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INVESTIGATING THE APPLICATION OF COLOR DOPPLER TO EVALUATE INTRAUTERINE FETAL DEVELOPMENT AND LIMITATIONS

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ABSTRACT

Background: Previous research indicated that in people with IUGR (intrauterine growth retardation), color Doppler is a more sensitive indication for predicting neonatal mortality. However, there is a dearth of information in the literature currently available on measuring the possible importance of color Doppler, either by itself or in combination with other Doppler indices, as a predictor of adverse perinatal outcomes.

Aim: The purpose of this study was to evaluate the application of color Doppler in determining intrauterine growth limitations with potential therapeutic applications.

Methods: This study evaluated 100 pregnant women who were recommended for obstetrics color Doppler ultrasound after it was determined that their fetus had intrauterine growth limitation based on greyscale ultrasound results.

Results: Uterine RI was high in 70% (n=70) of mother subjects and normal in 30% (n=30) of participants. In 62% (n=62) of the uterine arteries, a persistent early diagnostic notch was observed. Seventy-four percent (n=74) of the females had abnormal uterine artery flow velocity profiles in IUGR. Females had an increased umbilical artery PI in 62% (n=62). In 18% (n=18) and 6% (n=6) of the individuals, respectively, end-diastolic umbilical artery absence and reversal were seen. 82% (n=82) of the females had abnormalities in either the uterine or umbilical arteries.

Conclusions: Because Doppler imaging can provide indirect indicators of fetal damage and shows improved outcomes in high-risk pregnancies with IUGR, the current study suggests that it is a helpful monitoring tool throughout pregnancy. Therefore, all other monitoring modalities benefit from doppler evaluation.

Keywords: fetal growth, IUGR, intrauterine growth restriction, and therapeutic implications

INTRODUCTION

Intrauterine growth restriction (IUGR), which denotes a fetus with limited growth and weighing less than the tenth percentile for gestational age, is the term used to describe the abnormal fetus condition with aberrant development or size. The incidence of IUGR is 3-5% in a population of girls who are generally healthy and well-fed. However, moms who previously had inadequate development or hypertension had a rise in frequency of 15-20% or more. Within the same region, the incidence of IUGR varies by geography and subpopulation. According to recent research conducted by UNICEF, 25–30% of people in India have IUGR.One

Drug or alcohol abuse, poor nutrition, renal disease, collagen vascular disorders, and maternal hypertension that results in placental insufficiency are some of the causes of IUGR. IUGR can be brought on by fetal illnesses such as toxoplasmosis, CMV (cytomegalovirus), trisomy of the 13 and 18 chromosomes, and triploidy of the 13 and 18 chromosomes. Growth delay raises the risk of morbidity and perinatal mortality by eight to ten times when compared to newborns of the appropriate size.

IUGR fetal consequences include meconium aspiration syndrome, hypoxic-ischemic encephalopathy, hypothermia, hypocalcemia, hypoglycemia, neonatal hypoxia, intrapartum fetal acidosis, and stillbirth.2.

Assessment of uteroplacental blood flow, fetal blood circulation, and fetoplacental blood flow became possible with the advent of Doppler ultrasonography. Placental resistance may be determined by examining the uteroplacental and fetal circulations, and the non-invasive technique of Doppler ultrasonography can be used to examine the fetal response to hypoxia. Therefore, it is possible to identify tiny babies that are at a high risk of dying and developing perinatal illnesses as a result of weakened fetoplacental and uteroplacental circulations. The majority of systemic studies evaluated umbilical arterial (Umb A) Doppler velocimetry and fetal welfare. According to Doppler ultrasound evaluation of human fetal circulation, a fetus with IUGR has a much lower MCA (middle cerebral arterial) pulsatility index than a fetus in a typical pregnancy.

Hypoxemia in IUGR foetuses at cordocentesis has been found to be significantly correlated with abnormal MCA pulsatality index.3.

