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Original Research Article

Assessing Adverse Perinatal Outcomes using Ultrasound Doppler Parameters of Fetal Vessels in Pregnancies Suspected of Intrauterine Growth Retardation.

Kishan Kumar Thakur[1], Mithilesh Pratap[2], Ankita Anand[3]

[1]Senior Resident, Department of Radiology, Nalanda Medical College Hospital, Patna
[2]Professor, Department of Radiology, Nalanda Medical College Hospital, Patna
[3]Senior Resident, Department of Radiology, Nalanda Medical College Hospital, Patna

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Corresponding Author: Dr. Mithilesh Pratap
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Abstract:

Background: Intrauterine growth retardation (IUGR) is conveniently defined as fetal weight less than 10th percentile for gestational age. IUGR fetuses are at increased risk of hypoxemia, acidemia and intrauterine fetal demise. The correct detection of compromised IUGR fetus for timely intervention is a main objective of antenatal care.

Aims and Objectives: To evaluate the Doppler changes in fetal arterial system (specifically in middle cerebral artery, umbilical artery and thoracic aorta) in IUGR and to find any possible association between Doppler abnormalities and adverse perinatal outcomes in IUGR.

Materials and Methods: This was a two-stage study with real time gray scale B-mode and Color Doppler ultrasound studies of the fetuses with estimated birth weight less than 10th percentile beyond 24 weeks of gestation and follow-up after termination of pregnancy for detection of adverse perinatal outcome. The study included 50 cases during period between September 2022 and August 2023 at Nalanda Medical College Hospital, Patna, Bihar.

Result: The chance of cesarean section for fetal distress was highest for abnormal TA PI (OR = 9.17; 95%CI 0.99 - 212.12 and RR = 1.68) followed by an abnormal cerebroplacental ratio (OR = 7.28; 95% CI 0.77 - 167.93 and RR = 1.60). The chance of admission to NICU was highest for an abnormal cerebroplacental ratio (OR = 4.13; 95% CI 0.76 - 24.87 and RR = 1.94) followed by an abnormal TA PI (OR = 3.50; 95% CI 0.73 - 17.90 and RR = 1.83). The chance of perinatal death was maximum with an abnormal cerebroplacental ratio (OR = 16.0; 95% CI 1.36 - 428.19 and RR = 11.38) followed by an abnormal UA PI (OR = 9.85; 95% CI 0.87 - 255.53 and RR = 7.76).

Conclusion: Fetuses with an abnormal PI in MCA or UA or TA are at increased risk of adverse perinatal outcomes, An abnormal cerebroplacental ratio is maximally associated with adverse perinatal outcomes than abnormal PI in any individual vessel' The risk of perinatal death is also maximum in abnormal cerebroplacental ratio group.

Introduction

Intrauterine growth retardation (IUGR) is conveniently defined as fetal weight less than 10th percentile for gestational age [1]., SGA should no longer be seen as synonymous with IUGR [2]. IUGR fetuses are at increased risk of hypoxemia, acidemia and intrauterine fetal demise [3]. The correct detection of compromised IUGR fetus for timely intervention is a main objective of antenatal care. It is the leading cause of low birth weight (defined as birth weight less than 2500 gm) babies in India. [4] Less than 30% of infants with a birth weight <10th percentile are detected during pregnancy [5] IUGR is associated with many short- term complications like prematurity, necrotizing enterocolitis, hypoxic ischemic encephalopathy, intraventricular hemorrhage etc. [6,7,8] and long term sequele like short stature, learning disabilities etc. [9, 10]. Perinatal mortality rates are 4-8 times higher for growth retarded infants, and morbidity is present in 50% of surviving infants [11]. Fetal biometry, although a very good indicator of gestational age and fetal growth, cannot detect fetal comprise and hemodynamic changes in the fetus. Traditional tests of fetal well-being are often late when abnormal as described above. 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 organsare valuable in detecting the hemodynamic rearrangements that occur in response to fetal hypoxemia. Doppler ultrasound can detect uteroplacental insufficiency and even acid-base status of the fetus before any other test can do so [1] Several studies have concluded that changes in the Doppler flow

velocity waveform of the umbilical artery (UA), fetal MCA and thoracic aorta (TA) are good predictors of adverse perinatal outcome interms of timing of delivery, cesarean section for fetal distress, admission to neonatal intensive care unit (NICU) as well as various early complications in the newborn like necrotizing enterocolitis, hypoxic-ischemic encephalopathy, intraventricular hemorrhage etc. [4, 12]. The long-term problems include abnormal physical growth and neurodevelopmental outcome. These infants are more likely to develop adult onset disease because of fetal epigenetic changes. [13] It is the prime target of current antenatal care to identify those fetuses with IUGR, recognize the early signs of fetal compromise and to intervene in a timely manner to avoid adverse perinatal outcome.

