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Original Research Article

Evaluating IUGR with Color Doppler Along with a Clinical Correlate

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Abstract

Objective: The perinatal fate of newborns with IUGR can be considerably improved by early detection and prompt care. Common methods for monitoring fetuses include biophysical profiles and non-stress tests, although neither one is reliable for identifying preterm births. Doppler has made it considerably simpler to identify cases of IUGR early and with good consistency and efficacy for the perinatal outcome. 1) To link clinical findings in IUGR with color Doppler and the perinatal outcome was the study's primary goal. 2) To investigate the Doppler parameters' predictive effectiveness in the early identification of fetal compromise.

Method: Between May 2021 and June 2022, this research was done at MGM Medical College LSK Hospital, Kishanganj. The study comprised 70 singleton pregnancies with IUGR detected after 31 weeks of gestation, and these pregnancies were investigated and monitored clinically as well as using Doppler results until delivery. We used percentage to examine the prognostic efficacy (sensitivity, specificity, positive and negative predictive values) of waveforms from the middle cerebral artery and umbilical artery.

Results: MCA PI had the best sensitivity and specificity (77%, 92%) as a marker for the degree of fetal impairment in IUGR, however other ratios, such as MCA PI/UA PI and UA SD (>2), were also highly specific predictors of a poor perinatal outcome. A certain bad prenatal result in terms of mortality is linked to absent and reverse end diastolic flow in the umbilical artery. The accuracy of clinical evaluation and ultrasound biometry in identifying the ideal window for intervention in growth-restricted fetuses is limited. The positive predictive value for non-reactive non-stress testing was found to be just 23%, with a false positive rate of 74%.

Conclusion: Multiple vascular studies, one of the tests for antepartum fetal surveillance, has good accuracy compared to the other tests, and the color doppler study is a straightforward, rapid, non-invasive process.

Keywords: Umbilical Artery PI, Middle Cerebral Artery PI, and IUGR.

Introduction

A healthy utero-placental circulation must be developed in order to have a normal pregnancy. In India, where the condition is predominantly related to IUGR, LBW prevention is a top public health goal. A subset of instances known as Small for Gestational Age (SGA) newborns include foetuses affected with IUGR [1]. Low

birth weight babies are those who weigh less than 2500 g at birth, whereas SGAs are those who weigh less than the 10th percentile for their gestational age and less than 2500 g at delivery (small for gestational age).

The term "IUGR" refers to a foetus that has not reached a particular and arbitrary weight or anthropometric threshold (10th percentile) by a particular gestational age because of a pathologic condition that prevents the expression of the normal intrinsic growth potential [Figures 1 and 2]. Whereas IUGR is a clinical diagnosis and covers infants who have clinical indications of malnutrition, SGA is a statistical definition. Asymmetry (55%) and symmetry (33%) are both possible, as well as mixed (12%).

