Original Research Article

Doppler sonographic evaluation of intrauterine growth restriction of fetus and its correlation with perinatal outcomes among the population of riverine (char) areas of Barpeta Assam

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ABSTRACT

Background: Intrauterine growth restriction (IUGR) also known as fetal growth restriction (FGR), has been associated with a variety of detrimental perinatal outcomes. FGR is defined as estimated fetal weights (EFW) or abdominal circumference (AC) that fall within the third, or tenth percentiles with abnormal doppler parameters. FGR affects 10-15% of all pregnancies around the world.
Methods: Prospective observational study of singleton pregnant women complicated by FGR were enrolled during the study period from September 2021 to August 2022. 100 patients were included in the study.
Results: Abnormal umbilical artery flow was seen in 30% of cases, out of which 83% (25) had abnormal perinatal outcome. Out of 100 cases, live births were reported in 94%, stillbirths in 4%, and IUDs in 2%. There were 16 neonatal deaths and 15 neonatal complications among the adverse perinatal outcomes. Intraventricular hemorrhage and neonatal sepsis were the two leading causes of death. Neonatal sepsis, necrotizing enterocolitis and hypoxic ischemic injury was the leading cause of morbidity. Reverse end diastolic umbilical artery Doppler and bilateral uterine artery notch had 100% mortality. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of umbilical artery in predicting perinatal outcome in IUGR were 80.65%, 92.75%, 83.33% 91.43% and 89.47% respectively.
Conclusions: Umbilical artery PI is the most sensitive parameter and had highest positive and negative predictive value and Accuracy in relation to adverse perinatal outcomes.

Keywords: FGR, IUGR, MCA Doppler, Perinatal outcome, UA Doppler, Uterine artery Doppler

INTRODUCTION

Fetal growth restriction, also known as intrauterine growth restriction, is a common complication of pregnancy that has been associated with a many detrimental perinatal outcomes.[1] Fetal growth restriction (FGR) affects 10-15% of all pregnancies around the world.[2] The prevalence of FGR is 7.7% in India as per ISUOG.[3] FGR can be caused by a variety of factors, including maternal, placental or fetal. The most common non-genetic or placental cause is maternal malnutrition prior to and during pregnancy. In a harmful environment, FGR represents abnormal adaptive fetal growth. People born after the FGR are more likely to develop diseases as a result of subsequent stressors in their lives.

Fetal growth restriction is defined as estimated fetal weights (EFW) or abdominal circumference (AC) that fall within the third, or tenth percentiles with abnormal doppler parameters. A consensus-based definition of FGR has been created, and it takes both biometric and functional characteristics into account.[4]

The mortality and morbidity of fetuses with FGR can be reduced if the condition is diagnosed early. Proper antepartum, intrapartum, and neonatal management are essential for a successful perinatal outcome.

The value of fetal Doppler studies of the umbilical artery (UA), middle cerebral artery (MCA), and uterine arteries (UtA) in diagnosing adverse perinatal outcomes in patients with FGR is investigated in this study. In combination with biometry, Doppler sonography of the middle cerebral artery (MCA), umbilical artery (UA) and uterine artery provides the important tool to identify fetal growth restricted (FGR) fetuses at risk for an adverse outcome. Early prediction of adverse neonatal outcomes helps the obstetricians to consider appropriate antenatal surveillance and therapeutic intervention.

Intraventricular hemorrhage, periventricular leukomalacia, hypoxic ischemic encephalopathy, necrotizing enterocolitis, bronchopulmonary dysplasia, sepsis, newborn death and stillbirth were all considered to be adverse perinatal outcomes.[5]

This study aimed to establish predictive value of Doppler studies in FGR with relevance to perinatal outcome in a resource-constrained context.

METHODS

Study type

It was a prospective observational study.

Study place

Study was conducted at the department of radiology, Fakhruddin Ali Ahmed Medical College Hospital, Barpeta, Assam.

