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Indian Journal of Obstetrics and Gynecology Research

Journal homepage: [www.ijogr.org](http://www.ijogr.org)

## Original Research Article

## Doppler abnormalities and perinatal outcome in growth restricted fetuses in a tertiary care center: A retrospective study

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## ARTICLE INFO

## Article history:

Received 01-01-2024

Accepted 15-04-2024

Available online 20-08-2024

## Keywords:

Doppler

Birth weight

IUGR

Perinatal morbidity

Cerebro- placental ratio

## ABSTRACT

**Background:** Intrauterine Growth Restriction (IUGR), is a significant contributor to foetal and neonatal morbidity and mortality. The majority of prenatal problems that result in negative outcomes can be avoided with early identification and prompt management measures. Doppler ultrasonography is widely used to make the diagnosis of IUGR in foetuses and to monitor the progression in-utero. The purpose of the current study is to predict the perinatal prognosis of foetuses with growth restriction based on doppler abnormalities.

**Materials and Methods:** A retrospective analysis was conducted among 134 cases of diagnosed IUGR in routine ultrasound from the year 2015 to 2021. Socio-demographic data, baby delivery details, and the ultrasound details regarding doppler evaluation of Umbilical Artery (UA) and Middle cerebral artery (MCA) were collected. The fetal cerebro-placental ratio (CPR) was then analysed with the fetal outcomes in the cases.

**Results:** Abnormal doppler was found in 31 out of 134 cases, with a CPR<1. There was significant association of gestational age, mode of delivery and birth weight variables with abnormal doppler. The mean birth weight of the baby (2052 grams), and NICU admission of the babies (17.6%) have also shown statistical association with abnormal doppler (p<0.05).

**Conclusion:** Doppler velocimetry is the non-invasive method for identifying foetal growth restriction and anticipating perinatal difficulties, which aids the obstetrician in providing good antenatal care and prompt intervention and prevention of perinatal morbidity and mortality.

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## 1. Introduction

One of the biggest difficulties faced during antenatal care is foetal growth restriction, also known as intrauterine growth restriction (IUGR). IUGR is defined as Estimated Foetal Weight (EFW) below the 10th percentile for its gestational age. An increased risk of stillbirth, perinatal death, and morbidity is mostly linked to growth limitation in foetuses due to any reason.<sup>1</sup> Hence we aimed to determine

the perinatal outcome of growth restricted fetuses with abnormal and normal doppler studies. Growth-restricted infants have perinatal mortality rates that are 4–8 times higher, and 50% of the infants who survive have some sort of perinatal morbidity. Therefore, to enhance the foetal outcomes, early antenatal identification, monitoring, and delivery timing optimisation are required.<sup>2</sup> The umbilical and foetal cerebral circulation doppler flow velocimetry is a non-invasive technique used to assess the foetal condition. Doppler is comparatively more precise and may be a valuable tool in high risk cases to predict a poor perinatal

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outcome.<sup>3</sup>

Peak systolic to end-diastolic ratio (S/D) and pulsatility index (PI), which is calculated as the difference between peak systolic and end-diastolic flow divided by the average frequency shift value throughout the entire cardiac cycle, are the two Doppler indices most frequently used to monitor pregnancies with IUGR. Contrary to individuals with normal UA PI, those with abnormal UA Doppler have been linked to an elevated risk of poor perinatal outcomes.<sup>4</sup>

The foetal response to an oxygen shortage while in-utero is detected and assessed by the cerebroplacental ratio (CPR) examination. The middle cerebral artery pulsation index (MCA-PI) and umbilical artery pulsation index (UA-PI) are two doppler sonographic measures that together make up the cerebro-placental ratio.<sup>5</sup> More sensitive than umbilical artery doppler, it reveals foetal response to persistent hypoxic placental circumstances. The CPR levels are essentially consistent throughout the last ten weeks of pregnancy. It is known that pathological CPR is associated with an increased risk of perinatal problems, including neonatal acidosis, lower birth weight, and a lower APGAR score.<sup>6</sup> The goal of this study was to determine how the cerebroplacental ratio (CPR), umbilical artery doppler, and foetal outcome correlated with the prediction of intrauterine growth restriction (IUGR) in singleton pregnancies in a tertiary centre hospital.

