Research Article

# A prospective study of role of color Doppler in high-risk pregnancies in a tertiary care hospital

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## ABSTRACT

**Background:** High-risk pregnancies are associated with many adverse perinatal outcomes. The use of Doppler ultrasound offers a non-invasive way to study the fetal and maternal circulation and guide the clinical management. **Objective:** The aim of this study is to evaluate the role of color Doppler in the effective management of high-risk pregnancies. **Materials and Methods:** This was a prospective and observational study carried out for 2 years in the Department of Radiology with the help of the Department of Obstetrics and Gynecology. Antenatal women in the age group of 20-30 years with singleton pregnancy of gestational age of 26 weeks to term and presence of one of the high-risk factors were enrolled in the study. The risk factors considered were pregnancy-induced hypertension (PIH), diabetes, anemia, oligohydramnios, toxoplasmosis, and hepatitis. Doppler study of umbilical artery, fetal middle cerebral artery (MCA), and both the maternal uterine arteries was done. Parameters in the form of resistive index, pulsatility index, and systolic/diastolic ratio were taken. Details of obstetric history and delivery were taken. Patients were followed up at regular intervals. **Results:** A total of 110 cases were enrolled in the study. High-risk pregnancy was more common in the age group of 20-25 years. The most common high-risk factor in pregnancy was PIH which accounted for 49% of cases. Out of 110 high-risk pregnancies, 39% ($n = 43$) of cases resulted in intrauterine growth restriction (IUGR). PIH, anemia, and diabetes were more associated with IUGR as compared to oligohydramnios, hepatitis, and toxoplasmosis. Out of 110 high-risk cases, in 43% ($n = 47$) cases, umbilical artery findings were abnormal. 38% of cases of isolated fetoplacental insufficiency without uteroplacental insufficiency were more associated with intrauterine death. Isolated umbilical artery abnormality was more associated with adverse perinatal outcomes (72%) than isolated MCA abnormality. Survivability of fetus increased when early induction or lower (uterine) segment caesarian section was done on emergency basis. **Conclusion:** Doppler can be used as a reliable tool for fetal surveillance in high-risk pregnancy cases. It helps in guiding early intervention and improving fetal outcome.

**KEY WORDS:** Doppler Ultrasound; Gestational Hypertension; High-risk Pregnancy; Perinatal Outcome

## INTRODUCTION

Pregnancy can be considered as the most beautiful period of a woman's life. The recent medical advances are helpful in taking very good care of the female throughout her pregnancy. The pregnancy is constantly observed by clinical examination, laboratory investigations, and radiographic examinations at specific intervals throughout its course. The use of Doppler ultrasound has been recently introduced for the study of fetal circulation and various vessels including the both uterine artery, umbilical artery, and middle cerebral artery (MCA).

In obstetrics, the use of Doppler ultrasound to study blood flow is of major importance because fetal inaccessibility precludes many other methods of the study of fetal hemodynamics.

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The development of Doppler ultrasonographic technology has provided an opportunity to obtain a qualitative and quantitative assessment of maternal and fetal circulation using a non-invasive method.[1] It has been studied that Doppler velocimetry of umbilical artery in unselected and low-risk pregnancies cannot be recommended.[2] In contrast, it has been proved by many studies that Doppler has a very important role in screening of high-risk pregnancies.[3-5]

Abnormal fetal circulation is considered a major factor in fetal growth restriction, both as a cause and an indicator. Non-invasive investigation of fetal circulation has become possible with the use of Doppler.[3] There are many causes of high-risk pregnancies. Pregnancy-induced hypertension (PIH) or gestational hypertension being one of the most common.[6] Oligohydramnios can be idiopathic or may be associated with other conditions. Diabetes and anemia also have many adverse fetal and maternal outcomes. Among congenital infections, toxoplasmosis is a common infection which can affect the fetus. Hepatitis is one of the common acutely affecting infections in a pregnant female. Intrauterine growth restriction (IUGR) is the generally observed consequence in abovementioned conditions.

Considering the above facts, these six conditions were included in the present study with an aim to evaluate the importance of Doppler study in high-risk pregnancy and to correlate the findings of Doppler with clinical findings in high-risk pregnant women. Furthermore, we have evaluated the efficiency of Doppler in cases of IUGR for early clinical management in high-risk cases.