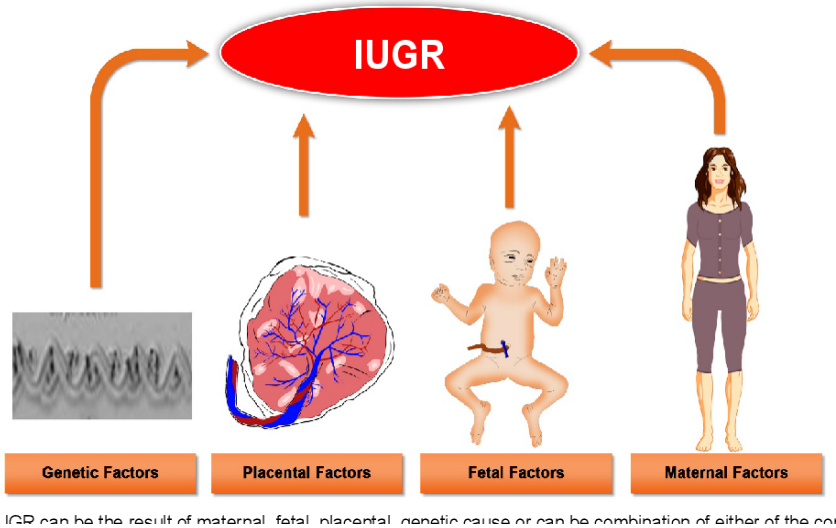

Figure 1: Complications associated with IUGR

The most common cause of IUGR is placental insufficiency (pre-eclampsia, chronic HT, DM, renal disease, cardiac disease, anemia), followed by maternal conditions not related to placental insufficiency (severe malnutrition, smoking, alcohol consumption, hemoglobinopathies), foetal chromosomal abnormalities, multifactorial foetal abnormalities, and foetal infections. It is linked to a higher risk of preterm birth, morbidity, and compromised neurodevelopment [3]. Hence, a key goal of prenatal treatment is risk prediction and accurate identification of the impaired IUGR foetus to enable prompt intervention.

Ultrasound measurements and clinical evaluation both aid in the early identification of IUGR. The biophysical profile (BPP) and the non-stress test have been the two most often used techniques for assessing health in foetuses classified as SGA (NST). Sadly, neither of these tests is very sensitive for predicting a bad outcome in pregnancies with IUGR. In the antenatal phase, ultrasound is widely used to determine the size of the foetus using serial biometric measurements, amniotic fluid index, and velocimetry study of UA and MCA [4]. Here, Color Doppler plays a crucial role in identifying these aberrant vascular resistance patterns [5].

In tiny and impaired fetuses, the foundation of risk evaluation is the fetal umbilical arteries [6]. However, a multiple vessel analysis enhances Doppler's overall accuracy and is more dependable and useful in determining the manner and timing of intervention.

The purpose of this study was to compare clinical and Doppler findings in IUGR and to determine the best timing for

intervention by examining the prognostic value of Doppler parameters.

Methods

Study Design: From May 2021 to June 2022, a prospective observational study was carried out in the Department of Radiology, MGM Medical College LSK Hospital, Kishanganj. 70 prenatal participants who were chosen from the antenatal ward and the outpatient department participated in the study. Each woman was carrying a singleton who was more than 31 weeks gestational age.

Methodology: From the time of recruitment until the time of delivery, the participants enrolled in the study were monitored. IUGR screening and diagnosis include [7] the following:

1. Correct calculation of gestational age.
2. With each antenatal appointment, abdominal palpation to measure fundal height.
3. An ultrasound of a potential SGA fetus.
4. Evaluation of foetal health when an SGA or IUGR fetus is identified. Doppler analyses and cardiotocography monitoring fall under this (CTG).

Calculating the gestational age

The most precise way to establish gestational age is via a dating ultrasound during the first trimester [7]. If the last menstrual period (LMP) is confirmed, with regular menstruation, and there is a discrepancy of less than 10 days between the LMP and ultrasound, the LMP estimate has fair accuracy if the earliest ultrasound is between 12 and 23 weeks of pregnancy. Ultrasound EDD is preferred if the LMP is a questionable or irregular period [8].

Assessment criteria

- S/D ratio, resistance and pulsatality index of the middle cerebral artery (5th percentile), and umbilical artery (>2SD) for the gestational age in accordance with the normative reference values.
- Kurmanavicius et al [9] reference for the umbilical artery was used.
- The reference values for umbilical artery P.I., cerebroumbilical ratio, and MCA P.I. ratio are given by Dandolo Gramellini et al. [10] and Giancarlo Mari et al. [11], respectively.

Umbilical artery S/D ratio reference values by Rajan et al and Acharya G et al were used [12,13].

1. The MCA/UA PI ratio needed to be less than 1.07 or 2SD for the ratios to be judged abnormal [10].
2. Less than a 1.3 MCA/UA S/D ratio

Perinatal outcome metrics that are abnormal

1. Stillbirth or IUD-related foetal death.
2. The death of a newborn within 31 days.
3. 5 Minute Apgar score 3.
4. Admission for more than 25 hours to NICU.
5. Newborn morbidity such as neonatal hyperbilirubinemia, cerebral haemorrhage, early-onset septicaemia, hypoglycemia, or hyaline membrane disease.
6. Caesarean section for distress in the foetus.
7. Alcohol with meconium stains

Sample size: 70 pregnant women met the inclusion area and were included in the study.