Period of study

The study took place from September 2021 to August 2022.

Selection criteria of the patients

Purposive sampling of 100 pregnant women complicated by FGR were selected for our study. FGR is defined as estimated fetal weights (EFW) or abdominal circumference (AC) that fall within the third percentiles, or tenth percentiles with abnormal doppler parameters.[4]

Procedures

Informed consent was taken from all patients before enrolment in our study. Based on sonographic studies, they suffered from FGR and qualified to enter the study. All singleton pregnant women of Riverine) areas of Barpeta district of Assam, irrespective of age or parity complicated by FGR were selected for our study. Brief history was taken for all the patients selected for our study and quick examination was performed as per the proforma given below. Estimated fetal weight (determined by Hadlock equation) or abdominal circumference (AC) that fall within the third percentiles, or tenth percentiles with abnormal doppler parameters for that gestational age were selected for our study. After taking their satisfaction, Doppler sonography and velocimetry including fetus middle cerebral artery, umbilical and uterine arteries were registered in SAMSUNG RS80A and SONOACE R7 ultrasonography machine with a 3.5 to 5 MHz curvilinear transducer ultrasound probe at around 32 to 34 weeks followed by Repeat Doppler sonography done after 1 to 4 weeks to verify the earlier ultrasonography findings. Umbilical artery PI readings more than the 95th percentile of standard values were considered abnormal. Absent diastolic flow, reversed diastolic flow or high resistance of umbilical artery were investigated. A middle cerebral artery PI less than 5 percentile from standard values was deemed abnormal. Early diastolic notch's existence and high resistance flow with PI more than 95 percentile of uterine artery were considered abnormal. The pregnancies were followed up and the final perinatal outcome of each case was noted.

Umbilical artery Doppler technique[6]

The free-floating loops in mid-position were used to record flow velocity waveforms.

Middle cerebral artery Doppler technique[6]

MCA's wave forms are recorded as it travels through the lateral sulcus. An enlarged axial section of the brain was acquired, showing the thalami and the sphenoid bone wings. The circle of Willis was mapped using colour doppler. The pulsed-wave Doppler gate was positioned in the MCA's proximal third, near to its internal carotid artery origin.

Uterine Artery doppler technique[6]

The probe was kept 3 cm medial to the anterior superior iliac spine and directed towards the uterus's lateral wall to examine the uterine artery. The crossroads of the uterine artery and the external iliac vessels were found, and the sampling location was taken 1 cm downstream from this point. Both uterine arteries had waveforms recorded

Ethical approval

The study was approved by institutional ethics committee.

Statistical analysis

The data were entered in Microsoft excel and data analysis was done using SPSS software. The chi square test was used to analyse the association between doppler parameters and perinatal outcomes. P value less than 0.05 was considered significant.

RESULTS

In this prospective study, which was conducted over a year, 100 pregnant women with FGR participated. Hence the statistical analysis was done on 100 cases. The chi-square test was used to analyse the association between the variables.

The patients were in the age group ranging from 17 to 41 years. Out of 100 women 56% belonged to age group 21-25 years, 19% belonged to age group 26-30 years, 13% were <20 years, 10% belonged to age group 31-35 years and 2% were above 35 years.

Out of the total 100 participants, 29% of them were primi, and 71% were multipara.

Out of the total 100 participants, 30% had oligohydroamios, 64% had normal liquor whereas 6% had polyhydroamnios.

Out of the total 100 women, it was seen that 34% had history of gestational hypertension of pregnancy whereas 31% had no specific history, 11% had associated anemia, 9% had heart disease and 7% had chronic maternal disease.

Doppler parameters

Umbilical artery Doppler

Out of the total 100 participants, abnormal umbilical artery flow was seen in 30% of cases, out of which 83% (25) had abnormal perinatal outcome. P value was significant (<0.001) (Table 1).

Table 1: UA Doppler pattern and perinatal outcomes.