Objectives

To evaluate the Doppler changes in fetal arterial system (specifically in middle cerebral artery, umbilical artery and thoracic aorta) in IUGR and to find any possible association between Doppler abnormalities and adverse perinatal outcomes in IUGR.

The specific objectives of the study were To record pulsatility index (PI) from each vessel and compare it to the reference value for gestational age to find if it is abnormal, To assess changes in end- diastolic flow in the selected vessels, To assess perinatal outcomes of the fetuses examined by following up the pregnancies up to termination and To compare the Doppler abnormalities with the adverse perinatal outcomes to find any possible association.

Materials and Methods

This study was conducted at the Department of Radiology, Nalanda Medical College and Hospital Patna, Bihar. Patients come here mainly from in and around Patna. Since this is a tertiary referral center, patients may also come from remote areas. Pregnant females referred from the Department of Gynecology and Obstetrics, after clinical suspicion of IUGR.

Inclusion criteria: Singleton pregnancy, Fetal gestational age of 24 weeks or more as confirmed by prior ultrasonography as early as possible and US-estimated fetal weight below the 10th percentile for gestational age or elevated ratio of head circumference (HC) to abdominal circumference (AC) more than 1.20 Exclusion criteria: Pregnancy with a documented major congenitalor chromosomal abnormality or both. The study was conducted between September 2020 and August 2021.

Systemic random sample, every 5th case was selected for the study, provided it fulfilled the inclusion criteria. Total number of cases was 50. Hospital based randomized, prospective, observational study.

Study Parameters

Pulsatility index (PI) values of the umbilical artery (UA), the middle cerebral artery (MCA) and the descending thoracic aorta (TA) of the fetus. Ratio of the PI values of MCA to UA (cerebroplacental ratio).

Changes in the flow velocity waveform (FVW): Absent or reversed end-diastolic flow (EDF).

Adverse perinatal outcome: The adverse perinatal outcomes were assessed according to the following parameters - Gestational age at delivery, Cesarean section for fetal distress, Birth weight, Admission to neonatal care unit & Perinatal death.

Methods

This was a two-stage study with real time gray scale B-mode and Color Doppler ultrasound studies of the fetuses with estimated birth weight less than 10th percentile beyond 24 weeks of gestation and follow-up after termination of pregnancy for detection of adverse perinatal outcome at Nalanda Medical College Hospital, Patna.

History and clinical examination were taken A 3.5 MHz curvilinear probe was used for the examination purpose. Pregnant females were placed in recumbent position on the examination table. 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). At first B-mode ultrasound study was performed for measuring fetal biophysical parameters namely the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL). Amniotic fluid volume was also noted. The average gestational age, effective fetal weight, the percentile fetal weight and HC to AC ratio were calculated automatically in the machine. If the EFW at the time of examination was found to be less than 10th percentile for the gestational age calculated from the first trimester US study for the particular pregnancy and/or HC to AC ratio was more than 1.20 some form of intrauterine growth retardation was present. Such fetuses were further evaluated by pulsed-wave Doppler examination of the selected fetal vessels.

Results

We performed fetal biometry of about 200 fetuses during the period of our study. Among them 50 fetuses fulfilled our inclusion criteria and were included into the study. All the 50 fetuses had estimated weight less than 10th percentile for the gestational age. Only 3 (6 percent) fetuses had head circumference to abdominal circumference ratio more than 1.2

