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ROLE OF DOPPLER ULTRASOUND IN IUGR TO IMPROVE FETAL OUTCOMES

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Abstract

Objective: *The aim of this study was to identify the role of doppler ultrasonography for the detection of IUGR, to explore its impact on different fetal outcomes. The study further attempted to determine the relationship between the doppler waveform patterns of IUGR, the likelihood of a C-section, and low birth weight.*

Study Design: *prospective cross-sectional study*

Study Setting: *Obstetrics and Gynecology Department, JPMC, Karachi.*

Study Duration: *Six months (from June to Nov, 2024)*

Methodology: *100 participants with high-risk, clinically suspected IUGR, 31–41 weeks pregnancies participated in prospective research. The patients were monitored up to delivery, and the greyscale and doppler results were compared to the infants' birth weights.*

Results: *The HC/AC ratio was determined to have the best sensitivity (70.2%), oligohydramnios to have the highest specificity (98%), and C/U ratio was found to be highly specific (98.8 %). The C/U ratio's sensitivity was discovered as 67.4%. The least sensitive was the middle cerebral artery (26.7%). The relationship between an aberrant uterine artery PI and a cesarean delivery result was found to be quite significant (p-value = 0.0095), however no statistically significant correlation between an aberrant umbilical artery, fetal middle cerebral artery, and C/U ratio PI values with cesarean section was found.*

Conclusion: *In order to identify IUGR, oligohydramnios and HC/AC ratio are both very specific parameters. The best measure for IUGR diagnosis in the third trimester is the C/U ratio, which was found to be better as compared to oligohydramnios and HC/AC ratio in both sensitivity and specificivity.*

INTRODUCTION

Doppler ultrasound has been utilized in obstetrics to get a real-time, non-invasive, direct assessment of the uteroplacental, fetoplacental, and fetal circulations' velocity waveform shape (1). Substantial evidence

exists between Doppler ultrasound and fetal and perinatal outcomes in a high-risk group (2). Furthermore, understanding the Doppler data is linked to decreased rates of neonatal deaths and less frequent use of treatments including cesarean sections for fetal distress, labor induction, and prenatal hospitalization (3).

In developing countries like India and Pakistan, there is a large prevalence of intrauterine growth retardation (IUGR) brought on by fetoplacental vascular insufficiency (4,5). Identification of fetuses at increased risk of perinatal compromise is necessary to improve the fetal outcomes. The literature has several studies that provide in-depth descriptions of changes in the waveforms and Doppler values of the fetal uterine arteries, umbilical artery, and middle cerebral artery(MCA) (6).

For predicting outcomes, intrauterine growth retardation(IUGR) fetuses the cerebroplacental ratio may be the most reliable Doppler marker. as pointed out by several previous studies (7,8). Despite its potential, there aren't many clinical papers that mention its importance, and most of the time just a limited number of afflicted patients are included in the study.

The ability of each doppler measure, however it might be difficult to anticipate low birth weight (for gestational age) during the third trimester (9). Doppler values have been linked to poor pregnancy outcomes (10). It has been shown that abnormal acid-base status and neonatal admission to a special care unit are related to lower flow resistance in the foetal cerebral circulation as indicated by low pulsatility index (PI) in the middle cerebral artery (MCA) or cerebroplacental ratio (CPR) (11).

Similarly, increasing uterine artery resistance has been linked to an increased chance of C- section (CS) due to fetal distress (12). More recently, it has been demonstrated that measuring Umbilical vein blood flow (UV) can help identify late-onset IUGR in fetuses at increased risk (5).

The aim of this study was to identify the role of doppler ultrasonography for the detection of IUGR, to explore its impact on different fetal outcomes. The study further attempted to determine the relationship between the doppler waveform patterns of IUGR, the likelihood of a C-section, and low birth weight.

METHODOLOGY:

This prospective cross-sectional study was conducted at the Department of Obstetrics and Gynecology, Jinnah Postgraduate Medical Centre (JPMC), Karachi, from June 2022 to December 2022, following formal approval from CPSP. The estimated sample size was 100, based on the prevalence of intrauterine growth restriction (IUGR) in high-risk pregnant women with a 95% confidence interval.

Eligible participants included women with a single pregnancy between 31 and 41 weeks of gestation, determined from their last menstrual period (LMP), and clinically diagnosed with IUGR based on inadequate weight gain, changes in abdominal circumference, or fundal height. Women with multiple pregnancies or fetal congenital defects were excluded.

All patients underwent a detailed clinical history review, laboratory testing, and ultrasonographic examination. They were advised to retain a full bladder for at least three hours before the assessment. The abdominal circumference was measured in a plane perpendicular to the transducer, ensuring the presence of the fetal spine, stomach bubble, horizontal portal vein, and liver. The femur length was determined by visualizing the fully calcified portion, avoiding tangential sections.