## MATERIALS AND METHODS

This was a prospective and observational study carried out in the Department of Radiology at the Civil Hospital affiliated with B. J. Medical College, Ahmedabad, for 2 years. The study was conducted with the help of Department of Obstetrics and Gynecology. The study was commenced after the approval of the Institutional Ethical Committee.

The study included 110 antenatal women with high-risk factor for pregnancy. The risk factors considered were PIH, diabetes, anemia, oligohydramnios, toxoplasmosis, and hepatitis.

### Inclusion Criteria

Patients meeting following criteria were selected for the study:

1. Age group 20-30 years.
2. Singleton pregnancy and gestational age of 26 weeks to term, who are in the reproductive age group and are sure of their last menstrual period or had a dating scan in the 1st trimester.
3. Pregnancy with high-risk factor with or without clinical evidence of growth retardation.
4. Clinical suspicion of IUGR.

### Study Procedure

Patients were recruited from the outpatient department and also from those admitted in antenatal ward. They were followed up at regular intervals from the date of enrolment to the time of delivery.

Details of obstetric history, age, last menstrual date, and underlying risk factors were noted. All patients were examined on essaotae AU3 color Doppler machine with 3.5 MHz curvilinear probe and with color and spectral Doppler. Detailed USG study in the form of maturity by biparietal diameter, femoral length, abdominal circumference, liquor, and expected fetal weight was measured. Doppler study of umbilical artery, fetal MCA, and both the maternal uterine arteries was done. Parameters in the form of a resistive index, pulsatility index (PI), and systolic/diastolic ratio (S/D) of all four arteries were taken. Follow-up Doppler study was done in required patients at 7th or 15th day according to the previous Doppler findings.

Details of delivery were taken in the form of induction, lower (uterine) segment caesarian section (LSCS), and termination of pregnancy. Details of fetal outcome were recorded in the form of birth weight, intrauterine death (IUD), stillbirth, intrauterine growth retardation (IUGR), survival in neonatal intensive care unit (NICU), and death in NICU.

## RESULTS

The present study was carried out over 110 high-risk pregnancies.

The patients were divided into two age groups, namely, 20-25 years and 26-30 years. 69% ($n$ = 76) of patients belonged to the age group of 20-25 years, and 31% ($n$ = 34) of patients belonged to 26-30 years age group.

Table 1 shows the incidence of various high-risk factors. Most common high-risk factor in pregnancy was PIH which accounted for 49% of cases ($n$ = 54).

In our study, due to various high-risk factors, 39% ($n$ = 43) of cases resulted in IUGR. Induction or LSCS was done in all the IUGR cases because of maternal high risk of pre-eclampsia, eclampsia, or fetal distress. After delivery, all the babies were admitted to NICU, where they were kept because of low birth weight. Table 2 shows the Doppler findings and fetal outcome in IUGR cases.

Table 3 shows the incidence of IUGR in the various high-risk conditions. This shows that PIH, anemia, and diabetes were

**Table 1:** Incidence of high-risk conditions (*n*=110)

| High-risk condition | *n* (%) |
|---|---|
| Pregnancy-induced hypertension | 54 (49) |
| Oligohydramnios | 18 (16.3) |
| Diabetes mellitus | 14 (12.7) |
| Iron deficiency anemia | 12 (11) |
| Toxoplasmosis | 6 (5.5) |
| Hepatitis | 6 (5.5) |

*n*: Number of cases

**Table 2:** Doppler findings and fetal outcome in IUGR cases (*n*=43)

| Fetal outcome | Doppler findings | | Percentage of survived fetuses |
|---|---|---|---|
| | Abnormal | Normal | |
| Survived in NICU | 19 | 5 | 56 |
| Died in NICU | 3 | 0 | 7 |
| Intrauterine death | 16 | 0 | 37 |
| Total | 38 | 5 | - |

IUGR: Intrauterine growth restriction, NICU: Neonatal intensive care unit

**Table 3:** Incidence of IUGR in various high-risk conditions

| High-risk condition | *n* (%) | |
|---|---|---|
| | IUGR | Non-IUGR |
| Pregnancy-induced hypertension | 26 (48) | 28 (52) |
| Oligohydramnios | 5 (27) | 13 (73) |
| Diabetes mellitus | 5 (35) | 9 (65) |
| Iron deficiency anemia | 5 (42) | 7 (58) |
| Toxoplasmosis | 1 (17) | 5 (83) |
| Hepatitis | 1 (17) | 5 (83) |

IUGR: Intrauterine growth restriction, n: Number of cases

more associated with IUGR as compared to oligohydramnios, hepatitis, and toxoplasmosis.