Inclusion criteria:

- Any pregnant woman, regardless of age or parity, who has high-risk factors or is clinically diagnosed with IUGR.
- Anatomy of a typical fetus.

Exclusion criteria:

- Multiple pregnancies.
- Congenital defects in the child.

Statistical Analysis: The Microsoft Excel program was used to evaluate all of the

data. Data collection and tabulation were followed by statistical analysis of the data. Calculated and compared with data from previous studies were the sensitivity, specificity, positive predictive value, proportion of false positive results, and negative outcomes.

Ethical Considerations: The study was approved by MGM Medical College LSK Hospital, Kishanganjafter written consent was provided by the participants.

Results

The age range for the group was 18 to 25 years, with a mean mother age of 22 years. In our study, pre-eclampsia (51%, n=31) and anemia (34%, n=20) were the two most frequent causes of IUGR. Out of 31 cases, 15 patients had severe pre-eclampsia, and 14 cases out of 20 had severe anemia. Of these 11, patients had both severe pre-eclampsia and severe anemia. The average gestational age was 33.3 weeks, with some patients needing abortions because of severe pre-eclampsia and others going into labor on their own. The majority of patients (60%) required cesarean sections, with the most frequent causes being fetal distress, meconium-tainted beverages, severe pre-eclampsia, and severe oligohydramnios. In the Doppler investigation, 5 individuals either had AEDF or REDF; all of these fetuses had poor perinatal outcomes. In our study, none of the patients showed aberrant DV waveforms because most instances were treated earlier.

The perinatal result in the study population is shown in Table 1. 45% of live newborns required NICU admission. There were three newborn fatalities recorded. The fetuses with absent or reversed umbilical artery diastolic flow were those. While severe negative effects like necrotizing enterocolitis and intracranial/intraventricular hemorrhage were extremely rare, neonatal hyperbilirubinemia was a more frequent consequence.

Table 1: Population perinatal outcome under research.

Perinatal Outcomes	Number or Percentage
Birth Weight	
>=2000	8.2%
1500-2000	48.2%
1000-1500	33.2%
<1000	6.8%
Live Birth	65 (44%)
Still Birth	5
Term babies	44%
Preterm	56%
Neonatal death	2
5 min APGAR <6	8
Neonatal complications	15 (28.4%)
Admission to NICU	25 (46.3%)

Double surface phototherapy was administered to these fetuses, who were then kept in the NICU for at least 8 days. Instead of being caused by IUGR, it appeared to be more of a preterm issue. The majority of the babies had birth weights between 1.0 and 2.0 kg, therefore the catch-up growth was rapid and typical. Little evidence of metabolic problems was found. On a grey scale B mode scan, we investigated the diagnostic efficacy of Doppler parameters, fundal height, and FL/AC ratio.

A fundal height lag of 3 cm or more compared to gestational age is considered significant. The sensitivity and specificity

of measuring fundal height were found to be 74 and 65%, respectively, in our study. The initial analysis of IUGR is often performed using ultrasonography in B mode. Although it becomes less accurate as the pregnancy progresses, combining a number of variables can increase its sensitivity and positive predictive value.

At 31 to 33 weeks of pregnancy, the head-to-abdominal ratio is typically one and drops below one around 33 weeks. Figure 2 shows the neonatal complications.

