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Role of Cerebroplacental Ratio in Diagnosing IUGR and Predicting Perinatal Outcome

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A B S T R A C T

According to sonographic measurement, IUGR exists when estimated fetal weight falls below the 10th percentile for gestational age. The cerebroplacental ratio (CPR) works as a sensitive tool to forecast fetal growth retardation because it evaluates both umbilical artery (UA) and middle cerebral artery (MCA) Doppler findings. The research examined CPR's diagnostic abilities for IUGR through comparison against low birth weight as the reference standard. Two hundred pregnant women underwent selection at the Department of Obstetrics & Gynecology within Sir Ganga Ram Hospital, Lahore, during labor room operations. The Doppler ultrasound technique assessed UA and MCA pulsatility indexes for IUGR diagnosis when their ratio fell below 1.08. Healthcare providers tracked the patients until they delivered their babies while logging down birth weights. A considerable number of participants who took part in the study were aged 28.8 ± 4.63 years, while their gestational age measured 38.72 ± 1.05 weeks, following an average maternal childbirth count of 3.08 ± 1.36. Among the 200 pregnant women studied, IUGR occurred in 23.5% (n=47), and low birth weight affected 26% (n=52) of the participants. The mean birth weight measurement stood at 2965.225 ± 387.15 grams. The diagnostic precision of CPR was excellent because it showed sensitivity values at 82.69% and specificity at 97.29%. Additionally, it demonstrated a positive predictive value of 91.48% and a negative predictive value of 94.12%, with overall accuracy reaching 93.5%. Medical professionals can rely on CPR as an exact tool to detect IUGR because research shows it can work effectively within healthcare environments without premium diagnostic instruments.

Keywords: Intrauterine Growth Retardation, Cerebroplacental Ratio, Diagnostic Accuracy, Doppler Ultrasound, Low Birth Weight.

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INTRODUCTION

The pathological condition known as intrauterine growth restriction (IUGR) manifests as a significant factor affecting the proper development and functionality of uteroplacental and fetal-maternal circulation, according to Bano et al. (2010). Statistics indicate that intrauterine growth restriction occurs in 1-3% of pregnant populations (Crispi et al., 2009). Characterization of IUGR frequency in Pakistan demonstrated a 28% occurrence, according to Zafar et al. (2012). Placental insufficiency functions as the main factor triggering IUGR, which leads to dangerous perinatal health consequences. Detection methods for placental insufficiency must remain at the forefront because they help minimize as well as eliminate its dangerous effects (Bano et al., 2010).

Three main biophysical testing methods that monitor fetal well-being consist of amniotic fluid volume measurement together with biophysical profile assessment combined with a non-stress test (CTG). Doppler velocimetry presents the most promising method to detect perinatal outcomes, according to Bano et al. (2010).

Studies demonstrate that Doppler ultrasonography provides a reliable assessment for monitoring hypoxic cardiovascular changes in fetuses. The umbilical artery, together with the middle cerebral artery, serves as the primary artery examined in fetal studies (Crispi et al., 2009). Evidence indicates that the cerebroplacental ratio (CPR) stands as a more sensitive indicator of IUGR fetus status than the umbilical artery pulsatility index or middle cerebral artery pulsatility index (Oros et al., 2011). The ratio of MCA PI to UA PI, known as CPR, should be below 1.08 to be considered abnormal, according to Eser et al. (2011). The fetal status (MCA) and placental status (UA) are both included within CPR data. The data demonstrates that CPR evaluation techniques have the potential for determining the IUGR status of a fetus within perinatal centers. The combined assessment of CPR provides better sensitivity when determining perinatal outcome compared to MCA PI and UA PI evaluations. The ability of CPR to assess fetal delivery oxygenation status makes it an outstanding screening tool to detect fetal pregnancies suffering from unfavorable outcomes and monitor IUGR fetuses (Oros et al., 2011). The deterioration of CPR occurs before MCA PI starts showing abnormalities. Quantitative assessment of CPR enables medical staff to receive notification regarding suspected fetal distress (Oros et al., 2011; Murata et al., 2011).

Research shows that CPR diagnosis of IUGR leads to 80.3% specificity and 61.1% sensitivity, whereas Bano et al. (2010) report 44.4% and 100% specificity and sensitivity. The specificity and sensitivity of CPR for identifying IUGR amounted to 58.3% and 87%, according to Kumbar et al. (2014). The purpose of this research is to determine the diagnostic accuracy of cerebroplacental ratio (CPR) in diagnosis of intrauterine growth retardation taking low birth weight as gold standard. It is known that the technology has been improved for Doppler USG which makes it easily accessible and cheap method for assessment of different problems and diseases at early stages particularly in peripheries where advance laboratory diagnostic tools are unavailable. Doppler USG has been proved to be useful diagnostic tool in pregnancy. Literature has showed that Doppler can be a reliable tool for assessment of fetal problems like IUGR on early stages and can be helpful in treatment. But contradictions are also present in literature which showed that we cannot totally rely on this method. So, to confirm the accuracy of Doppler USG for prediction of IUGR, we want to conduct this study. This study will help us to improve our knowledge and practice and we may be able to implement the results of this study in future.