Umbilical-A Doppler pattern	Perinatal outcome			Chi	P value
	Abnormal outcome	Normal outcome	Total		
Abnormal	25	5	30		
Normal	6	64	70	58.84	<0.001
Total	31	69	100		

Table 2: MCA Doppler pattern and perinatal outcomes.

MCA Doppler pattern	Perinatal outcome			Chi	P value
	Abnormal	Normal	Total		
Abnormal	12	3	15		
Normal	19	66	85	19.8	<0.001
Total	31	69	100		

Umbilical artery AEDF was present in 8% of cases, out of these 75% (6) had mortality. Umbilical artery AEDF was absent in 92% of cases, out of these 16% (15) had morbidity and 10% (9) had mortality. P value <0.001 (significant).

Umbilical artery REDF was present in 7% of cases, out of 100% (7) had mortality. P value <0.001 (significant).

Out of the total 100 participants, abnormal MCA Doppler flow (IDF) was seen in 15% of cases, out of which 80% had abnormal perinatal outcome. P value was significant (<0.001) (Table 2).

Out of the total 100 participants, abnormal umbilical artery flow was seen in 18% of cases, out of which 80% (14) had abnormal perinatal outcome. P value was significant (<0.001). Bilateral uterine artery end diastolic notch was present in 4% of cases, out of these 100% (4) had mortality. P value <0.001 (significant).

There were 16 neonatal deaths and 15 neonatal complications among the adverse perinatal outcomes.

Table 3: UtA Doppler pattern and perinatal outcomes.

| Uterine A Doppler pattern	Perinatal outcome			P value
	Abnormal outcome	Normal outcome	Total	
Abnormal	14	4	18	
Normal	17	65	82	<0.001
Total	31	69	100	
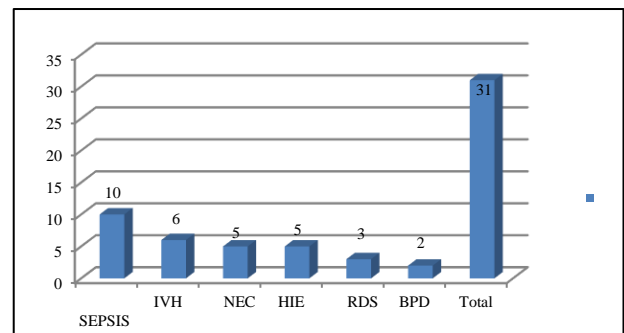
Figure 1: Adverse neonatal outcomes and its frequency.

Neonatal sepsis and intraventricular hemorrhage were the two leading causes of adverse neonatal outcomes followed by NEC and HIE.

Representative cases

Case 1

20 years old G2P1 woman showing reverse end diastolic flow in umbilical artery Doppler at 32 weeks 6 days GA, delivered IUD baby at 33 weeks due to lack of immediate intervention.
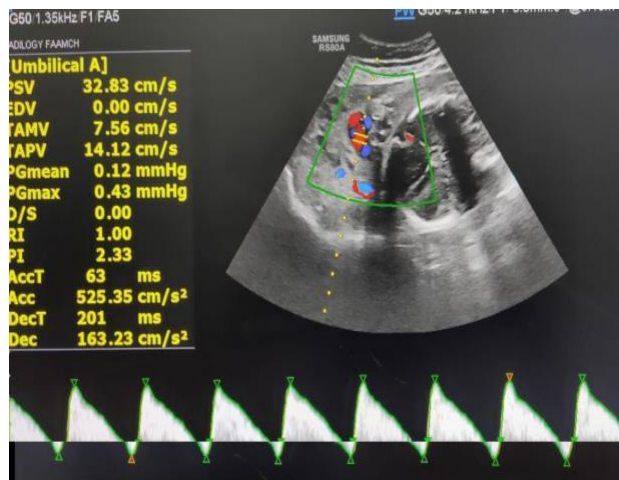

Figure 2: Umbilical artery doppler showing reverse end diastolic flow at 32 weeks 6 days GA.