## 2. Materials and Methods

A hospital based study was conducted in the Department of Obstetrics and Gynaecology, MGMRI, Puducherry. After obtaining IHEC approval for this study, the retrospective records satisfying inclusion criteria, from the year 2015 to 2021, were enrolled into the study. The study population comprised of all singleton non anomalous pregnancies diagnosed as Fetal growth restriction in routine antenatal ultrasound before delivery.

As the study aims to predict the IUGR outcomes, it was observed in research by Beune et al., that the prevalence of foetal growth restriction in pregnancy was at 67.4% ( $p=0.674$ ,  $q=1-p=0.34$ ), and so the same prevalence was assumed for this study.<sup>7</sup> Assuming alpha value as 0.05, and absolute precision (d) at 0.08, the sample size is calculated to be 134. Cochran's formula of Sample size ( $n$ ) =  $4 * p * q / d * d$ .

Sociodemographic data from the case records were collected, which includes maternal age, smoking and alcohol habits, socioeconomic status, parity, coexisting maternal medical disorders, previous and current obstetric information, and their ultrasound examinations. The data related to the birth details of the baby such as mode of delivery, gender of the baby, and birth weight were also collected. Neonatal outcome was assessed by examining the 1 and 5 min APGAR score, birth weight, admission to NICU, need for the surfactant, phototherapy

and perinatal morbidities. Perinatal mortality including still birth and early neonatal death, if any, were also noted. EFW (Estimated fetal weight) will be calculated using the Hadlock formula based on the combination of biparietal diameter, head circumference, abdominal circumference, and femur length. GE Voluson-E8 machine (GE Healthcare) was used and ultrasound study of the patients done using plus colour doppler with 3–7 MHz transabdominal curvilinear transducer. Doppler evaluation of the umbilical artery (UA) was performed in a free loop of umbilical cord. All Doppler waveforms were recorded in the absence of fetal breathing movements or uterine contractions. CPR was calculated as the simple ratio between the MCA PI and the UA PI. A single cut-off value of CPR = 1 was taken, CPR < 1 was considered as abnormal while CPR  $\geq 1$  was considered as normal.

The collected data was analysed with IBM SPSS statistics software 23.0 version. Descriptive data was analysed using frequency analysis and percentage analysis for categorical variables and mean & standard deviation for continuous variables. Statistical association was done using chi-square tests and t-tests based on the type of data. p value less than 0.05 is considered statistically significant.

## 3. Results

The study was conducted on 134 singleton pregnancies collected from the records. Out of the 134 deliveries, 63 were males, and 71 were female babies. Only 6 out of 134 were under 34 weeks of pregnancy. In the study, 88 patients were having high risk pregnancy (65.7%), where most of them are having hypothyroidism followed by pregnancy induced hypertension. Majority of the pregnancies underwent caesarean section (56%), in which 49.3% were emergency section and 6.7% were elective.

The birth weight of the babies were measured, and 44.8% were between 2000–2500 grams, followed by more than 2500 grams babies (22.4%). There were 15 babies in the less than 1500 grams category.

31 out of 134 (23.1%) patients had showed abnormal doppler with a CPR value of greater than 1. When the mean baby weight was compared, the mean weight was comparatively lesser in the cases with abnormal doppler, and this difference was statistically significant ( $p < 0.05$ ). In our study, Apgar score did not show any statistical significance with the doppler.

In the present study, there were no cases of perinatal mortality noticed. There were no still births, and only one patient with normal doppler showed low Apgar score of less than 6. NICU admission was seen in 23 out of the 134 cases, and 11 out of 31 cases of abnormal doppler had NICU admission, and this was statistically significant ( $p=0.04$ ). Around 35% of abnormal doppler babies had NICU admission, compared to only 11% of the babies with