MATERIALS AND METHODS

Study Design and Duration

A Cross sectional study design was employed for this research and the duration of the study was six months after approval of the synopsis.

Setting

The study was conducting in the Department of Obstetrics and Gynecology, Sir Ganga Ram Hospital, Lahore.

Sample Size

The study size of 200 cases is derived using 95% confidence intervals, a 13.5% margin of error, and the estimated proportion of IUGR, which is 28% and sensitivity and specificity of CPR i.e. 58.3% with 11% margin of error and 87% with 7%margin of error respectively taking birth weight as gold standard.

Sampling Technique

Non-probability: consecutive

Selection Criteria

Inclusion Criteria

The target patient group includes women from 18 to 40 years of age who have less than five children and are carrying a single baby after the 30th week of pregnancy, according to ultrasound results

Exclusion Criteria

Females with premature rupture of membrane (on clinical examination)

Females with PIH (BP ≥ 140/90 mmHg), preeclampsia (BP > 140/90 mmHg with proteinuria +1 on dipstick method)

Females with macrosomia (>4000gram weight of fetus), congenital anomaly to fetus (on ultrasonography)

Unbooked females or females presented in emergency for delivery

Females having anemia (HB<9mg/dl)

Data Collection Procedure

200 women who met the inclusion requirements were chosen from the labor room of the Sir Ganga Ram Hospital's Obstetrics & Gynecology Department in Lahore. Consent was received after being informed. Names, ages, gestational ages, and contact details were also recorded. Then patients underwent Doppler assessment by a radiologist by using 3.5MHz convex probe. Doppler ultrasound examination when patient was in lying on the table in left lateral position.

Measurement of umbilical artery and middle cerebral artery pulsatility indices (PI) formed part of the evaluation. If <1.08, then cases were labeled as positive for IUGR and if ≥1.08, then cases were labeled as negative for IUGR. Then participants received additional follow-up care at the outpatient department before giving birth. After delivery, birth weight was measured by using weighing machine. Baby weight was labeled as low or normal birth weight (as per operational definition). All this information was documented on proforma (attached).

Data Analysis

SPSS version 17 was used for both data entry and statistical analysis. The researchers presented the quantitative variables, including maternal age, along with gestational age and neonatal birth weight, as mean values along with standard deviation (SD). The research displayed categorical data items through frequencies and percentages. The diagnostic measurements, including sensitivity, specificity, PPV, NPV, and diagnostic accuracy for C-reactive protein, were calculated using the 2×2 contingency table against birth weight as the reference standard.

The assessment of intrauterine growth restriction (IUGR) along with low birth weight during CPR evaluation was presented as frequencies and percentages. The researchers used maternal age, parity, BMI, and history of low-birth-weight infants as group variables to categorize their data. The study used the Chi-square test to check statistical associations while treating a p-value of 0.05 or below as significant.

RESULTS

A research group consisting of 200 participants was established to examine the diagnostic capabilities of the cerebroplacental ratio (CPR) in detecting intrauterine growth restriction (IUGR) through the assessment of low birth weight as the standard. Data revealed the participants' age distribution, where 61.5 percent (n=123) were between 18 and 30 years old and 38.5 percent (n=77) were between 31 and 40 years old. The research participants had a mean age of 28.8 ± 4.63 years (Table 1).

Table 1: Age distribution (n=200).

Age (in years)	No. of patients	%
18-30	123	61.5
31-40	77	38.5
Total	200	100
Mean ± SD	28.8 ± 4.63	

The study participants were distributed between 37 and 39 weeks of gestation at 75.5% (n = 151) and 40 through 41 weeks at 24.5% (n = 49). The calculated mean gestational period measured 38.72 ± 1.05 weeks (Table 2). The research participants were divided into two parity groups where 62.5% (n=125) had 1 to 3 children and 37.5% (n=75) had more than three children. The study participants had an average parity value of 3.08 children with a standard deviation of 1.36 (Table 3).

Table 2: Gestational age (n=200).

Gestational age (in weeks)	No. of patients	%
37-39	151	75.5
40-41	49	24.5
Total	200	100
Mean ± SD	38.72 ± 1.05	

Table 3: Parity distribution (n=200).