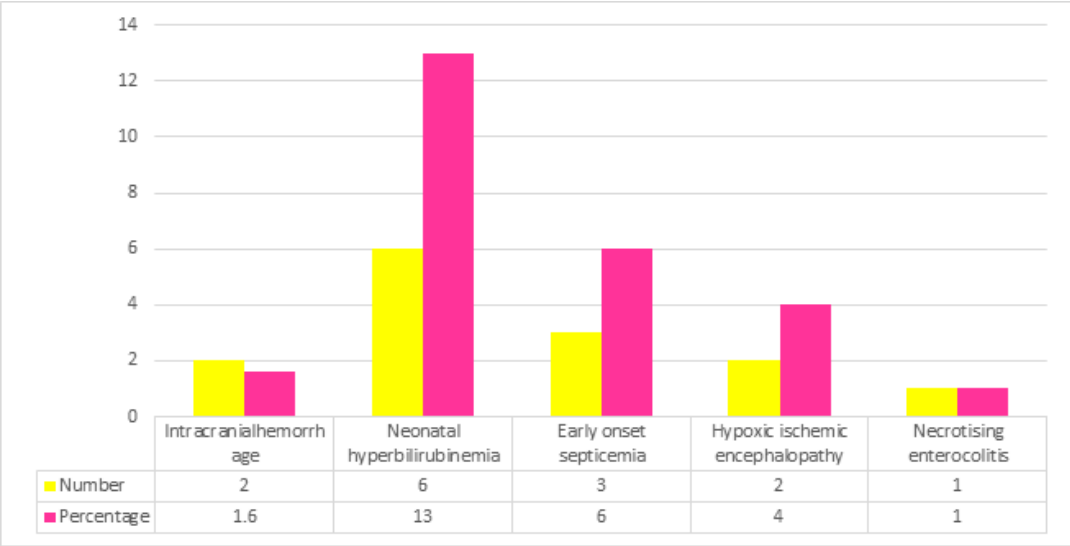

Figure 2: Complications in neonatal

The umbilical artery SD ratio was found to have lower specificity and positive predictive value than the cerebro placental ratio (CPR2). This is because, unlike the Pulsatility Index, the SD ratio only considers the greatest velocity during systole and the minimum velocity at the end of the diastole. As a result, if the diastolic flow is disturbed, the SD ratio will change. Non-stress tests were regularly conducted in accordance with the results of the Doppler, but their sensitivity was found to be only 54%, with a positive predictive value of 26% and high false positive rates. As a result, a non-stress test alone does not have a high level of accuracy in predicting a poor perinatal outcome, but it can be significant in determining the timing of an intervention in cases of early foetal compromise visible on Doppler, even though Doppler still serves as the primary study in management decisions.

Discussion

Fundal height measurements, even when carefully taken, are only 26 to 76 percent sensitive in predicting IUGR [14]. The sensitivity and specificity of measuring fundal height were found to be, respectively, 75% and 66% in our study. The initial analysis of IUGR is often performed using ultrasonography in B mode. As the pregnancy progresses, its accuracy declines, but combining multiple factors, such as estimated foetal weight, head circumference, and abdominal circumference, might increase sensitivity and positive predictive value [15].

The belly circumference is the first biometric measurement to change in all growth-retarded foetuses [16]. Using a cutoff of 23.4, we examined the FL/AC ratio and discovered that the sensitivity and specificity were, respectively, 56% and 75%. Although the FL/AC ratio is an age-independent measure whose mean value differs in normal and IUGR foetuses,

Benson CB et al [17] studied the ratio and discovered that the sensitivity was 56% and the specificity was 74%. They came to the conclusion that the ratio is not clinically useful as a predictor of IUGR. Even with a 10% incidence rate for IUGR, only 19% of foetuses with FL/AC ratios above the cutoff are likely to develop IUGR. According to many research, the HC/AC and TCD/AC ratios are stronger indicators for predicting asymmetrical IUGR [18]. About 85% of growth-restricted foetuses can be detected by a ratio larger than one [16]. The range of abdominal circumference's sensitivity for identifying birthweights below the 10th centile is between 48% and 87%, while its specificity is between 69% and 85% [19].

The sensitivity of the UA PI was found to be 64% in the study by Gramellini et al., which is equivalent to our investigation, but the sensitivity of the MCA PI was found to be 24% different, despite being the most specific indicator (100%) in both studies [10]. The disparity can be a result of our study's smaller sample size. With the exception of MCA PI sensitivity (41.6% vs. 78%) and UA SD ratio (>3) specificity (45.4% vs. 81%, respectively), the investigation by Lakhar et al. produced results that were similar to ours [5].

Increased perinatal morbidity and mortality are a result of the high prevalence of intrauterine growth retardation (IUGR) in the general obstetric population (11%) and its low detection rate (41%). To identify IUGR newborns, a clinical examination and Doppler correlation are essential. Fundal height evaluation has conflicting evidence; some studies claim it is a strong predictor of IUGR, while others indicate no benefit [20]. Given that its strength is in serial evaluation, it appears to be more of a surveillance tool than a screening one. As a result, the accuracy is decreased, and inter-server variation is increased.