**Table 1:** Baseline demographic details

Variable	Frequency	Percentage
<b>Parity</b>		
1	94	70.1
2	35	26.1
3	5	3.7
<b>Gestational Age</b>		
28-32 weeks	1	0.7
32-34 weeks	5	3.7
34-37 weeks	36	26.9
>37 weeks	92	68.7
<b>High Risk Pregnancy</b>		
Yes	88	65.7
No	46	34.3
<b>Mode of Delivery</b>		
Spontaneous Vaginal Delivery	53	39.6
Emergency CS	66	49.3
Forceps delivery	1	0.7
Elective CS	9	6.7
Vacuum Assisted Delivery	5	3.7
<b>Gender of the Baby</b>		
Male	63	47.0
Female	71	53.0
<b>Birth Weight</b>		
1000-1500	15	11.2
1500-2000	29	21.6
2000-2500	60	44.8
>2500	30	22.4

**Table 2:** Comparison of continuous variables with doppler

		Normal Doppler (n=103)	Abnormal Doppler (n=31)	p-value
<b>Baby Weight</b>	Mean	2281.9	2052.5	0.045*
	SD	382.3	508.6	
<b>Apgar Score at 1 Min</b>	Mean	7.91	7.74	0.204
	SD	0.544	0.92	
<b>Apgar Score at 5 Min</b>	Mean	8.9	8.9	0.698
	SD	0.31	0.35	
<b>Age of the Mother</b>	Mean	30.1	29.08	0.588
	SD	5.1	4.64	

normal doppler showed NICU admission. Phototherapy was required in 12 out of 103 patients with normal doppler, and 12 out of 31 cases with abnormal doppler, but the association was not statistically significant.

The validity of UA-PI, MCA-PI were analysed with the outcome of the study subjects. MCA-PI showed the highest diagnostic accuracy than CPR, but the sensitivity of CPR (94.3%) in measuring the outcome was higher than both UA and MCA pulsatility index. MCA-PI showed better specificity (92.85%) than either of UA-PI and CPR values in the current study.

**Table 3:** Perinatal outcome in the two groups

	Normal Doppler (n=103)	Abnormal Doppler (n=31)	P value
<b>Still birth</b>	0	0	-
<b>Low APGAR score</b>	0	1	0.32
<b>NICU admission</b>	12 (11.65%)	11 (35.48%)	0.04*
<b>Phototherapy DSPT</b>	0.055	-	-
	16 (69.6%)	7 (30.4%)	-

**Table 4:** Validity of the doppler methods in assessing outcomes

	Sensitivity	Specificity	Diagnostic Accuracy
<b>UA-PI</b>	92.4%	75%	83.7%
<b>MCA-PI</b>	93.4%	92.8%	93.1%
<b>CPR</b>	94.3%	89.2%	91.8%

The other maternal variables were cross tabulated with Doppler, and gestational age showed statistical significance, with 16.9% of the abnormal doppler cases were under 34 weeks, compared to only 0.8% of normal cases. Mode of delivery also showed significance, with higher percentage of caesarean sections in abnormal doppler than in normal doppler (p=0.015). Lower EFW values (<1500 grams) were also seen more in abnormal doppler (21 out of 31 cases), and is statistically significant.

#### 4. Discussion

In the current study, perinatal outcomes of IUGR with normal and abnormal UA Doppler waveforms were compared. One of the major risk factor in the study, pregnancy induced hypertension results in IUGR, the pathophysiology behind being placental insufficiency, which impairs blood flow to the uterine and umbilical arteries. This insufficient foetal circulation causes foetal growth to be constrained. The present study comprised 134 pregnant women with IUGR, 101 of whom had normal UA Doppler and 31 of whom had abnormal UA Doppler data (23%). Similar frequencies were observed in a research by Tolu et al, where in a sample of 170 patients, there were 21.7% aberrant doppler waveforms.<sup>8</sup>

In a research by Kshirsagar et al., out of 100 participating women, 42% delivered naturally at full term, and 25% underwent full term caesarean section.<sup>9</sup> Contrarily, in our study, 39.6% of the women had a natural delivery while 56% required a caesarean section. In SGA fetuses, decreased MCA PI and MCA/UA PI, which represent the cerebroplacental ratio, are the first indicators of foetal hypoxemia. Middle cerebral artery exhibited superior sensitivity, specificity, and positive predictive value than umbilical artery in 102 research participants, according to