Parity	No. of patients	%
1-3	125	62.5
>3	75	37.5
Total	200	100
Mean ± SD	3.08 ± 1.36	

Among pregnant women, 23.5% had intrauterine growth restriction (IUGR) affecting 47 participants (n=47) while 153 women (76.5%) showed no signs of the condition (Table 4). Frequency of low birth weight (on gold standard) was calculated as 26% (n=52) while 74% (n=148) did not exhibit sign of the morbidity (Table 5). Mean birth weight was calculated as 2965.225±387.15 grams (Table 6).

Table 4: Frequency of IUGR (n=200)

IUGR	No. of patients	%
Yes	47	23.5
No	153	76.5
Total	200	100

Table 5: Frequency of low birth weight (on gold standard) (n=200)

Low Birth Weight	No. of patients	%
Yes	52	26
No	148	74
Total	200	100

Table 6: Mean birth weight (n=200).

Birth weight(gm)	Mean	SD
	2965.225	387.15

Low birth weight served as the gold standard to evaluate the diagnostic accuracy of the cerebroplacental ratio which resulted in sensitivity at 97.29% and specificity at 82.69% together with positive predictive value at 91.48% and negative predictive value at 94.12% and overall accuracy at 93.5% (Table 7).

Table 7: Diagnostic accuracy of cerebroplacental ratio (CPR) in diagnosis of intrauterine growth retardation taking low birth weight as the gold standard (n=200).

CPR	Low birth weight (Gold standard)		Total
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a) 43 (21.5%)	False positive (b) 4 (2%)	a + b 47(23.5%)
Negative	False negative(c) 9 (4.5%)	True negative (d) 144 (72%)	c + d 153(76.5%)
Total	a + c 52 (25%)	b + d 148(74%)	200(100%)

Note: *Intrauterine growth restriction diagnosis revealed an 82.69% sensitivity through the cerebroplacental ratio (CPR) while the specificity reached 97.29%. The positive predictive value reached 91.48% while both the negative predictive value equaled 94.12% and the overall diagnostic accuracy amounted to 93.5%.*

Table 8: Stratification for age (Age: 18-30).

CPR	Low birth weight (Gold standard)		P value
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a) 31	False positive (b) 1	
Negative	False negative(c) 6	True negative (d) 85	0.000
Total	a + c 37	b + d 86	

Note: *Test results indicated 83.78% sensitivity along with a specific value of 98.83%. The positive predictive value amounted to 96.88% and the negative predictive value to 93.40% while the diagnostic accuracy reached 94.31%.*

Age: 31-40

CPR	Low birth weight (Gold standard)		P value
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a) 12	False positive (b) 3	0.000
Negative	False negative(c) 3	True negative (d) 59	
Total	a + c 15	b + d 62	

Note: *Test results indicated 80 % sensitivity along with a specific value of 95.16%. The positive predictive value amounted to 80% and the negative predictive value to 95.16% while the diagnostic accuracy reached 92.21%.*

Table 9: Stratification for parity (Parity: 1-3)

CPR	Low birth weight (Gold standard)		P value
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a) 30	False positive (b) 4	0.000
Negative	False negative(c) 6	True negative (d) 85	
Total	a + c 36	b + d 89	

Note: *The test demonstrated 83.33% sensitivity together with 95.50% specificity. The Positive Predictive Value came to 88.23% and the Negative Predictive Value reached 93.40% which resulted in an overall diagnostic accuracy of 92%.*

Parity: >3

CPR	Low birth weight (Gold standard)		P value
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a) 13	False positive (b) 0	0.000
Negative	False negative(c) 3	True negative (d) 59	
Total	a + c 16	b + d 59	

Note: *The sensitivity of this test amounted to 81.25% with 100% specificity. The results show complete accuracy with positive predictive value also at 100% and negative predictive value at 95.16% which together lead to a diagnostic accuracy of 96%.*

Table 10: Stratification for body mass index <30

CPR	Low birth weight (Gold standard)		P value
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a) 30	False positive (b) 4	0.000
Negative	False negative(c) 6	True negative (d) 109	
Total	a + c 36	b + d 113	

Note: *The test demonstrated an 83.33% sensitivity alongside a 96.40% specificity value. The research findings indicated an 88.24% PPV and 94.78% NPV with a final diagnostic accuracy reaching 93.29%.*

>30

CPR	Low birth weight (Gold standard)		P value
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a)	False positive (b)	0.000
	13	0	
Negative	False negative(c)	True negative (d)	
	3	35	
Total	a + c	b + d	
	16	35	

Note: *A test analysis confirmed 81.25% sensitivity combined with complete specificity of 100% and a positive predictive value of 100%. All results from the predictive values demonstrated 100% PPV and 92.10% NPV which led to an overall diagnostic accuracy of 94.11%.*