In order to regulate the flow of oxygenated blood from the placenta, the human fetal DV (ductus venosus) is essential. DV typically carries 20–30% of the placenta's well-oxygenated blood to the left side of the heart. The remaining 70–80% travels mostly through the liver to the right heart before returning to the placenta by the ductus arteriosus and descending aorta.

70% of the blood from the umbilical vein is transferred via DV in the challenged fetus in order to maintain a high oxygen supply to critical organs such the brain, heart, and adrenal glands while reducing liver perfusion by 30%. When the fetus is less than 30 weeks gestation, this oxygenated blood redirection and decreased supply to non-vital organs including kidneys, stomach, and muscles allow the fetus to have a longer life. The myocardial stiffens and central venous pressure rises when the oxygen supply to it is reduced. Real fact that reduction in DV flow is recorded before that of uterine and umbilical artery flow suggests that it may be a more accurate predictor of neonatal mortality in IUGR participants.

The importance of this measure in predicting adverse perinatal outcomes, either by itself or in conjunction with other Doppler indices, is, however, little quantified.5. In order to determine the best delivery time in complex pregnancies, the current study was conducted to evaluate the relationship between changes in the umbilical artery, ductus venosus flow pattern, fetal middle cerebral artery, and uterine artery as an isolated parameter and combined model in a fetus with IUGR.

MATERIALS AND METHODS

In order to determine the best delivery time in complex pregnancies, the current study was conducted to evaluate the relationship between changes in the umbilical artery, ductus venosus flow pattern, fetal middle cerebral artery, and uterine artery as an isolated parameter and combined model in a fetus with IUGR.

After receiving approval from the relevant institutional ethical committee, the study was conducted at Department of Radiology. Prior to participation, all individuals gave their written and verbal informed permission.

The research comprised 100 pregnant women who were referred for Obstetrics Doppler ultrasonography after it was determined that their fetus had intrauterine growth restriction based on greyscale ultrasound results. Women without pregnancy-related conditions or risk factors, pregnant women delivering or registering at the Institute, women with reliable pregnancy dating confirmed by early first-trimester ultrasound using BPD or CRL or with known LMP, and women with singleton pregnancy >28 weeks and diagnosed with a fetus with IUGR based on greyscale ultrasound findings were all eligible to participate in the study.

Exclusion criteria were antenatal females with clinical suspicion of IUGR and no greyscale ultrasound; fetuses with congenital anomalies; multiple pregnancies; active labor; gestational age <28 weeks; and subjects unwilling to participate. All of the individuals had ultrasound evaluation, which included a complete morphological assessment, fetal weight, and an assessment of the amniotic fluid index. During each examination, Doppler assessments were performed from the umbilical and uterine arteries. With an isolation angle near zero and on the side next to the transducer, the fetal middle cerebral artery PI was measured at its origin. A transverse or mid-sagittal piece of the fetal abdomen was used to measure the ductus venosus flow during atrial systole.

To better locate the pulsed wave, color Doppler imaging was used. Measurements were collected from the frozen image following at least three consecutive uniform flow velocity waveforms with a high signal-to-noise ratio.

Follow-up Doppler scans were performed as clinically necessary to determine if Doppler indices were improving or declining. However, only the most recent Doppler ultrasound performed within the 72 hours following delivery is used to examine

perinatal outcomes. Pregnancy outcomes were deemed favorable or uneventful when none of the following occurred: NICU admission for low-birth-weight difficulties, 5-minute APGAR scores or less than 7, emergency cesarean section for fetal distress, and perinatal mortality.

The existence of a diastolic notch and a uterine artery RI more than 0.58 were considered abnormal. It was considered abnormal if the Umb A Pulsality index ratio was more than the 95th percentile for gestational age. When the middle cerebral artery pulsatility index (MCA6) dropped below the fifth percentile of gestational age, it was deemed abnormal, according to Gramellini et al. MCA The PI/Umb ratio was evaluated. Velometry was deemed normal above and pathological below a single cut-off value of 1.08 for the MCA/UMb A PI ratio (cerebral-umbilical ratio) in our assessment, which was based on reference values of Grmaellini D et al.