Table 4 shows the Doppler findings and fetal outcome in various high-risk conditions. All the cases of PIH with IUGR showed abnormal Doppler findings. In PIH with non-IUGR cases also, 55% of cases showed abnormal Doppler findings. Survivability increased as early induction or LSCS was done on emergency basis, and IUGR fetuses were admitted in NICU in both PIH and diabetes cases. LSCS was done in all the cases of oligohydramnios as there was very less or almost absent liquor. Fetuses were admitted to NICU. In one case of non-IUGR with fetal death, there was bilateral renal agenesis. Only two cases of iron deficiency anemia had IUGR, and both showed abnormal Doppler findings. In toxoplasmosis, out of three fetal deaths, two were sudden IUD without previous abnormal Doppler findings. In hepatitis, 66% of cases showed normal Doppler study. Spontaneous labor occurred in five out of six hepatitis cases, and 2 fetuses died after spontaneous delivery.

**Table 4:** Correlation between Doppler findings and fetal outcome in various high-risk conditions

| Fetal outcome | Doppler findings | |
|---|---|---|
| | Abnormal (*n*) | Normal (*n*) |
| PIH | | |
| IUGR | | |
| Fetal survival | 14 | - |
| Fetal death | 12 | - |
| Non-IUGR | | |
| Fetal survival | 12 | 10 |
| Fetal death | 6 | - |
| Diabetes | | |
| IUGR | | |
| Fetal survival | 3 | 1 |
| Fetal death | 1 | - |
| Non-IUGR | | |
| Fetal survival | - | 7 |
| Fetal death | 2 | - |
| Oligohydramnios | | |
| IUGR | | |
| Fetal survival | 4 | - |
| Fetal death | 1 | - |
| Non-IUGR | | |
| Fetal survival | 8 | 4 |
| Fetal death | 1 | - |
| Iron deficiency anemia | | |
| IUGR | | |
| Fetal survival | 1 | 3 |
| Fetal death | 1 | - |
| Non-IUGR | | |
| Fetal survival | - | 7 |
| Fetal death | - | - |
| Toxoplasmosis | | |
| IUGR | | |
| Fetal survival | - | - |
| Fetal death | 1 | - |
| Non-IUGR | | |
| Fetal survival | - | 3 |
| Fetal death | - | 2 |
| Hepatitis | | |
| IUGR | | |
| Fetal survival | - | 1 |
| Fetal death | - | - |
| Non-IUGR | | |
| Fetal survival | 1 | 2 |
| Fetal death | 1 | 1 |

PIH: Pregnancy-induced hypertension, IUGR: Intrauterine growth restriction, *n*: Number of cases

Out of 110 high-risk cases, in 43% (*n* = 47) of cases, umbilical artery findings were abnormal. In these cases,

early intervention was done, and fetal survivability was 55% ($n$ = 26). 82% ($n$ = 14) of fetuses with absent or reversal of diastolic flow were IUD. In cases of isolated uteroplacental insufficiency (UPI) without fetoplacental insufficiency (FPI), 93% ($n$ = 15) survived. Whereas, cases of isolated FPI without UPI were more associated with IUD (38% ($n$ = 6)) (Table 5).

Table 6 shows abnormal Doppler findings of MCA and uterine artery and fetal affection in the form of any of the adverse consequences, i.e., IUGR, pre-eclampsia, preterm labor, and development of FPI. Isolated MCA abnormality had good perinatal outcome (80%). Whereas, isolated umbilical artery abnormality was more associated with adverse perinatal outcomes (72%).

## DISCUSSION

In this study, we have evaluated the role of Doppler in high-risk pregnancies. The predictive value of Doppler findings in various cases of high-risk pregnancies was studied, and its importance in management of fetal outcome was determined. In our study of high-risk pregnancy cases, there were 43 cases of IUGR fetuses, and among them, 38 cases had abnormal Doppler findings, which warranted early intervention among these cases.