Amniotic fluid levels were assessed by measuring the largest vertical pocket free of fetal parts or the umbilical cord. Oligohydramnios was defined as fluid less than 2 cm, normal levels ranged from 2 to 8 cm, and polyhydramnios was greater than 8 cm. Doppler velocimetry was performed to measure pulsatility index (PI) values, with the cerebral/umbilical pulsatility ratio (C/U ratio) calculated. Uterine artery waveforms were analyzed at the cervico-corporal junction, comparing indices from both sides when necessary. The umbilical artery was assessed at three sites: midpoint, placental insertion, and fetal umbilical insertion, with PI values recorded. IUGR diagnosis was based on comparisons with standard ultrasound assessments, including HC/AC ratios and Hadlock's gestational aging charts. Growth restriction was diagnosed if measurements were more than 2 SD below the mean for gestational age. A structured proforma was used

to record patient history, examination findings, ultrasound parameters, and neonatal birth weight.

RESULTS:

specificity predictive values, and likelihood of C section and low foetal birth weight.

All of the patients ranged in age from 20 to 41. The majority of the cases were between the ages of 20 and 26. The bulk of high-risk instances (31% of all cases) had PIH, which was followed by 20% of cases with a prior history of giving birth to children who had growth retardations.

In the age range of 21 to 25 years. The majority of our patients' gestational ages were 35.1-37 (31%) and 33.1-35 weeks (27%), respectively, at the time of evaluation.

Babies with low birth weight were discovered in 83% of high-risk situations. According to Lubchenco classification, newborns were categorized:

1. Low birthweight = Weight less than 2.5 kg,
2. Timely for the occasion = weight more than 2.5kg.

After that, these values were compared with standard ultrasonic assessments of the HC/AC ratio and likewise showed a correlation with the subsequent birth weight. In terms of detecting IUGR cases, HC/AC had a sensitivity of 70.2 %, a specificity of 92 %. A significant correlation was found (p-value 0.0001) between HC/AC ratio and likelihood of IUGR

Oligohydramnios had a positive predictive value of 100, a negative predictive value of 10.2, a sensitivity of 36.8%, and a specificity of 92%. For identifying SFD patients. There was no statistically significant link between oligohydramnios and an aberrant result (p-value 0.201).

The relationship between an aberrant uterine artery PI and a cesarean delivery result was found to be quite significant (p-value = 0.0095). There was shown to be no statistically significant relationship between an aberrant umbilical artery PI and the result of a cesarean section (p-value = 0.2789). It was determined that there was no statistically significant correlation between an aberrant fetal middle cerebral artery PI and the result of a cesarean section (p-value = 0.1814).

A statistically significant correlation between an aberrant C/U ratio and a cesarean section result could not be established (p-value = 0.0954). The uterine artery waveform was 37.7% sensitive, 68% specific, 91.8 positive predictive, and 12.6 negative predictive for IUGR in the high-risk patients. The umbilical artery waveform's sensitivity for detecting IUGR in the high-risk group was 62.9%, with 83% specificity, 96.6 positive predictive value, and 20 negative predictive value.

The Middle Cerebral Artery Waveform had a sensitivity of 26.7%, a specificity of 90%, a positive predictive value of 67.5, and a negative predictive value of 9.78 for IUGR in the high-risk group. The C/U ratio's sensitivity for detecting IUGR in the high-risk group was 67.4%, with 98% specificity, 100% positive predictive value, and 26.3 negative predictive value.

With a p-value of 0.7408, the relationship between aberrant uterine artery PI and an abnormal result (SFD) was not statistically significant. A statistically significant relationship existed between aberrant umbilical artery PI and fetal outcome (p value = 0.0132).

It was no statistically significant (p value = 0.2786) link between aberrant fetal middle cerebral artery and poor fetal outcome. The relationship between an aberrant C/U ratio and low birthweight result (SFD) was highly significant (p value 0.0001).

Fetal Outcomes

The majority of cases (57%) were delivered vaginally, while 42% were delivered through C-section. Fetal Distress was the most common indicator of C-section delivery. Out of 100 babies, 89 were determined to be under 2.5 kg at delivery, falling into the low-birth-weight group.

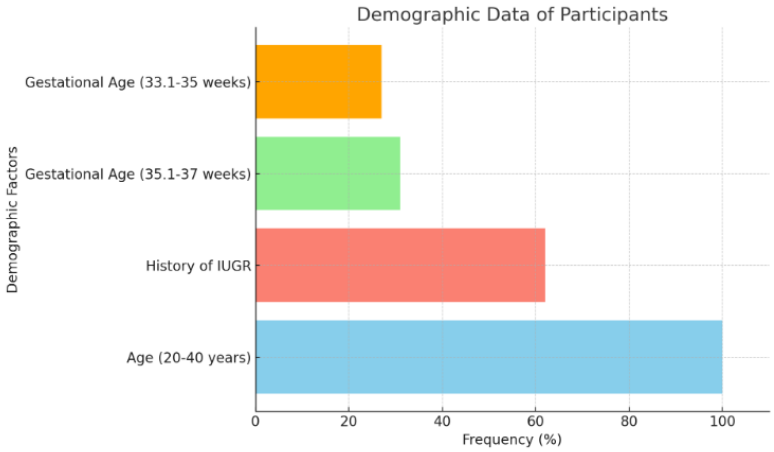

Figure 1 Demographic data of the Participants

Predictive values to determine fetal outcomes

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
HC/AC ratio	70.2%	92%	90	10.2
Oligohydramnios	36.8%	98%	100	11.4