SPSS (Statistical Package for the Social Sciences) software version 21.0 (IBM Corp., Armonk, NY, USA) was used to statistically analyze the collected data. This included chi-square, independent t-test, Mann Whitney U, and descriptive measure evaluation. The findings were presented as frequency, percentages, mean, and standard deviation. Statistical significance was defined as a p-value of less than 0.05.

RESULTS

In order to determine the best delivery time in complex pregnancies, the current clinical prospective study was conducted to evaluate the relationship between changes in the umbilical artery, ductus venosus flow pattern, fetal middle cerebral artery, and uterine artery as an isolated parameter and combined model in a fetus with IUGR.

The research comprised 100 pregnant women who were referred for Obstetrics Doppler ultrasonography after it was determined that their fetus had intrauterine growth restriction based on greyscale ultrasound results. The most frequent cause of IUGR in the current investigation was determined to be pregnancy-induced hypertension, which was reported in 50% (n=50) of the individuals. According to reports from 24% (n=24) of study participants, IUGR was the only indication for the Doppler investigation. Twenty percent (n=20) of the trial participants had IUGR with anaemia that complicated pregnancy. Ten percent (n=10) of the research participants reported having a poor obstetrics history.

As indicated in Table 1, 60% of the study participants were between the ages of 31 and 35. This was followed by 30% (n=30) of the participants who were between the ages of 36 and 40 weeks and 10% (n=10) of the participants who were between the ages of 26 and 30 weeks.

The uterine artery resistance index (RI) was normal in 30% (n=30) and high in 70% (n=70) of the study participants when the diastolic notch, flow velocity profile, and RI alterations were evaluated. Of the 62 research participants, 62% had a diastolic notch. Of the research participants, 26% (n = 26) had a normal flow velocity profile, whereas 74% (n = 74) had an aberrant one (Table 2).

End-diastolic flow in the umbilical artery was reversed, nonexistent, and positive in 6% (n=6), 18% (n=18), and 76% (n=76) of the research participants, respectively, according to the Color Doppler results for the umbilical artery. In 38% (n=38) and 62% (n=62) of the study participants, respectively, umbilical artery PI was normal and high (Table 3). According to the Doppler examination of the uterine and umbilical arteries, 58% (n=58) of the study participants had only umbilical artery change, 74% (n=74) had only uterine artery change, and 82% (n=82) had both uterine and umbilical artery change (Table 4). The study participants' prenatal outcomes were also evaluated, and Table 5 shows that 38% (n=38) of the study participants had uneventful perinatal outcomes, whereas 62% (n=62) had poor outcomes.

Sensitivity, specificity, PPV (positive predictive value), NPV (negative predictive value), and diagnostic accuracy were 88% 78% 88%, 78%, and 86% for MCA/UMbPI, 60%, 84%, 86%, 54%, and 70% for MCA PI, 84%, 80%, 88%, 74%, and 84% for Umb PI, 86%, 54%, 78%, 66%, and 76% for UA RI, and 84%, 70%, 84%, 70%, and 80% for UA diastolic notch, respectively, when perinatal outcomes were compared to the study subjects' Color Doppler indices.

DISCUSSION

The current study comprised 100 pregnant women who were referred for Obstetrics Doppler ultrasonography after it was determined that their fetus had intrauterine growth limitation based on greyscale ultrasound results. The most frequent cause of IUGR in the current investigation was determined to be pregnancy-induced hypertension, which was reported in 50% (n=50) of the individuals.

According to reports from 24% (n=24) of study participants, IUGR was the only indication for the Doppler investigation. Twenty percent (n=20) of the trial participants had IUGR with anemia that complicated pregnancy. Ten percent (n=10) of the

research participants reported having a poor obstetrics history. 60% (n=60) of the study participants were between the ages of 31 and 35. This was followed by 30% (n=30) of the participants who were between the ages of 36 and 40 weeks and 10% (n=10) of the participants who were between the ages of 26 and 30 weeks. These findings were equivalent to those of studies conducted by Coomarasamy A et al. in 2001 and Papageorghiou AT et al. in 2002, in which the authors evaluated participants using demographic information similar to that of the current investigation.

