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Original Article

Utility of Colour and Spectral Doppler in the Diagnosis of Intrauterine Fetal Growth Restriction and Its Role in Predicting Adverse Perinatal Outcome

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ABSTRACT

Background: Intrauterine growth restriction (IUGR) is a major contributor to perinatal morbidity and mortality worldwide. Early diagnosis and timely intervention are essential for improving fetal outcome.
Materials and Methods: This prospective observational study was conducted in the Department of Radiodiagnosis, PDMMC Hospital, Amravati. A total of 120 clinically suspected IUGR pregnancies between 28 and 40 weeks gestation were enrolled. Colour and spectral Doppler examinations of the UA and MCA were performed serially from 28–30 weeks until delivery. PI and RI values were recorded and compared with established reference values. Neonatal birth weight, APGAR score, NICU admission, respiratory distress, and perinatal mortality were used to assess diagnostic accuracy.
Results: Among 120 pregnancies, 86 neonates were confirmed as growth restricted at birth. Abnormal UA PI was observed in 72 cases, while abnormal MCA PI was noted in 78 cases. UA PI demonstrated an overall diagnostic accuracy of 70%, while UA RI showed 54% accuracy. MCA PI had the highest diagnostic accuracy of 76.6%, whereas MCA RI demonstrated an accuracy of 70.3%. Sensitivity and specificity increased with advancing gestational age. Abnormal Doppler findings were significantly associated with low birth weight, NICU admission, fetal distress, and adverse perinatal outcome.
Conclusion: Colour and spectral Doppler assessment of UA and MCA is a reliable, non-invasive method for early detection of IUGR and prediction of adverse perinatal outcome. MCA PI showed superior diagnostic performance among evaluated Doppler parameters.

Keywords: *Intrauterine growth restriction, Doppler ultrasonography, Umbilical artery.*

INTRODUCTION

Intrauterine growth restriction (IUGR) is defined as failure of the fetus to achieve its genetically determined growth potential and is one of the most important causes of perinatal morbidity and mortality. The incidence of IUGR varies between 5% and 15% globally and is considerably higher in developing countries due to maternal malnutrition, anemia, hypertensive disorders of pregnancy, and inadequate antenatal care. (1,2)

Placental insufficiency remains the most common cause of IUGR. Chronic reduction in uteroplacental blood flow results in fetal hypoxia and redistribution of fetal circulation. (3) These adaptive hemodynamic changes can be assessed non-invasively using Doppler ultrasonography.(4,5) Doppler velocimetry provides information regarding blood flow characteristics in fetal and placental circulation and has become an integral component of fetal surveillance. (6)

The umbilical artery Doppler reflects placental vascular resistance. Increased resistance due to placental insufficiency results in elevated pulsatility index (PI) and resistive index (RI). Conversely, the middle cerebral artery demonstrates reduced resistance due to the brain-sparing effect, resulting in decreased PI and RI values. These Doppler changes often precede abnormal cardiotocography and biophysical profile findings. (7,8)Several studies (9,10,11,12) have demonstrated the utility of Doppler indices in identifying fetuses at risk of hypoxia, acidosis, preterm delivery, and perinatal mortality. However, variation exists regarding the relative predictive value of PI and RI measurements in different fetal vessels.

Hence, the present study was undertaken to evaluate the diagnostic accuracy of UA PI, UA RI, MCA PI, and MCA RI in clinically suspected IUGR pregnancies and to determine their role in predicting adverse perinatal outcomes.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Radiodiagnosis, PDMMC Hospital, Amravati, over a period of two years. A total of 120 pregnant women who were clinically suspected of having intrauterine growth restriction (IUGR) and were referred for Doppler evaluation were enrolled in the study. Pregnant women with singleton pregnancies, gestational age greater than 28 weeks, and willingness to participate were included. Cases with multiple gestations, major congenital fetal anomalies, intrauterine fetal demise at presentation, and uncertain gestational age were excluded from the study. Institutional ethical committee approval was obtained prior to commencement of the study, and informed consent was obtained from all participants.

