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Assessment of Birth Weight Status and Intrauterine Growth Retardation using Cerebro-Umbilical Pulsatility Ratio at the Largest Teaching Hospital in Bangladesh

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Abstract

Background: Intrauterine Growth Retardation (IUGR) poses a substantial challenge in perinatal care, contributing significantly to preventable stillbirths, neonatal intensive care admissions, and long-term neurodevelopmental sequelae. Therefore, prompt identification and rigorous antenatal surveillance are paramount to guiding the optimal timing of delivery and improving overall neonatal outcomes **Objective:** The purpose of the present study was to assess the birth weight status among pregnant women attending Dhaka Medical College Hospital. **Methodology:** This was a cross-sectional study, conducted in the Department of Radiology & Imaging in collaboration with Department of Obstetrics and Gynecology of Dhaka Medical College between July 2018 to December 2018. All pregnant women in their third trimester admitted to Dhaka Medical College Hospital were selected as the study population. Purposive sampling was done after fulfilling inclusion and exclusion criteria. Doppler Ultrasonographic examination was performed, the Pulsatility index of the Umbilical Artery (UA) and the Middle Cerebral Artery (MCA) were noted and the ratio of the MCA and UA (the C/U ratio) were calculated. The weight of the babies were taken within one hour of birth by using infant meter after standardization. **Results:** Color Doppler evaluation of the Middle Cerebral Artery to Umbilical Artery Pulsatility Index ratio (C/U ratio) in 90 pregnant women (30 to 40 weeks gestation) predicted IUGR in 37(41.1%) fetuses. Post-delivery assessment revealed 68.8% as low birth weight whereas 31.2% had normal birth weights. **Conclusion:** Color Doppler assessment of the Cerebral Umbilical Pulsatility Ratio is a highly reliable tool for the early detection of IUGR, helping clinicians intervene early to prevent adverse perinatal outcomes. *[Journal of National Institute of Neurosciences Bangladesh, July 2025;11(2):121-125]*

Keywords: Intrauterine Growth Retardation, Low Birth Weight, Color Doppler Ultrasonography, Cerebral Umbilical Pulsatility Ratio

Introduction

Intrauterine Growth Retardation (IUGR) occurs when a fetus fails to achieve its genetically determined growth potential, often defined as an estimated fetal weight below the 10th percentile for gestational age[1,2]. As the second leading cause of perinatal mortality, IUGR carries a high burden of morbidity, including intrapartum asphyxia, meconium aspiration, neonatal hypoglycemia, and long-term neurodevelopmental impairment. The primary underlying cause is placental insufficiency. Under chronic fetal hypoxia, blood flow is redistributed to vital organs, causing Middle Cerebral Artery (MCA) vasodilation and a concomitant increase in placental vascular resistance within the Umbilical Artery (UA). The primary goal of antenatal care is the accurate identification of the compromised growth-restricted fetus to facilitate timely clinical intervention. Among noninvasive fetal surveillance methods, umbilical artery

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and middle cerebral artery (MCA) Doppler velocimetry offer the most robust evaluation of fetal well-being[3-4].

Evidence indicates that the Cerebro-Umbilical (C/U) ratio provides superior diagnostic accuracy for predicting small-for-gestational-age (SGA) fetuses and adverse perinatal outcomes compared to either the umbilical artery pulsatility index (UAPI) or MCA pulsatility index (MCA-PI) independently, demonstrating notably high specificity and positive predictive value[5-6]. Intrauterine growth restriction (IUGR) impairs umbilical blood flow through increased placental vascular resistance. Chronic fetal hypoxia triggers a compensatory hemodynamic shift that redistributes cardiac output toward critical organs, particularly the brain, heart, and kidneys. This "brain-sparing effect" manifests as vasodilation in the middle cerebral artery (MCA), increasing end-diastolic velocity and decreasing the MCA pulsatility index (PI)[7-8]. An abnormal cerebro-umbilical (C/U) ratio (<1.08) captures this redistribution. Unlike individual vessel indices, the C/U ratio remains stable throughout the final ten weeks of pregnancy, providing greater diagnostic accuracy than either the umbilical or cerebral PI evaluated independently[9,10].