Case 2

25-year-old G3P2 woman showing uterine artery early diastolic notch and low resistance flow in MCA at 32weeks delivered a preterm baby at 33 weeks who showed intraventricular hemorrhage in follow up USG cranium.

Figure 3: Uterine artery Doppler showing early diastolic notch.
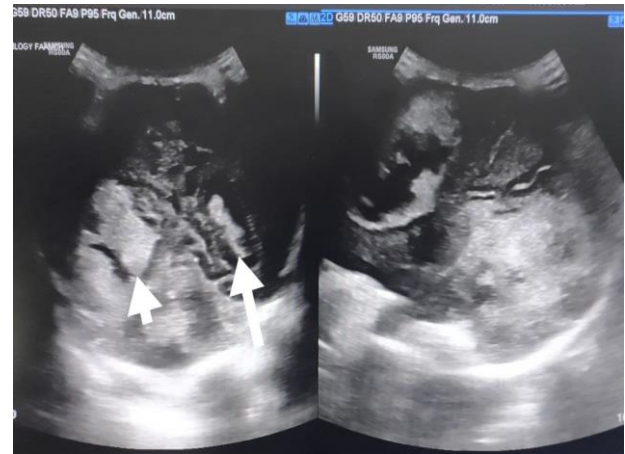
Figure 4: Follow up USG cranium showing intraventricular hemorrhage.

DISCUSSION

Prospective study included pregnant women from Riverine areas of the Barpeta district of Assam whose pregnancy affected by fetal growth restriction. The chi square test was used to analyze the association between doppler parameters and perinatal outcomes. Morbidity and mortality are correlated with increasing PI values for UA and UtA. Morbidity and mortality are correlated with a declining PI value for MCA. 69% of the patients had a normal perinatal outcome, compared to 31% of the 100 cases that had an adverse perinatal outcome.

Out of 100 cases, live births were reported in 94%, stillbirths in 4%, and IUDs in 2%. There were 16 neonatal deaths and 15 neonatal complications among the adverse perinatal outcomes. 7% patients underwent instrumental delivery, and 42% of those patients experienced abnormal outcomes. Out of the 59 patients who underwent LSCS delivery, 30% experienced abnormal outcomes. Out of the 34 patients who had vaginal delivery, 29% had abnormal outcomes. The modes of delivery did not significantly affect the perinatal outcome. It is seen that 34% had history of hypertension on pregnancy whereas 31% had no specific history, 11% had associated anemia, 9% had heart disease and 7 % had chronic maternal disease.

Intraventricular hemorrhage and neonatal sepsis were the two leading causes of death. Neonatal sepsis, necrotizing enterocolitis and hypoxic ischemic injury was the leading cause of morbidity.

100 participants were included for final analysis, and out of those 30 of them had abnormal umbilical artery Doppler parameter. Umbilical artery sensitivity, specificity, positive and negative predictive values and accuracy for perinatal outcome are respectively 80.65%,92.75%, 83.33% 91.43% and 89.47%. This is consistent with the views expressed by Bano at el, Yadav et al, Yoon et al and Ozeren et al.[7-10]

UA PI had 46%, 93.3%, 87.5%, 63.6%, and 70% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively for perinatal outcome in a study by Bano at el.[7] Sensitivity was lower than the current study. Specificity and positive predictive value matched with the current study.

UA PI had 69 %, 97 %, 95%, 81%, and 85% sensitivity, specificity, positive predictive value, negative predictive

value and accuracy respectively for perinatal outcome in Ozeren's study.[10] This is quite similar with the current study.

Yadav et al in their study found that UA PI had 84.21% sensitivity, 88.88% positive predictive value and 90% accuracy.[8] This is consistent with the current study findings.

Table 4: Comparison of UA Doppler parameters with other studies.