In the present study, the 20-25 years of age group had more high-risk pregnancies as compared to the 26-30 years age group. In our study, PIH was found to be the most common risk factor in pregnant women. This is similar to the findings of a recent review which concludes that hypertensive disease of pregnancy is one of the leading causes of maternal mortality worldwide.[6]

**Table 5:** Abnormal umbilical artery Doppler findings and fetal outcome

| Doppler findings | Fetal outcome *n* (%) | |
|---|---|---|
| | Survival | Death |
| Abnormal umbilical artery with end diastolic velocity | 55 (26) | 45 (21) |
| Absent end diastolic flow | 18 (3) | 64 (11) |
| Reversal of end diastolic flow | 0 | 18 (3) |
| Uteroplacental insufficiency without fetoplacental insufficiency | 93 (15) | 7 (1) |
| Fetoplacental insufficiency without uteroplacental insufficiency | 62 (10) | 38 (6) |

*n*: Number of cases

**Table 6:** Abnormal middle cerebral artery and uterine artery Doppler findings and fetal outcome

| Doppler findings | Fetal outcome *n* (%) | |
|---|---|---|
| | Good | Bad |
| Abnormal middle cerebral artery with normal umbilical artery | 80 (12) | 20 (3) |
| Abnormal umbilical artery with normal middle cerebral artery | 28 (2) | 72 (5) |
| Diastolic notch in uterine artery | 93 (14) | 7 (1) |

*n*: Number of cases

In our study, 39% of cases were IUGR. A birth weight below 10$^{th}$ percentile was used to define small for gestational age baby or intrauterine growth retardation. A study conducted by Low has found that, among 127 cases of high-risk pregnancy, there were 35% of cases of IUGR.[1] In our study, out of 43 IUGR cases, 38 cases, i.e., 88% of cases had abnormal Doppler findings. 16 cases, i.e., 37% cases among IUGR fetuses were IUD. This is similar to the findings of the study of Northern regional health authority coordinating group, which says that 36% of IUD of normally formed singleton fetuses are associated with IUGR.[4] Thus, we can even say that it is very important to carry out Doppler study of all IUGR cases to find out the final fetal outcome. Kramer and Weiner had concluded that all IUGR cases should be followed up with Doppler velocimetry as soon as possible.[7]

In our study, a very high number of cases of IUGR were associated with PIH. Other diseases had both IUGR and non-IUGR cases in quite similar number. Conditions such as infective pathologies were not associated with many IUGR cases, but anemia and diabetes had a few number of cases with growth retardation. A study carried out by Bhatt et al. shows that, out of 100 cases of PIH, 60% of cases had IUGR. This is also supported by the present study as 48% of PIH cases had IUGR.[8] Similarly, a study conducted by Casey et al. suggests that, out of 147 cases of oligohydramnios, 26% had IUGR.[9] Steer had found in a study of maternal hemoglobin and birth weight that severe anemia is associated with the birth of small babies.[10] In our study, it was found that fetal survival in high-risk cases with abnormal Doppler findings was increased with early interventions in the form of induction or LSCS. Even the cases which had not reported growth retardation, but had abnormal Doppler findings, were also intervened, and out of 18 cases, 12 survived, so it is very important in cases like PIH to regularly evaluate the fetal status with the help of color Doppler. Ducey had also concluded that Doppler provides an important tool to identify women at significant risk for adverse outcome. Applying therapeutic intervention to these women is more likely to identify useful clinical protocols and ultimately improve outcome.[11] In the cases of iron deficiency anemia, even with normal Doppler study, three were IUGR and underwent preterm labor. All the females were severely anemic with Hb < 7-8 g%. Severe maternal anemia was associated with low birth weight, higher induction rates, operative delivery, and fetal death.[12,13] Furthermore, in cases of anemia, Doppler does not give any significant parameters which can help in the improvement of fetal outcome.[14] Toxoplasmosis and acute viral hepatitis do not show significant Doppler changes which can help in good perinatal outcome. Toxoplasmosis is an infection which can be transmitted to the fetus from the

mother. Infection transmission in 3rd trimester is associated with bad outcome in the form of spontaneous delivery. Viral hepatitis is an acute infection, so the fetus may not have a chance to react, and this may be the reason for the normal Doppler study but bad perinatal outcome.