A significant increase in the rate of antenatal identification of SGA newborns from 29% to 54% was identified when fundal height was measured and plotted on customised growth charts in comparison to routine clinical assessment by palpation [21]. The Royal College of Obstetricians and Gynecologists recommendations [22] so advocate serially measuring fundal height and plotting it on personalised growth charts. However, some pregnancies are not appropriate for primary surveillance by fundal height measurement and instead require ultrasound biometry, such as (1) fundal height measurement unsuitable (e.g., due to fibroids, a high maternal body mass index, or a deviated uterus) or Breech or transverse presentation. (2) Questionable dates (3) Twins or hydramnios (4) High-risk pregnancy (for example, because of a history of SGA). Intrauterine growth restriction (IUGR) caused by the placenta is primarily a vascular condition. The distinctive foetal multi-vessel cardiovascular symptoms are seen at the end, which begins with aberrant tertiary villous vessels [23].

Doppler ultrasound assessment of a number of vessels, including the precordial veins for the cardiac consequences of placental failure, middle cerebral arteries (MCA) for preferred brain perfusion, and maternal uterine arteries and foetal umbilical arteries, can be used to confirm these effects. Doppler anomalies in these vascular areas deteriorate together with IUGR, indicating a stepwise pattern of disease development [23]. Doppler surveillance in IUGR is based on this assumed sequence and the expectation of foetal worsening. The three indices S/D, Pl, and Rl in the umbilical artery decrease with growing gestation in a healthy pregnancy [24].

Yet, in the early stages of IUGR, the umbilical artery's diastolic flow is reduced because of an increase in resistance in the tiny arteries and arterioles of the tertiary

villi. As a result, Pl and Rl of the umbilical artery have higher S/D ratios. Diastolic flow declines, then disappears, then reverses as placental insufficiency gets worse. In their investigation, Yoon et al. showed that the absence of an umbilical artery waveform is a powerful and independent predictor of a poor neonatal outcome [25]. Throughout pregnancy, the circulation of the foetus has a low resistance. It is extremely susceptible to foetal hypoxia, which causes a redistribution of cardiac output towards the fetus's brain (a phenomenon known as the "brain sparing effect") and causes an increase in diastolic flow with a drop in the MCA's pulsatility index.

An aberrant MCA/UA PI Doppler ratio is highly connected with a worse prognosis for the foetus because the MCA/UA ratio contains information on both placental health and foetal responsiveness. At any gestational age, in healthy pregnancies, the cerebral arteries' diastolic component is lower than that of the umbilical arteries. As a result, the MCA/UA PI is more than 1 and the cerebrovascular resistance continues to be higher than the placental resistance. If the flow distribution favours the brain during abnormal pregnancies, the index drops below 1. Our study's CPR had a high specificity and positive predictive value (85% and 86.8%), which is comparable to the findings of Gramellini et al. and Lakhar et al., who found that this parameter was 100% specific [5,10].

A study found that changes in the ductus venosus correlate better with foetal acidosis and are linked with seriously damaged foetuses, requiring urgent care, even though none of the cases in our analysis reached that point [26,27].

Conclusion

Doppler patterns exhibit a longitudinal pattern, with the middle cerebral artery and other peripheral arteries exhibiting early alterations after the umbilical artery. Doppler has shown to be more sensitive in identifying fetal compromises early and assists in the proper time of delivery when compared to other methods of fetal monitoring. Although ratios like MCA PI/UA PI and UA SD (>2) were comparably specific predictors for a bad perinatal outcome, MCA PI was the most sensitive and specific indicator for the level of fetal impairment in our investigation. Hence, if UA PI is aberrant, MCA PI should be done to determine the degree of brain sparing, underscoring the need of looking at two arteries in Doppler. Because of its non-invasive nature and potential for in-home monitoring, non-stress testing can be used to supplement Doppler results in a compromised fetus, but it should not be relied upon as the only indicator of perinatal outcome.

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