Table 11: Stratification for history of low birth

Yes

CPR	Low birth weight (Gold standard)		P value
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a)	False positive (b)	
	11	0	
Negative	False negative(c)	True negative (d)	0.000
	3	30	
Total	a + c	b + d	
	14	30	

Note: *The test demonstrated 78.57% sensitivity alongside 100% specificity. The study findings showed complete diagnostic accuracy through 100% positive predictive value along with 90.91% negative predictive value leading to an overall 93.18% diagnostic accuracy.*

No

CPR	Low birth weight (Gold standard)		P value
	IUGR (Positive)	IUGR(Negative)	
Positive	True positive(a)	False positive (b)	
	32	4	
Negative	False negative(c)	True negative (d)	0.000
	6	114	
Total	a + c	b + d	
	38	116	

Note: *This test demonstrated higher specificity at 96.61% along with sensitivity rating of 84.21%. The positive predictive value reached 88.89% while the negative predictive value stood at 95% which resulted in a total diagnostic accuracy of 94.81%.*

DISCUSSION

The current study was line up with the view to discover the diagnostic accuracy of cerebroplacental ratio (CPR) in diagnosis of intrauterine growth retardation taking low birth weight as gold standard. It is known that the technology has been improved for Doppler USG which makes it easily accessible and cheap method for assessment of different problems and diseases at early stages particularly in peripheries where advance laboratory diagnostic tools are unavailable. Doppler USG has been proved to be useful

diagnostic tool in pregnancy. Literature has showed that Doppler can be a reliable tool for assessment of fetal problems like IUGR on early stages and can be helpful in treatment. But contradictions are also present in literature which showed that we cannot totally rely on this method. So to confirm the accuracy of Doppler USG for prediction of IUGR, we want to conduct this study. The research findings can guide future healthcare decisions as well as management approaches in clinical practice thus advancing medical knowledge and professional abilities.

The data showed that maternal participants averaged 28.8 ± 4.63 years in age, while gestational periods measured at 38.72 ± 1.05 weeks. The average parity was 3.08 ± 1.36. Among the studied participants, intrauterine growth restriction (IUGR) was diagnosed in 23.5% (n = 47) of subjects, although low birth weight measurements confirmed this condition in 26% (n = 52) of babies. The measured birth weight mean amounted to 2965.23 ± 387.15 grams. The diagnostic performance measurement of cerebroplacental ratio (CPR) in detecting IUGR through low-birth-weight reference demonstrated an overall accuracy of 93.5% with a positive predictive value of 91.48%, a negative predictive value of 94.12%, a specificity of 82.69%, and a sensitivity of 97.29%.

Our study demonstrates similar diagnostic accuracy for cerebroplacental ratio detection of intrauterine growth restriction to Shahinaj et al. (2010), whose work established 80.3% sensitivity and 61.1% specificity. The research by Bano et al. (2010) showed 44.4% sensitivity combined with a 100% specific measure. The different sensitivity levels in our results match the reported specificity figures of these studies. The study by Kumbar et al. (2014) produced a test performance of 58.3% sensitivity alongside 87% specificity, which differs from both our examined parameters. The most efficient way to forecast negative neonatal outcomes comes from a cerebroplacental ratio measurement above the 95th percentile of the umbilical artery Doppler pulsatility index. An abnormal CPR detection along with such cases results in similar unfavorable neonatal outcomes comparable to those from umbilical artery absent or reversed end-diastolic flow.

Another study has established that fetal conditions presenting with abnormal CPR values lead to both reduced fetal growth rate and increased chances for NICU hospitalization and require emergency cesarean delivery for fetal distress after 37 weeks gestation regardless of birth weight (Khalil et al., 2015a; Khalil et al., 2015b).

The measurement of the cerebroplacental ratio provides a better method than umbilical artery Doppler for forecasting adverse conditions during fetal growth restriction (FGR). More research is necessary for CPR to qualify as an implementable clinical standard for managing FGR pregnancies. Future studies need to determine a perfect CPR threshold for indicating adverse outcomes, investigate how CPR improvements in initially abnormal values influence results and study the capabilities of CPR to lead FGR late-onset management.

CONCLUSION

The study concluded that the diagnostic accuracy of the cerebroplacental ratio (CPR) matches well to identify cases of intrauterine growth restriction (IUGR) when using low birth weight as the reference standard. The CRP measurement presents itself as a helpful diagnostic tool, especially when sophisticated laboratory services are absent.

CONFLICT OF INTEREST

The authors confirm that there are no conflicts of interest to disclose.

AUTHORS' CONTRIBUTION

All authors have actively contributed to the revision of the manuscript and have reviewed and approved the final submitted version.

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