All enrolled patients underwent detailed history taking and clinical examination followed by routine obstetric ultrasonography. Subsequently, colour and spectral Doppler examinations were performed using standardized imaging protocols. Umbilical artery Doppler measurements were obtained from a free-floating loop of the umbilical cord, while middle cerebral artery Doppler assessment was carried out at the proximal third of the vessel near its origin from the internal carotid artery. The Doppler parameters evaluated included umbilical artery pulsatility index (UA PI), umbilical artery resistive index (UA RI), middle cerebral artery pulsatility index (MCA PI), and middle cerebral artery resistive index (MCA RI). Serial Doppler examinations were performed from 28–30 weeks of gestation until delivery whenever indicated. All patients were followed up until delivery, and neonatal outcomes were recorded. The outcome measures included birth weight, APGAR score, neonatal intensive care unit (NICU) admission, respiratory distress, meconium aspiration syndrome, fetal distress, and perinatal mortality. The collected data were entered into Microsoft Excel and analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequency and percentage. Diagnostic performance of Doppler parameters was assessed by calculating sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy. A p-value of less than 0.05 was considered statistically significant.

Colour Doppler image showing normal tracing pattern of middle cerebral artery and umbilical artery at 30 weeks of gestation.

RESULTS

Table 1. Maternal Demographic Characteristics (n=120)

Variable	Number (%)
Age <20 years	12 (10.0)
20–25 years	45 (37.5)
26–30 years	40 (33.3)
>30 years	23 (19.2)
Primigravida	68 (56.7)
Multigravida	52 (43.3)

The majority of women belonged to the 20–30 years age group. Primigravidae constituted 56.7% of the study population.

Table 2. Diagnostic Performance of Doppler Parameters

Parameter	Sensitivity (%)	Specificity (%)	Accuracy (%)
UA PI	72.1	64.7	70.0
UA RI	58.1	48.5	54.0
MCA PI	80.2	68.4	76.6
MCA RI	73.2	61.7	70.3

MCA PI demonstrated the highest sensitivity and overall diagnostic accuracy for detection of IUGR.

Table 3. Perinatal Outcome Among Study Subjects

Outcome	Number (%)
Birth weight <2.5 kg	86 (71.7)
APGAR <7 at 5 min	22 (18.3)
NICU admission	30 (25.0)
Respiratory distress	18 (15.0)
Meconium aspiration	12 (10.0)
Perinatal mortality	4 (3.3)

Low birth weight was the most common adverse outcome observed.

Table 4. Association of Abnormal Doppler Findings with Adverse Outcome

Outcome	Abnormal Doppler n (%)	Normal Doppler n (%)
NICU Admission	26 (86.7)	4 (13.3)
Fetal Distress	18 (81.8)	4 (18.2)
Low APGAR	19 (86.4)	3 (13.6)
Perinatal Mortality	4 (100)	0

Abnormal Doppler findings showed a significant association with adverse perinatal outcomes.

DISCUSSION

IUGR remains a major obstetric challenge because of its association with increased perinatal morbidity and mortality. The present study evaluated the utility of colour and spectral Doppler examination in identifying IUGR and predicting adverse perinatal outcomes.

The majority of patients belonged to the 20–30 years age group, similar to studies by Gramellini et al. and Bhatt et al. Most patients were primigravidae, reflecting increased vulnerability to placental insufficiency in first pregnancies.

Umbilical artery Doppler is a well-established indicator of placental resistance. In the present study, UA PI demonstrated an overall diagnostic accuracy of 70%, whereas UA RI showed comparatively lower accuracy of 54%. These findings support the observation that PI is a superior index because it incorporates the entire Doppler waveform and is less affected by measurement variability. (13)

Middle cerebral artery Doppler demonstrated better predictive capability than umbilical artery Doppler. MCA PI showed the highest diagnostic accuracy (76.6%) among all evaluated parameters. This finding reflects the physiological brain-sparing phenomenon observed in fetuses experiencing chronic hypoxia. Similar observations were reported by Bahado-Singh et al., Baschat et al., and Alfirevic et al.

The sensitivity and specificity of Doppler indices increased with advancing gestational age. This may be attributed to progressive placental insufficiency resulting in more pronounced hemodynamic changes during later gestation. Several investigators have reported similar trends in Doppler studies of high-risk pregnancies.

The present study also demonstrated a strong association between abnormal Doppler findings and adverse neonatal outcomes. NICU admission, respiratory distress, fetal distress, and low APGAR scores were significantly more common in fetuses with abnormal Doppler parameters. Perinatal mortality occurred exclusively among fetuses with abnormal Doppler studies.