Color Doppler ultrasonography provides a noninvasive method for evaluating these fetoplacental hemodynamic shifts. Although individual indices (UA PI or MCA PI) are used, the Cerebro-Umbilical Pulsatility Index ratio (C/U ratio = MCA PI / UA PI) remains relatively constant during the final 10 weeks of gestation (with an abnormal cut-off threshold at)[11,12]. Evidence demonstrates that the C/U ratio offers superior diagnostic accuracy, higher specificity, and stronger positive predictive value compared to single-vessel parameters alone. Identifying an abnormal ratio allows for timely clinical intervention, enabling obstetricians to optimize the timing of delivery and significantly reduce adverse perinatal outcomes. The purpose of the present study was to assess the birth weight status among pregnant women attending Dhaka Medical College Hospital.

Methodology

Study settings and Population: This was a cross-sectional study, conducted in the Department of Radiology & Imaging in collaboration with the Department of Obstetrics and Gynecology of Dhaka Medical College between July 2018 to December 2018. The study population consisted of women of singleton pregnancy with gestational age from 30-40 weeks.

Study Procedure: Purposive sampling was done after fulfilling inclusion and exclusion criteria. Doppler Ultrasonographic examination was performed; the Pulsatility index of the umbilical artery (UA) and the middle cerebral artery (MCA) were noted, and the ratio of the MCA and UA (the C/U ratio) were calculated. The weight of the babies was taken within one hour of birth by using infant meter after standardization.

Measurement of IUGR: IUGR was diagnosed based on establishment of accurate early dating, assessment of risk factors, followed by ultrasound for fetal growth. The diagnosis of IUGR (aka antenatal SGA) was made when the fetal weight (EFW) is less than 10.0% percentile for gestational age as calculated by biometric measurements4. At term, a birth weight less than 2,500 g (5lb, or 8oz) is considered IUGR. The parameters used in the Doppler USG include: PI of MCA= Pulsatility Index (PI) of fetal MCA, PI of UA = Pulsatility Index (PI) of fetal UA, C/U ratio: Ratio of the MCA PI to the UA PI.

Diagnostic Criteria: UA PI and MCA PI: Gramellini et al2 have quoted the normal values of UA PI and MCA PI and the C/U ratio, and we used those values for interpreting the Doppler indices. The mean values quoted by Gramellini et al2 ±2 SD were considered as normal for the corresponding gestational age.

C/U ratio: C/U pulsatility index Ratio = MCA PI/ UA PI. According to Gramellini et al[2] the C/U ratio remains constant in the last 10 weeks of pregnancy, and therefore we used a single cut-off value of 1.08 throughout this study, where all cases were of 30 to 41 weeks' gestation. Doppler velocimetry was considered normal when the C/U ratio was above 1.08, and below that value, velocimetry was considered abnormal. Normal C/U Pulsatility index ratio was defined as more than 1.08, and Abnormal C/U Pulsatility index ratio was defined as less than 1.08. Birth weight is classified into two main categories: Normal Birth Weight (NBW), which ranges from 2,500 to 3,999 grams, and Low Birth Weight (LBW), which is defined as any birth weight under 2,500 grams.

Statistical analysis: Statistical analysis was performed by Windows based software named as Statistical Package for Social Science (SPSS), versions 22.0 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Continuous data were expressed as mean, standard deviation, minimum and maximum. Categorical data were summarized in terms of frequency counts and percentages. Chi-square test was used for comparison of categorical variables and Student t test was applied for continuous variables. Every efforts were made to obtain missing data. A two-sided P value of less than 0.05 was considered to indicate statistical significance.