The estimated fetal weight was less than 10th percentile in all the cases. It was less than 3rd percentile in 44% cases. The mean estimated fetal weight was 1980 gm. On Doppler ultrasound study, 58% of the

fetuses had some abnormality in the Doppler parameter we chose namely the pulsatility index Distribution of the PI abnormalities is detailed in table 1. We found abnormal PI values from MCA in 19 cases (65% of the total abnormalities); from the UA in 17 cases (58% of the total abnormalities) and from TA in 13 cases (45% of the total abnormalities). In 13 cases (45% of the total abnormalities) the cerebroplacental ratio was also abnormal (i.e. less than 1In 16 cases, there were abnormalities in more than one vessel. Abnormal PI values were obtained from both MCA and UA; MCA and TA; UA and TA in 4 cases each. In another 4 cases, there were abnormalities in all the three vessels. Isolated abnormality in the MCA, UA and TA was present in 7, 5 and 1 cases, respectively (table 1). We also observed the qualitative changes in the flow velocity waveform in the arteries. There were changes in the end- diastolic flow in 13 (26%) cases in the form of either absent or reverse end-diastolic flow The details of the perinatal outcome in the 50 fetuses examined are given in table 2. The mean gestational age at delivery of all the cases was 34.8 weeks and the overall mean birth weight was 2271 gm. Birth weight in 68% of the babies born was less than 2500 gm. The mean gestational age at delivery was much lower (33.8 weeks) in the abnormal PI group than the normal PI group (35.4 weeks) (The mean birth weight in the abnormal PI group was also lower (1821 gm) as compared to the normal PI group (2363 gm) There were 4 stillbirths and 46 livebirths. In 29 cases (63% of the liveborn), cesarean section had to be performed for fetal distress. The remaining 17 cases (37%) were born by normal delivery. Of the 46 liveborn neonates, 20 (43%) had to be admitted to neonatal intensive care unit. One baby died in the neonatal period. The total number of cases showing at least one of the adverse perinatal outcomes was 34 Among the 29 cases born by cesarean section, 17 neonates also had to be admitted to NICU We observed that an abnormal MCA PI was significantly associated with cesarean section for fetal distress ($p < 0.01$) and perinatal death ($p < 0.04$). An Abnormal UA PI was also significantly associated with cesarean section ($p < 0.04$) and perinatal death ($p < 0.02$). An abnormal TA PI was significantly associated with only cesarean section for fetal distress ($p < 0.02$). On the other hand, an abnormal cerebroplacental ratio (less than 1) was significantly associated with cesarean section for fetal distress ($p < 0.04$), admission to NICU ($p < 0.05$), as well as perinatal death ($p < 0.01$) (table 3) Next we calculated the Odd's ratio (OR) and relative risk (RR) for each abnormal PI. We observed that abnormal PI in all the vessels successfully identified the group of women with increased risk of adverse perinatal outcome (table 4). The chance of cesarean section for fetal distress was highest for abnormal TA PI (OR = 9.17; 95%CI 0.99 - 212.12 and RR = 1.68) followed by an abnormal cerebroplacental ratio (OR = 7.28; 95% CI 0.77 - 167.93 and RR = 1.60). The chance of admission to NICU was highest for an abnormal cerebroplacental ratio (OR = 4.13; 95% CI 0.76 - 24.87 and RR = 1.94) followed by an abnormal TA PI (OR = 3.50; 95% CI 0.73 - 17.90 and RR = 1.83). The chance of perinatal death was maximum with an abnormal cerebroplacental ratio (OR = 16.0; 95% CI 1.36 - 428.19 and RR = 11.38) followed by an abnormal UA PI (OR = 9.85; 95% CI 0.87 - 255.53 and RR = 7.76).

Table 1: US Doppler parameters

PI values	
UA	1.25 ± 0.42*
MCA	1.52 ± 0.42*
TA	2.03 ± 0.37*
Abnormal PI (No. of cases)	
UA (> 2 SD)	17 (34)
MCA (< 2 SD)	19 (38)
TA (> 2 SD)	13 (26)
Distribution of changes	
Only UA	5 (10)
Only MCA	7 (14)
Only TA	1 (02)
UA+MCA	4 (08)
MCA + TA	4 (08)
UA + TA	4 (08)
UA + MCA + TA	4 (08)
Total	29 (58)

Table 1: The details of the abnormal PI values in the selected vessels in the 50 fetuses examined. Total number of cases with abnormal PI was 29.