The findings support the concept that Doppler abnormalities occur before clinical deterioration and therefore permit timely intervention. Early identification of high-risk fetuses allows close monitoring, administration of corticosteroids when required, and appropriate timing of delivery. (14,15,16,17)

MCA PI emerged as the single best predictor of adverse perinatal outcome in this study. This observation is consistent with the findings of Severi et al., Baschat et al., and Cruz-Martinez et al., who reported superior predictive performance of cerebral Doppler parameters.

The strengths of the present study include prospective design, serial Doppler evaluation, and assessment of multiple fetal outcomes. Limitations include single-center design and absence of cerebroplacental ratio assessment, which has gained importance in recent years. (18)

Overall, colour and spectral Doppler evaluation significantly improved detection of fetal compromise and facilitated clinical decision-making. Integration of Doppler assessment into routine surveillance protocols for suspected IUGR can contribute substantially to reduction in perinatal morbidity and mortality.

CONCLUSION

Colour and spectral Doppler ultrasonography is a valuable, non-invasive technique for assessment of pregnancies complicated by suspected IUGR. Among the evaluated parameters, MCA PI demonstrated the highest diagnostic accuracy, followed by MCA RI and UA PI. Abnormal Doppler findings were significantly associated with adverse perinatal outcomes including low birth weight, fetal distress, NICU admission, and perinatal mortality. Routine incorporation of Doppler surveillance in high-risk pregnancies can facilitate early diagnosis, timely intervention, and improved neonatal outcome.

REFERENCES

1. Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A. Cerebral-umbilical Doppler ratio as predictor of adverse perinatal outcome. Obstet Gynecol. 1992;79:416-20.
2. Bahado-Singh RO, Kovanci E, Jeffres A, Oz U, Deren O, Copel JA. The Doppler cerebroplacental ratio and perinatal outcome. Am J Obstet Gynecol. 1999;180:750-6.
3. Baschat AA. Doppler application in the delivery timing of fetal growth restriction. Clin Obstet Gynecol. 2010;53:858-68.
4. Alfirevic Z, Stampalija T, Gyte GM. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. Cochrane Database Syst Rev. 2013;11.
5. Severi FM, Bocchi C, Visentin A, Falco P, Cobellis L. Uterine and fetal cerebral Doppler predict neonatal outcome. Ultrasound Obstet Gynecol. 2002;19:225-34.
6. Baschat AA, Gembruch U. The cerebroplacental Doppler ratio revisited. Ultrasound Obstet Gynecol. 2003;21:124-7.
7. Cruz-Martinez R, Figueras F, Hernandez-Andrade E, Gratacos E. Longitudinal brain perfusion changes. Ultrasound Obstet Gynecol. 2011;37:191-5.
8. Harrington K, Carpenter RG, Nguyen M, Campbell S. Changes observed in Doppler studies. Ultrasound Obstet Gynecol. 1995;6:19-28.
9. Hecher K, Campbell S, Doyle P, Harrington K. Assessment of fetal compromise. Circulation. 1995;91:129-38.
10. Figueras F, Gratacos E. Update on diagnosis and classification of fetal growth restriction. Fetal Diagn Ther. 2014;36:86-98.
11. Arbeille P. Fetal Doppler ultrasound. Eur J Obstet Gynecol Reprod Biol. 1997;75:51-60.
12. Trudinger BJ, Giles WB, Cook CM. Doppler umbilical artery studies. Br J Obstet Gynaecol. 1985;92:23-30.
13. Wladimiroff JW, Tonge HM, Stewart PA. Doppler assessment in fetal growth retardation. Br J Obstet Gynaecol. 1986;93:471-7.
14. Ott WJ. Doppler velocimetry in high-risk pregnancy. Clin Obstet Gynecol. 1995;38:489-96.
15. Bhatt CJ, Arora J, Shah MS. Role of colour Doppler in IUGR. Indian J Radiol Imaging. 2003;13:417-20.
16. Divon MY, Hsu HW. Prenatal diagnosis of growth restriction. Clin Obstet Gynecol. 1993;36:114-25.
17. Vergani P, Locatelli A, Andreotti C. Prognostic value of fetal Doppler. Prenat Diagn. 2002;22:801-8.
18. Unterscheider J, Daly S, Geary MP. Optimizing fetal growth restriction management. Am J Obstet Gynecol. 2013;208:290-6.