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Evaluation of the Ultrasound Doppler Parameters of Foetal Vessels in Pregnancies with Suspected Intrauterine Growth Retardation: A Prospective Study

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Introduction

Definition of IUGR

Intrauterine Growth Retardation is defined as foetal weight below the 10th percentile for gestational age [1].

IUGR vs. small-for-gestational age (SGA): While often used interchangeably, IUGR and SGA are not synonymous. SGA includes a broader spectrum: Foetuses with IUGR, constitutionally small but healthy foetuses, and cases misdiagnosed as small [2].

Risk associated with IUGR: Unlike most SGA cases, IUGR foetuses face increased risks of serious conditions such as hypoxemia, acidemia, and intrauterine foetal demise [2].

The incidence of IUGR varies from 3-10% of all live births, increasing in specific groups like stillborn infants and women with a history of hypertension or IUGR [1].

IUGR in India: A major cause of low birth weight babies, posing significant challenges to maternal and child health and socio-economic conditions [3].

Importance of early detection: The prime target in antenatal care is the early identification of IUGR to prevent adverse outcomes, emphasizing the need for accurate diagnostic methods [4].

Since the 1960s, ultrasonography, especially fetal biometry, has been essential in assessing fetal size and growth, surpassing traditional methods [5].

Colour doppler ultrasound's efficacy: This advanced technique has been pivotal in studying foetal hemodynamic, providing insights into uteroplacental insufficiency and fetal acid-base status [2].

Predictive value of doppler studies: Changes in the Doppler flow velocity waveform of the umbilical artery, middle cerebral artery, and thoracic aorta are strong predictors of adverse perinatal outcomes. These include timing of delivery, caesarean sections for fetal distress, NICU admissions, and early complications in newborns like necrotizing enterocolitis and hypoxic-ischemic encephalopathy [4].

Clinical implications: The ability to predict such outcomes underscores the importance of incorporating Doppler ultrasound in routine prenatal screening for IUGR, aiding in timely intervention and management [6].

Aims

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

Objectives

To calculate pulsatility index (PI) of middle cerebral artery, umbilical artery and thoracic aorta and compare it to the reference value for gestational age among Pregnancies with suspected Intrauterine Growth Retardation. To assess changes in end-diastolic flow in the selected vessels. To assess perinatal outcomes among study subjects. To find out any possible association between Doppler abnormalities with adverse perinatal outcomes.

Study area: Department of Radiology, IQ City Medical College & Hospital. Study conducted from November 2022 to June 2023. Patients primarily from Durgapur and extending to remote regions as a tertiary referral centre.

Study population: Pregnant females suspected of IUGR referred by the Department of Gynecology and Obstetrics.

Inclusion criteria: Singleton pregnancy [7]. Fetal gestational age of 24 weeks or more as confirmed by prior ultrasonography as early as possible. Fetal weight below the 10th percentile or HC/AC ratio greater than 1.20 based on ultrasonography.

Exclusion criteria: Pregnancies with major congenital or chromosomal abnormalities.

Sample size: 50 cases, Systematic random sampling,

Study design: Prospective, observational , hospital-based study.

Ultrasound system: GE Volusion S8 - featuring: Curved-array transducer (3.5-5.0 MHz). Wall filter settings (50-100 Hz). Sample volume adjustments to fully cover vessel diameters.

Informed consent: Detailed information provided to patients regarding study objectives, methods, possible side effects, followed by obtaining written consent.

Study parameters: Doppler indices: Pulsatility index (PI) values for the umbilical artery (UA), the middle cerebral artery (MCA), and the descending thoracic aorta (TA) [8]. Cerebroplacental ratio: The ratio of PI values between MCA and UA. Flow velocity waveform alterations: Noting absent or reversed end-diastolic flow (EDF).

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Adverse perinatal outcomes evaluated: Gestational age at delivery. Caesarean section performed due to fetal distress. Birth weight metrics. Neonatal intensive care unit (NICU) admissions. Instances of perinatal death.

Patient history and examination techniques: Collection of comprehensive maternal history. Physical examinations assessing general health and specific pregnancy-related factors. Routine laboratory investigations conducted with ethical considerations for consent [9].

Ultrasound technique: Utilization of a 3.5 MHz curvilinear probe for examination. Gestational age determined by previous ultrasound records or patient-reported LMP. Measurements of fetal biophysical parameters including BPD, HC, AC, and FL. Amniotic fluid volume recorded with outcomes automatically calculated. Specific examination sites for UA, MCA, and TA detailed for PI value calculation and assessment of EDF changes.

Observation and support: Presence of a female attendant throughout all procedures.

Comprehensive follow-up: Monitoring of pregnancies until termination, including visits to wards, labour rooms, and NICU, supplemented by telephone contact. Systematic recording of any adverse perinatal outcomes in line with the study's parameters. Our study has similar or higher OR and sensitivity values for the CPR and the UA PI than the other studies, suggesting that our results are reliable and valid. However, our study also has some limitations, such as the small sample size, the lack of DV PI measurement, and the lack of long-term follow-up of the neonates [10].

Conclusion

Perinatal outcomes monitored

Gestational age at delivery, caesarean section for fetal distress, birth weight, NICU admission, and perinatal death.

Live births vs. IUFD: 4 intrauterine fetal deaths; 46 live births with 29 via caesarean section.

NICU admissions and neonatal mortality: 20 neonates admitted to NICU; 1 neonatal death.

Caesarean section cases

Abnormal doppler findings: 14 in MCA PI, 12 in UA PI, 11 in TA PI, and 9 in cerebroplacental ratio <1.

Risk analysis: Highest Odd's ratio and relative risk for abnormal TA PI.

NICU Admissions

Significant findings: Abnormal MCA PI (10 cases), UA PI (9 cases), and abnormal cerebroplacental ratio <1 (7 cases) — highest risk in cerebroplacental ratio.

Perinatal deaths

Common abnormalities: 4 cases each with abnormal MCA PI, UA PI, and cerebroplacental ratio <1.

Highest risk: Abnormal cerebroplacental ratio.

Key conclusions

Abnormal PI in MCA, UA, or TA increases the risk of adverse perinatal outcomes. The cerebroplacental ratio <1 shows the highest association with adverse outcomes. The highest risk of perinatal death is observed with an abnormal cerebroplacental ratio. A/REDF in TA is significantly associated with cesarean section and NICU admission. REDF in UA poses the highest risk for perinatal death. Overall Assessment: Doppler ultrasonography is a crucial tool in IUGR pregnancy management, indicating the need for larger-scale studies for further validation.

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