Out of 110 high-risk pregnancies, 47 had abnormal umbilical artery in the form of increased S/D ratio and increased resistance index and pulsatility index. Hence, 47 cases had FPI and they may or may not have UPI. In the abnormal cases, in 26 (55%) cases, fetuses survived, and in 21 (45%) cases, there was perinatal fetal death. In the cases, in which early intervention was done in the form of induction or LSCS, there was a good fetal outcome in terms of fetal survivability. In cases, in which no early intervention was done, there was a high rate of perinatal death either in the form of IUD or death in NICU. However, there was no exact cutoff point at which intervention should be done, and it was done based on clinical judgement in favor of mother or in the favor of fetus in cases of fetal distress. This suggests that abnormal umbilical artery can give clue to the clinicians to take decision for early intervention in high-risk pregnancy and by that can improve perinatal outcome. Reed et al. concluded that IUGR is associated with abnormalities in fetal circulation. These abnormalities are best evaluated with umbilical artery and venous study. Doppler ultrasound, particularly, of umbilical artery has been useful in fetus at risk for growth restriction.[3] Furthermore, absence or reversal of flow in umbilical artery had bad fetal outcome and in the form of perinatal death. Wenstrom et al. concluded that absent end diastolic flow in umbilical artery after 20 weeks of gestation may be associated with varying maternal and fetal abnormalities, and management should be individualized for that.[15] In our study, abnormal fetoplacental circulation was more associated with adverse perinatal outcome as compared to abnormal uteroplacental circulation. In the present study, 15 cases of high-risk pregnancy had increased diastolic flow in MCA, reduced pulsatility index, and reduced S/D ratio in MCA with normal umbilical artery. All the cases were more than 33-34 weeks pregnant, and out of them, 12 (80%) had a good outcome. In 7 cases, there was only umbilical artery abnormality and no MCA abnormality. All these cases had an adverse perinatal outcome. This suggests that umbilical artery Doppler findings are a better predictor of adverse perinatal outcome than an abnormal MCA. Fong et al., by their study in 293 suspected IUGR fetuses, concluded that in suspected IUGR, umbilical artery PI is a better predictor of adverse perinatal outcome than abnormal MCA.[16] Wladimiroff concluded that, in the presence of IUGR, significant reduction of PI has been established in cerebral arteries. This reduction in PI was determined by rise in end diastolic flow velocity, suggesting a drop in cerebral vascular resistance called brain sparing effect.[17] 2 cases in which there was severely abnormal umbilical artery and severe IUGR, but one normal MCA and absent diastolic flow had IUD within 48 h. This suggests that there was severe brain edema which gives increased resistance to blood flow in cerebral arteries. This is called reversal of adaptation. Rowland and Vyas found that reversal of adaptation in fetal hypoxemia as indicated by rise in MCA pulsatility index may be a predictor of IUD within 48 h.[18] In the present study, 15 cases had a persistent diastolic notch in uterine artery with increased pulsatility index. Out of these 15, 14 cases had adverse perinatal outcome. Ochi et al. found that elevated PI and the presence of diastolic notch in the uterine artery flow velocity are indicators of increased uterine arterial resistance and impaired uterine circulation.[19]

Thus, this study assesses the role of color Doppler in early identification of fetal distress in most common high-risk pregnancy cases. It provides an insight into the use of color Doppler as an effective management tool to improve fetal outcome in these cases. There were certain limitations in our study. Due to logistical reasons, we could only include the most commonly occurring high-risk pregnancy situations and not the rare cases of high-risk pregnancy. The study sample was small and was limited only to the high-risk pregnancies and normal pregnancies were excluded from the cases.

## CONCLUSION

All the diseases which affect the pregnancy in a gradual manner can give rise to abnormal fetal growth in the form of IUGR and that can lead to abnormal Doppler findings in the form of UPI and FPI. Doppler analysis is a very reliable criterion to evaluate the fetus in the cases of PIH with IUGR and can help clinician take decisions regarding early intervention. In diseases such as anemia, toxoplasmosis, and acute hepatitis, Doppler does not show significant changes. Umbilical artery Doppler is a very good parameter for fetal surveillance. Furthermore, persistent diastolic notch in uterine artery is a very reliable criterion to predict the future outcome of the fetus. Thus, Doppler ultrasound makes it possible to distinguish between a compensated and decompensated placental insufficiency. Further studies are needed to evaluate further predictive value of Doppler ultrasound and establish clinical protocols in IUGR cases with the help of Doppler findings in high-risk pregnancies.

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