Table 2: Perinatal outcome

Gestational age at delivery (weeks)	34.80 ± 2.28
Birth weight	2271.43 ± 370.22*
BW <2500 gm (No. of cases)	34 (68)
Normal delivery	17 (34)
CS for fetal distress	29 (58)
Admission to NICU	20 (40)
Only CS	12 (24)
Only admission to NICU	3 (6)
CS + NICU	17 (34)
IUFD	4 (8)
Perinatal death	1 (2)

Table 2: Details of the perinatal outcome in the 50 fetuses examine

Table 3: Strength of association

		CS (29)	NIC U (20)	PD (5)
	Abnorm al PI (19)*	14/16 (87%) #	10/16 (62%)	4/19 (21%)
MC			10/3	
A	Normal	15/30	0	1/31
	PI (31)	(50%)	(33%)	(3%)
	P value	p <	p <	p <
		0.01	0.06	0.04
	Abnorm al PI (17)	12/14 (85%)	9/14 (64%)	4/17 (23%)
			11/3	
UA	Normal	17/32	2	1/33
	PI (33)	(53%)	(34%)	(3%)
	P value	p <	p <	p <
		0.04	0.06	0.02
	Abnorm al PI (13)	11/12 (91%)	8/12 (66%)	1/13 (8%)
TA	Normal PI (37)	18/33 (54%)	12/33 (36%)	4/37 (11%)
	P value	p <	p <	p <
		0.02	0.07	0.76

Table 3: Showing the strength of association between the abnormal PI values for each vessel and abnormal cere-broplacental ratio with adverse perinatal outcomes. Z test for proportion were done and a p value less than 0.05 was considered to be significant.

Table 4: Degree of association

		Odd's ratio	**Relative risk**
	CS	7.00 (CI 1.17 - 53.84)	1.75
MCA	NICU	3.33 (CI 0.8 -14.49)	1.88
	PD	8.0 (CI 0.72 - 205.95)	6.53
	CS	5.29 (CI 0.88 - 41.84)	1.61
UA	NICU	3.44 (CI 0.78 - 15.87)	1.87
	PD	9.85 (CI 0.87 - 255.53)	7.76
	CS	9.17 (CI 0.99 - 212.12)	1.68
TA	NICU	3.50 (CI 0.73 - 17.90)	1.83
	PD	0.69 (CI 0.03 - 7.91)	0.71
	CS	7.28 (CI 0.77 - 167.93)	1.60
CPR	NICU	4.13 (CI 0.76 - 24.87)	1.94
	PD	16.0 (CI 1.36 - 428.19)	11.38

Table 4: Showing the Odd's ratio and relative risk of adverse perinatal outcome for abnormal PI values for each vessel examined

Discussion

Intrauterine growth retardation (IUGR) has been conveniently defined as fetal weight below 10th per-centile for gestational age. It is associated with

significant morbidity and mortality of the neonates. The pathophysiology of IUGR involves uteroplacental insufficiency and a fetal response to hypoxia. Timely diagnosis of fetal compromise offers the best chance to reduce perinatal complications associated with IUGR. Pulsed Doppler ultrasonography has been used to evaluate the fetal status. Several studies have confirmed that Doppler examination of fetal vessels give us a good idea of fetal status. It also helps to detect fetuses likely to be compromised and predicts perinatal complication. The purpose of our study was to evaluate the role of Doppler ultrasound parameters of selected fetal vessels in pregnancies with suspected IUGR. We studied 50 singleton pregnancies of more than 24 weeks of gestational age with estimated fetal weight less than 10th percentile for gestational age. We performed Doppler ultrasound on fetal MCA, UA and TA; recorded the PI values obtained from each vessels and any end- diastolic flow changes, if present. We followed the pregnancies up to termination and assessed the perinatal outcome in terms of gestational age at delivery, cesarean section for fetal distress, birth weight, admission to NICU and perinatal death. Among the various markers evaluated in the study, umbilical artery pulsatility index (PI) demonstrated strong efficacy throughout both early and late stages of the third trimester. However, the Cerebral/Umbilical pulsatility index (PI) measured during the third visit showed notable sensitivity and specificity. Out of the 50 fetuses examined, 4 died in-utero (IUFD). Out of the 46 liveborns, 29 fetuses were born by cesarean section and 20 fetuses had to be admitted to NICU. 1 neonate died in the neonatal period. Of the29 fetuses born by cesarean section, 14 cases had abnormal MCA PI, 12 cases had abnormal UA PI, 11 cases had abnormal TA PI and 9 cases had cerebroplacental ratio less than 1. The p values were significant in all the cases. The Odd's ratio and relative risk of cesarean section were highest for abnormal TA PI. Of the 20 fetuses admitted to NICU, 10 cases had abnormal MCA PI, 9 cases had abnormal UA PI, 8 cases had abnormal TA PI and 7 cases had cerebroplacental ratio less than 1. This was significant only in case of abnormal cerebroplacental ratio which had the highest Odd's ratio and relative risk, as well. Among the 5 perinatal deaths, abnormal MCA PI, UA PI and cerebroplacental ratio less than 1 was present in 4 cases each. The p values were significant in all the cases. Abnormal TA PI was present in 1 case which was not statistically significant. The Odd's ratio and relative risk of perinatal death were highest for abnormal cerebroplacental ratio.