**Table 5:** Comparison of variables in the two groups

Variable	Normal Doppler	Abnormal Doppler	p-value
<b>Parity</b>			0.132
1	73 (77.7%)	21 (22.3%)	
2	28 (80%)	7 (20%)	
3	2 (40%)	3 (60%)	
<b>Gestational Age</b>			
28-32 weeks	0	1	0.001*
32-34 weeks	1 (20%)	4 (80%)	
34-37 weeks	25 (69.4%)	11 (30.6%)	
>37 weeks	77 (83.7%)	15 (16.3%)	
<b>High Risk Pregnancy</b>			0.481
Yes	67 (76.1%)	21 (23.9%)	
No	36 (78.3%)	10(21.7%)	
<b>Mode of Delivery</b>			0.015*
Spontaneous Vaginal Delivery	46 (88.8%)	7 (13.2%)	
Emergency CS	44 (66.7%)	22 (33.3%)	
Forceps delivery	0	1	
Elective CS	8 (88.9%)	1 (11.1%)	
Vacuum Assisted Delivery	5	0	
<b>Hypothyroidism</b>			0.562
Present	21 (77.8%)	6 (22.2%)	
Absent	82 (76.6%)	25 (23.4%)	
<b>Hypertension</b>			0.359
Present	15 (83.3%)	3 (16.7%)	
Absent	88 (75.9%)	28 (24.1%)	
<b>Birth Weight</b>			0.001*
1000-1500	15	11.2	
1500-2000	29	21.6	
2000-2500	60	44.8	
>2500	30	22.4	

\*p-value <0.05 is significant.

a study by Lopez-Mendez et al.<sup>10</sup>

In our investigation, the cases with abnormal doppler had lower mean birth weights and shorter gestational ages at delivery. This conclusion is in line with those of other research from our country that have been published. In line with Lakhkar et al.'s finding that 82% of the infants with abnormal doppler were in the 1.5 to 2.5 kg weight range in their study, the current investigation also discovered low birth weight mean in the abnormal doppler group (Mean=2052 grams).<sup>11</sup> In our study, gestational hypothyroidism (20.15%) was the main risk factor, followed by hypertension (14.5%). This finding was in line with the research by Saki et al<sup>12</sup> who describes thyroid dysfunction during pregnancy associated with IUGR and low Apgar score even in subclinical forms and study by Chatmethakul et al., which identified hypertension as a significant risk factor for IUGR.<sup>13</sup>

The present study had 36.6% of NICU admissions in abnormal doppler group, compared to just 11.65% of NICU admissions in normal doppler group. NICU admission rates were 17.6% compared to 55% and 66%, respectively, by Odibo et al,<sup>14</sup> and Ebrashy et al.<sup>15</sup> There

were no deaths in our study, including stillbirths, when it came to neonatal mortality. Other perinatal problems such respiratory distress, hyperbilirubinemia and need for phototherapy were directly related to the decline in the doppler velocimetry, as expected; the same findings were reported by Martini et al.<sup>16</sup> According to research by Tolu et al, newborns with abnormal Doppler scans had a 4 times higher risk of dying before their due date than newborns with normal UA Doppler studies.<sup>8</sup> Both the mode of delivery and the prevalence of hypertension were unrelated to the outcomes of the perinatal period. However, newborns born at gestational ages under 34 weeks had a higher likelihood of needing NICU hospitalisation, developing respiratory distress syndrome, and requirement of Phototherapy. The current study observed lower EFW values in abnormal doppler compared to normal doppler, and this association was statistically significant. A study by Novac et al, observed the similar effect, where EFW values gradually decrease with abnormality in the doppler waveforms.<sup>17</sup>

## 5. Conclusion

The study concludes that the abnormal doppler (CPR<1) is statistically relevant in determining the composite adverse perinatal outcome of growth-restricted fetuses, which helps in decision-making, early diagnosis and to optimise a proper management strategy.

## 6. Ethical Statement

We confirm that all aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of IHEC (Institute Human Ethics Committee) board of the hospital.

## 7. Sources of Funding

No funding was received for the study.

## 8. Conflict of Interest

We wish to confirm that there are no known conflicts of interest associated with this publication.

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**Cite this article:** Vinodhini K, Coumary A S. Doppler abnormalities and perinatal outcome in growth restricted fetuses in a tertiary care center: A retrospective study. *Indian J Obstet Gynecol Res* 2024;11(3):415-419.