Ethical considerations: All procedures of the present study were carried out in accordance with the principles for human investigations (i.e., Helsinki Declaration 2013) and also with the ethical guidelines of the Institutional research ethics. Formal ethics approval was granted by the local ethics committee. Participants in the study were informed about the procedure and purpose of the study and confidentiality of information provided. All participants consented willingly to be a part of the study during the data collection periods. All data were collected anonymously and were analyzed using the coding system.

Results

A total number of 90 pregnant women were recruited for this study after fulfilling the inclusion and exclusion criteria. Among the study population, the mean gestational week was 34.87 ± 9.82. About 52.0% were diagnosed around 30-34 week of gestation (Table 1).

Table 1: Gestational week of the Pregnant Women (n=90)

Gestational age	Frequency	Percent
30 to 34 weeks	47	52.2
35 to 37 weeks	38	42.2
More than 37 weeks	5	5.5
Total	**90**	**100.0**

More than half of the study participants were nulliparous followed by multiparous women with 1 to 3 prior deliveries and grand multiparous women (Figure I).

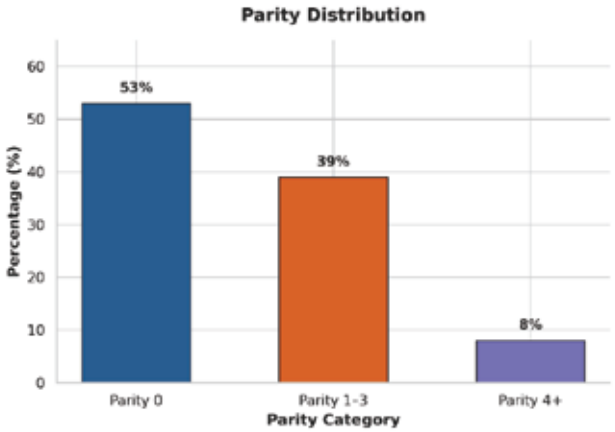

Figure I: Distribution of Obstetrics History of Study Population (n=90)

Color flow mapping with pulsatility index (PI) of the umbilical artery and middle cerebral artery (MCA) ratio (C/U ratio) among the study population predicted IUGR in 37 cases (41.1%) and normal birth weight in 62(68.8%) cases (Figure II).

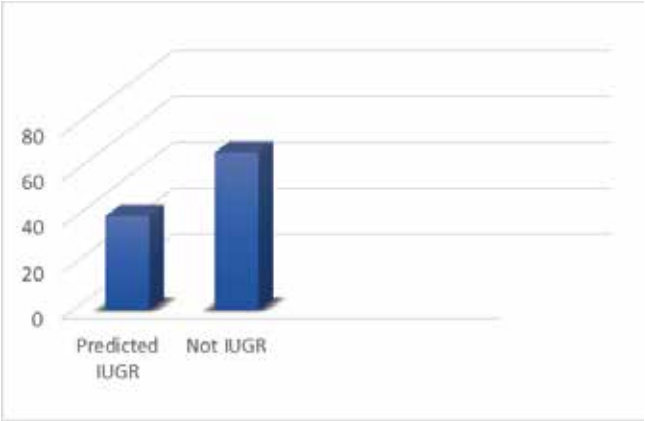

Figure II: Prediction of IUGR according to Pulsatility Index (PI) Ratio (C/U ratio) (n=90)

Among the 90 newborn babies, 28 (31.2%) babies weighed 2.5 Kg or more. The remaining 62 (68.8%) were low birth weight (LBW) babies (Table 2).