Conclusion

Based upon our findings we arrived at the following conclusions Fetuses with an abnormal PI in MCA or UA or TA are at increased risk of adverse perinatal outcomes, An abnormal cerebroplacental ratio is maximally associated with adverse perinatal outcomes than abnormal PI in any individual vessel' The risk of perinatal death is also maximum in abnormal cerebroplacental ratio group, Fetuses with absent or reduced end diastolic flow in TA are at increased risk of cesarean section for fetal distress and admission to NICU and Fetuses with reduced end diastolic flow in the UA have the highest risk of perinatal death. Thus, we may conclude that Doppler ultrasonography of fetal vessels is a very useful tool in assessing adverse perinatal outcomes in pregnancies with IUGR. Although a larger study with more cases will be more helpful in assessing the exact roles of Doppler ultrasonography in pregnancies with IUGR.

References

1. Callen PW (Ed.). Ultrasonography in Obstetrics and Gynecology, 5th ed. 2008; Philadelphia; Saunders.
2. B McMaster Fay RA. Intrauterine growth restriction: Recent developments, definitions and future research. Clin Obstet Gynecol Reprod Med. 2019; 5.
3. Eric E. Sanerbrei, Khanh T Nguyen, Robert L. Nolan. A Practical Guide to Ultrasound in Obstetrics and Gynecology, 2nd ed. 1998; Lippincott- Raven, NY.
4. Dewbury K, Meire H, Cosgrove D, Farrant P. Ultrasound in Obstetrics and Gynecology. 2nd ed. 2001; Churchill Livingstone.
5. Verlijsdonk JW, Winkens B, Boers K, Scherjon S, Roumen F Suspected versus non-suspected small-for- gestational age fetuses at term: perinatal outcomes J Matern Fetal Neonatal Med. 2012 Jul; 25(7):938-43.
6. Sharma D, Shastri S, Sharma P. Intrauterine Growth Restriction: Antenatal and Postnatal Aspects. Clin Med Insights Pediatr. 2016 Jul 14;10:67-83.
7. Doctor BA, O'riordan MA, Kirchner HL, et al. Morbidity and mortality among very-low-birthweight neonates with intrauterine growth restriction. The Vermont Oxford Network. Am J Obstet Gynecol 2000; 182:198.
8. Kramer MS, Olivier M, McLean FH et al. Impact of intrauterine growth retardation and body proportionality on fetal and neonatal outcome. Pediatrics 1990; 86:707.
9. Karlberg J, Albertsson-Wikland K. Growth in full-term small-for- gestational-age infants: from birth to final height. Pediatr Res 1995; 3 8:733.
10. McCarton CM, Wallace IF, Divon M et al. Cognitive and neurologic development of the premature, small for gestational age infant through age 6: comparison by birth weight and gestational age. Pediatrics 1996; 98:1167.
11. O'Keeffe MJ, O'Callaghan M, Williams GM et al. Learning, cognitive and attentional problems in adolescents born small for gestational age. Pediatrics 2003; 112:301.

12. Ertan AK, He JP et al. Comparison of perinatal outcome in fetuses with reverse of absent end-diastolic flow in the umbilical artery and/or descending aorta. J Perinat Med 2003;31(4):30 7-312.
13. Khanduri S, Chhabra S, Yadav S, Sabharwal T, Chaudhary M, Usmani T, Goyal A, Sharma H. Role of Color Doppler Flowmetry in Prediction of Intrauterine Growth Retardation in High-Risk Pregnancy. Cureus. 2017 Nov 8;9(11): e1827.