hypoxemia. These studies can be used in a complementary fashion to the traditional biophysical profile and non-stress test. [9]

In present study it was seen that the sensitivity of pulsatility index in predicting adverse perinatal outcome of umbilical artery was similar to middle cerebral artery findings. Sensitivity of PI UA for IUD was 100%, for preterm birth was 93.33%, for NICU admission was 94.44%, for neonatal complication was 93.75% and for death was 85.71%. Sensitivity for PI MCA for IUD was 0%, for preterm birth was 3.33%, for NICU admission was 2.7%, for neonatal complication was 0% and for death was 0%. Sensitivity values for resistive index of umbilical artery for IUD was 100%, for preterm was 90%, for NICU admission was 91.67%, for Complications was 93.75% and for death was 85.71%. Sensitivity values for resistive index of Middle cerebral artery were 100%, all the parameters. Sensitivity values for S/D of umbilical artery for IUD were 100%, for preterm was 90%, for NICU admission was 91.67%, for Complications was 93.75% and for death was 85.71%. Sensitivity values for S/D of middle cerebral artery for IUD were 100%, for preterm was 96.67%, for NICU admission was 97.22%, for Complications was 93.75% and for death was 85.71%. Sensitivity of MCA/UMB pulsatility index for IUD was 100%, for preterm was 93.33%, for NICU admission was 94.44%, for complication was 93.75% and foe death was 85.71%. Sensitivity of MCA/UMB resistive index for IUD was 100%, for preterm was 93.33%, for NICU admission was 94.44%, for complication was 93.75% and foe death was 85.71%

Study by Mahale N et al [8] showed efficacy of PI in predicting the adverse perinatal outcome as sensitivity for MCA was 90% and for UA was 90.7% and for MCA/UA was 75%. These findings were opposite to present study findings. Study Gramellini D et al [10] showed efficacy of PI in predicting the adverse perinatal outcome as sensitivity for MCA was 24% and for UA was 64% and for MCA/UA was 68%. These findings were similar to present study.

Study by Lakhkar BN et al [5] showed efficacy of PI in predicting the adverse perinatal outcome as sensitivity for MCA was 41.6% and for UA was 50% and for MCA/UA was 47.2%. These findings were similar to present study. Study by Rekha BR et al [11] showed that sensitivity in predicting NICU admission for UA PI was 25%, MCA PI was 58%. In a study by Dhand H et al [12], the predictive value for Doppler for detecting abnormal fetal outcome, the sensitivity for UA PI and MCA PI was 44%, 71% respectively and specificity was 61.5% and 92% respectively. Fong KW et al [13] showed that sensitivity of MCA PI was more than UA PI i.e 72.4% > 44.7%. Similar results were seen in present study.

Study by Gyawal Mi et al [6] showed that umbilical artery S/D ratio sensitivity was 76%. Chanprapaph et al [14] which showed 66.7%, 78.85%, 74.42% and 65.08% respectively. Fleischer A et al reported S/D ratio greater than 3 had a sensitivity of 78 percent in predicting IUGR. [15]

Present study shows that the Sensitivity of middle cerebral artery in predicting adverse perinatal outcome is more as compared to umbilical artery. We can also say that for predicting adverse events of perinatal period, Doppler of middle cerebral artery will help a lot, which can be used to decrease the perinatal mortality as well as morbidity.

## CONCLUSION

Doppler studies of multiple vessels in the fetoplacental circulation can help in the monitoring of compromised fetus and can help us in predicting neonatal morbidity. Middle cerebral artery flow indices were better predictor for evaluating neonatal outcome. This may be helpful in determining the optimal time of delivery in intrauterine growth retarded pregnancies.

## RECOMMENDATIONS:

Colour Doppler study with larger sample size should be done for all IUGR cases to evaluate middle cerebral artery flow indices for prediction of any neonatal complications and timely management for better neonatal outcome.

## LIMITATION

Multiple fetal vessel color Doppler was not done in our study as the study was done in a rural area where cost was major factor for doing investigation.

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