Table 2: Birth Weight of the Baby (n=90)

Birth Weight of Baby	Frequency	Percent
Less than 2.5 kg	62	68.8
2.5 to 2.99 kg	28	31.2
More than 3.0 kg	0	0
Total	**90**	**100.0**

Discussion

This prospective study demonstrates that Intrauterine growth restriction (IUGR) remains a major contributor to perinatal morbidity and mortality worldwide. Timely detection during antenatal care is critical to optimizing delivery timing and neonatal management. In the present study, we evaluated the gestational profile, obstetric background, Doppler-derived Cerebro-Umbilical (C/U) ratio, and birth outcomes among 90 pregnant women

The mean gestational age of presentation in this study was 34.87±9.82 weeks, with the majority (52.2%) presenting between 30 to 34 weeks of gestation. This aligns with late-third-trimester screening protocols, as uteroplacental insufficiency typically manifests or produces noticeable growth lags during this window. This distribution indicates that most of the women were recruited in the late preterm / early term window, when Doppler velocimetry is most informative and consistent with the gestational window in which C/U ratio measurements carry maximum clinical relevance[2-5].

Over half of the study participants were nulliparous

(53.3%, n = 48), followed by women with 1–3 prior deliveries (38.8%, n = 35) and grand multiparous women (7.7%, n = 7). Nulliparous pregnancy is a well-established demographic risk factor for fetal growth compromise. Large population-based analyses have demonstrated that nulliparous mothers carry a significantly higher prevalence of LBW and SGA than multiparous mothers, and the risk for SGA among nulliparous women with no other risk factors approximates 9.0% compared with roughly 5.0% among parous women without other risk factors. The predominance of nulliparas in the present cohort may therefore have contributed to the overall burden of growth restriction observed and supports the relevance of universal Doppler surveillance in first pregnancies[6-10].

In the present series, color flow mapping with pulsatility index of the umbilical artery and middle cerebral artery expressed as the C/U ratio predicted IUGR in 37 cases (41.1%) and a normal birth weight in 62 cases (68.8%) of the study population. The high proportion flagged as suspicious / predicted IUGR is consistent with reported diagnostic performance of CPR in at-risk pregnancies[11-13]. Earlier prospective work has reported that abnormal CPR in clinically suspected IUGR has a sensitivity of 84.4% to 89.2% for LBW and up to 90.6% for low APGAR scores, with specificities in the range of 71.0% to 91%. Another series specifically evaluated with a similar CPR threshold described an abnormal CPR incidence of 39.4% among antenatal mothers with sonologically diagnosed or at-risk IUGR, a figure very close to the 41.1% abnormal prediction rate observed in the current study[14-15]. Collectively, these observations support the view that the cerebroplacental ratio is a useful integrated Doppler marker that captures the brain-sparing hemodynamic response more reliably than umbilical artery PI alone, particularly when umbilical artery waveforms are still within normal limits.

Among the 90 neonates delivered in the present study, 62(68.8%) were low birth weight (less than 2.5 kg) and 28(31.2%) weighed between 2.5 to 2.99 kg; no neonate weighed 3.0 kg or more. The complete absence of neonates in the ≥3.0 kg category and the heavy skewing toward the LBW range is in line with the antenatal Doppler suspicion of growth compromise reported in this cohort. Previous Doppler studies in high-risk pregnancies have similarly reported that abnormal Doppler findings are strongly associated with LBW in one prospective series; 93.75% of pregnancies with abnormal Doppler delivered a baby of less than 2.5 kg[16-17]. The fact that all neonates in the present series fell below 3.0 kg, despite C/U ratio predicting normal birth weight in 62 cases, suggests a degree of discordance between antenatal Doppler prediction and actual birth weight that warrants further scrutiny.

Conclusion

In conclusion, color doppler evaluation of the cerebro-umbilical (C/U) ratio has identified intrauterine growth retardation (IUGR) in third-trimester pregnancies, over half of which are detected between 30 to 34 weeks of gestation. Post-delivery outcomes confirmed a significant burden of low birth weight of newborns. These findings demonstrate that antenatal C/U ratio surveillance is a valuable, non-invasive tool to guide timely clinical interventions and improve perinatal outcomes.