Predictive values to determine fetal outcomes and significance value to determine the probability of C-section

	Sensitivity	Specificity	p-value for C- section probability
Uterine Artery	33.5%	68%	0.0095
Umbilical Artery	62.9%	83%	0.2789
Middle Cerebral Artery	26.7%	90%	0.1814
C/U ratio	67.4%	98%	0.0954

DISCUSSION

This study evaluated the role of ultrasonography in detecting IUGR, particularly in high-risk pregnancies, to improve prenatal care and reduce maternal and neonatal complications. Both high-risk and clinically suspected IUGR cases were monitored until delivery, recording birth weight and delivery method.

A significant proportion of cases involved young mothers aged 21–25 years, with those aged 23–28 years at higher risk for IUGR. Clinical history indicating high risk should prompt further screening with ultrasonography. Studies have found oligohydramnios to be a reliable predictor of at-risk fetuses (13), while Doppler has been highlighted as an effective tool in assessing adverse fetal outcomes (14).

Doppler analysis of the uterine artery in this study found abnormalities in 37% of high-risk cases, with 54.05% of these cases requiring cesarean section. These cases had higher rates of perinatal complications, including IUGR and fetal mortality. In the current investigation, uterine artery Doppler readings predicting adverse fetal outcomes exhibited a sensitivity of 33.5%, specificity of 68%, positive

predictive value of 91.8%, and a negative predictive value of 11.1 (Table 3).

The umbilical artery Doppler was also useful in predicting poor fetal outcomes, with a positive predictive value of 96.6% and a specificity of 83% (15). Of the 60 high-risk cases with abnormal umbilical artery Doppler values, 29 showed decreased end-diastolic flow, and 32 cases (83.87%) had poor fetal outcomes. Thirteen cases had absent end-diastolic flow, while two cases had reversed flow. In 26 of the 60 cases, a cesarean section was performed, with a 43.3% incidence when an anomaly in the umbilical artery was present.

The middle cerebral artery (MCA) and umbilical artery pulsatility index (PI) ratio proved more reliable in detecting fetal distress than independent measurements (16). Eight percent of high-risk cases had abnormal MCA values, with a 62.5% cesarean delivery rate. The MCA Doppler values had a positive predictive value of 87.5%, negative predictive value of 9.78%, sensitivity of 26.7%, and specificity of 90.0% for predicting unfavorable fetal outcomes. Oligohydramnios was found when the largest vertical amniotic fluid pocket measured less than 2 to 2.5 cm, showing a sensitivity of 21.1% for IUGR detection. These results align with Qayyum et al. (2022), who reported a sensitivity of 22% and specificity of 99.99% for IUGR (17).

The cerebral/umbilical pulsatility ratio (C/U ratio) has been identified as a highly sensitive and specific indicator of IUGR and poor perinatal outcomes (3). It is more accurate than using the uterine, umbilical, or middle cerebral artery alone (18). In this study, 64% of high-risk patients had an abnormal C/U ratio, with 23 requiring cesarean birth, resulting in a surgical delivery rate of 38.5%. The C/U ratio demonstrated a sensitivity of 67.4%, specificity of 98%, positive predictive value of 100%, and negative predictive value of 26.3% for predicting IUGR and fetal distress.

This study is one of the most comprehensive analyses of Doppler ultrasonography in predicting IUGR outcomes. Its strengths include a prospective design, a large sample size, and blinding of obstetricians to Doppler data. However, its cross-sectional design limits the ability to assess serial Doppler changes throughout pregnancy. Future longitudinal studies with larger sample sizes are recommended for more generalized conclusions.

CONCLUSION

There is a clear role of Doppler abnormalities in identifying poor pregnancy outcomes like mortality rates, morbidity rates and C- section. Doppler ultrasonography improvements have made it easier for us to access fetal circulation as well. The fetal cerebral arteries have drawn a lot of attention and has been studied widely throughout the literature.

The role of the Uterine artery is of well-known importance. Our study showed 54.05% of the cases with aberrant uterine arteries underwent caesarian sections. They were also found to have adverse fetal outcomes, including perinatal death, and IUGR. In the current study, umbilical artery Doppler values had a sensitivity of 64.4%, a specificity of 80.0%, and were favorable in predicting poor fetal outcomes. As a result, it could help to enhance both the health of the mother and the fetus in the future. Future studies should be done as a more longitudinal study design and a much larger sample size to generalize the findings in the general population.

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