UA Doppler	Bano at al[7]	Ozeren et al[9]	Yadav et al[8]	Our study
Sensitivity	46%	69%	84.21%	80.65%
Specificity	93.3%	97%		92.75%
PPV	87.5%	95%	88.88%	83.33%
NPV	63.6%	81%		91.43%
Accuracy	70%	85%	90%	89.00%

Absent end diastolic umbilical artery Doppler had 75% mortality. This is consistent with the views expressed by Rajarajeswari et al and Padmini et al.[11,12]

Reverse end diastolic umbilical artery Doppler had 100 mortalities. This is consistent with the views expressed by Padmini et al.[12]

Table 5: Comparison of MCA Doppler parameters with other studies.

MCA Doppler	Srirambhatla et al[13]	Mahale et al[14]	Our study
Sensitivity	60%	69%	39%
Specificity	89%	97%	95%
PPV	75%	95%	80%
NPV	81%	81%	77%
Accuracy	79%	85%	78%

Srirambhatla et al in their study in AIIMS Hyderabad found that MCA had a 60%, 89%, 75%, 81% and 79% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively for adverse perinatal outcome.[13] Except sensitivity this is quite similar with the current study. Sensitivity of MCA PI is quite lower in our study.

Mahale et al found that MCA has a 65%, 80.5%, 65%, 93% and 82% sensitivity, specificity, positive predictive value, negative predictive value and accuracy respectively for adverse perinatal outcome.[14] Accuracy is similar with the current study, sensitivity negative predictive value is higher than the current study, specificity and positive predictive value is lower than the current study.

The uterine artery has a sensitivity, specificity, positive predictive, negative predictive value and accuracy of

45.16%, 94.20%, 77.78%, 79.27% and 79.00% respectively, in predicting perinatal outcome.

Table 6: Comparison of UtA doppler parameters with other studies.

Uterine-A Doppler	Hwang et al[16]	Martinez-Portilla et al[15]	Our study
Sensitivity	48.7%,	46%	45.16%
Specificity	74.4%	83%	94.20%,
PPV	52.7%		77.78%
NPV	66.9%		79.27%
Accuracy			79.00%

UtA was reported to have a sensitivity of 46% and a specificity of 83% in predicting composite adverse perinatal outcome, according to Martinez-Portilla et al.[15] Hwang et al in a study found that UtA had 48.7%, 74.4%, 52.7%, and 66.9% sensitivity, specificity, positive predictive and negative predictive value.[16] Sensitivity is similar with the current study however specificity, positive predictive and negative predictive value is quite lower than the current study.

UA PI has the highest sensitivity, positive and negative predictive value and accuracy in relation to adverse perinatal outcomes. MCA PI has the highest specificity followed by uterine artery PI. However, middle cerebral artery PI has the lowest sensitivity. Uterine artery early diastolic notch is associated with high morbidity and mortality.

Our study has a sample size limitation, so it would be better to conduct additional research with a large sample of pregnant women of Riverine areas, additional modalities, and also combine all Doppler indices with other tests related to FGR used in clinical care. This could

increase the predictive accuracy and clinical importance of the tests.

CONCLUSION

As the impact of FGR is very detrimental, early evaluation of these patients with the available imaging modality will help in the further management of the patient and thus reducing the mortality as well as morbidity. UA PI has the highest sensitivity, positive and negative predictive value and accuracy in relation to adverse perinatal outcomes and it can be used as a routine check-up, follow-up in high-risk pregnancies suspected of FGR, and to help manage and control FGR. Early assessment of the UA waveform should be carried out alongside MCA and uterine artery analysis as all indices have a positive relationship with adverse maternal and neonatal outcomes, particularly FGR. When an abnormal Doppler finding is discovered, the obstetrician is informed of the potential difficulties that could arise, and the delivery should be scheduled at a tertiary care facility with excellent neonatal facilities.

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