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Data Availability
The datasets generated and analyzed during this study are not publicly available due to patient confidentiality and institutional data protection policies. However, anonymized data may be made available from the corresponding author upon reasonable request, subject to approval by the institutional ethics committee.

Ethics Approval and Consent to Participate
Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations. The ethical approval was obtained from July 2014 to December 2014.

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References

1. Fleischer A, Schulman H, Farmakides G, Bracero L, Blattner P, Randolph G. Umbilical artery flow velocity waveforms and intrauterine growth retardation. Am J Obstet Gynecol. 1985;151:502–5
2. Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A, et al. Cerebral umbilical Doppler ratio as a predictor of adverse perinatal outcome. Cerebral and umbilical ratio: Obstet Gynecol. 1992;79:416–20.
3. Schulman H, Fleischer A, Stern W, Farmakides G, Jagani N, Blattner P, et al. umbilical wave ratios in human pregnancy. Am J Obstet Gynecol. 1984;148:985–90.
4. Giles WB, Trudinger BJ, Baird PJ. Fetal umbilical flow velocity waveform and placental resistance pathological correlation. Br J Obstet Gynaecol. 1985;92:31–8.
5. Tatjana Reihs, Matthias Hofer. In: Obstetrics and gynecology Sonography. 2nd ed. Matthias Hofer., editor. New York: Thieme; 2004. pp. 61–72.
6. Quaranta P, Currell R, Redman CW, Robinson JS. Prediction of small-for-dates infants by measurement of symphysis-fundal height. Br J Obstet Gynaecol. 1981;88:115–9.
7. Chang TC, Robson SC, Boys RJ, Spencer JA. Prediction of the small for gestational age infant: Which ultrasonic measurement is best? Obstet Gynecol. 1992;80:1030–8.
8. Warsof SL, Cooper DJ, Little D, Campbell S. Routine ultrasound screening for antenatal detection of intrauterine growth retardation. Obstet Gynecol. 1986;67:33–9.
9. Afzal A, Nasreen K. Biophysical score in high-risk pregnancy. Prof Med J. 2006;13:362–9.
10. Chauhan SP, Sanderson M, Hendrix NW, Magann EF, Devoe LD. Perinatal outcome and amniotic fluid index in the antepartum and intrapartum periods: A meta-analysis. Am J Obstet Gynecol. 1999;181:1473–8.
11. Forfar J, McIntosh N, Arnell GC, et al. Forfar and Arnell text book of pediatrics. Google book result. 2003:167–8.
12. Yoon BH, Romero R, Roh CR, Kim SH, Ager JW, Syn HC, et al. Relationship between the fetal biophysical profile score, umbilical artery Doppler velocimetry, and fetal blood acid-base status determined by cordocentesis. Am J Obstet Gynecol. 1993;169:1586–94.
13. Gonzalez JM, Stamilio DM, Ural S, Macones GA, Odibo AO. Relationship between abnormal fetal testing and adverse perinatal outcomes in intrauterine growth restriction. Am J Obstet Gynecol. 2007;196:48–51.
14. Padmagirison R, Rai L. Fetal doppler versus NST as predictors of adverse perinatal outcome in severe preeclampsia and fetal growth restriction. J Obstet Gynecol. 2006;56:134–8.
15. McIntire, D.D., Bloom, S.L., Casey, B.M., and Leveno, K.J. Birth weight in relation to morbidity and mortality among newborn infants. (Level II-2)N Engl J Med. 1999; 340:1234–1238.
16. Copel, J.A. and Reed, K.L. Doppler ultrasound in obstetrics and gynecology. (Level III)in: 1st ed. Raven Press, New York, NY; 1995: 187–198.
17. Trudinger, B.J. Doppler ultrasonography and fetal well being. (Level III)in: E.A. Reece, J.C. Hobbins, M. Mahoney, R.H. Petrie (Eds.) Medicine of the fetus and mother. JB Lipincott Co, Philadelphia, PA; 1992.