Regarding the alterations in the study participants' diastolic notch, flow velocity profile, and uterine artery resistance index (RI), the RI was raised in 70% (n=70) of the individuals and normal in 30% (n=30). Of the 62 research participants, 62% had a diastolic notch. Of the research participants, 26% (n = 26) had a normal flow velocity profile, whereas 74% (n = 74) had an aberrant one. These findings were in line with those of investigations by Baschat AA et al. (2001) and Chien PF et al. (2000), in which the authors reported Doppler findings comparable to those of the current research.

End-diastolic flow in the umbilical artery was reversed, nonexistent, and positive in 6% (n=6), 18% (n=18), and 76% (n=76) of the research participants, respectively, according to the Color Doppler assessment of umbilical artery findings. Of the study participants, 38% (n=38) had normal umbilical artery PI, whereas 62% (n=62) had high PI. Regarding the evaluation of the uterine and umbilical arteries on Doppler examination, 58% (n=58) of the study participants had only umbilical artery change, 74% (n=74) had only uterine artery change, and 82% (n=82) had both uterine and umbilical artery change.

These results were consistent with those of Xu R et al. (2020) and Martin AM et al. (2001), whose research' findings on Color Doppler showed similar end diastolic flow and umbilical artery PI to those of the current study.

Prenatal outcomes were evaluated in the current study as well, and it was found that 38% (n=38) of the study patients experienced uneventful prenatal events, whereas 62% (n=62) experienced poor perinatal outcomes. These findings were consistent with earlier research by Vogel JP et al. (2013) and Napolitano R et al. (2012), where the authors found perinatal outcomes comparable to those of the current study.

According to the study's findings, 88% of the study subjects' prenatal outcomes had sensitivity, specificity, PPV (positive predictive value), NPV (negative predictive value), and diagnostic accuracy when compared to the Color Doppler indices. 78% The corresponding values for MCA/UmbPI were 88%, 78%, and 86%; MCA PI was 60%, 84%, 86%, 54%, and 70%; Umb PI was 84%, 80%, 88%, 74%, and 84%; UA RI was 86%, 54%, 78%, 66%, and 76%; and UA diastolic notch was 84%, 70%, 84%, 70%, and 80%.

These results aligned with the findings of Park YW et al.'s 2005 study and Mari G et al.'s 2007 study, where the authors reported that the current study's Color Doppler sensitivity, specificity, PPV (positive predictive value), NPV (negative predictive value), and diagnostic accuracy were comparable to those of their studies.

CONCLUSIONS

The present study, considering its limitations, concludes that Doppler imaging is a useful monitoring tool in pregnancy as it can offer indirect indications of fetal impairment and depicts enhanced outcomes in high-risk pregnancies with IUGR. Hence, doppler assessment helps all other monitoring modalities. Future studies are needed with subjects from different geographical backgrounds for definitive conclusions.

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Gestational age (weeks)	**Number (n)**	**Percentage (%)**
26-30	10	10
31-35	60	60
36-40	30	30
Total	100	100

Table 1: Gestational age distribution in the study subjects at the Doppler examination

Parameters	**Number (n)**	**Percentage (%)**
RI		
Normal	30	30
Elevated	70	70
Diastolic notch		
Present	62	62
Absent	38	38
Flow velocity profile		
Abnormal	74	74
Normal	26	26

Table 2: Changes in the uterine artery resistance index (RI), diastolic notch, and flow velocity profile in the study subjects

Parameters	**Number (n)**	**Percentage (%)**
End diastolic flow in umbilical artery		
Reversal	6	6
Absent	18	18
Positive	76	76
Umbilical artery PI		

Normal	38	38
Elevated	62	62

Table 3: Umbilical artery findings on the Color Doppler

Parameters	Number (n)	Percentage (%)
Only umbilical artery change	58	58
Only uterine artery change	74	74
Both uterine and umbilical artery change	82	82

Table 4: Assessment of uterine and umbilical artery on Doppler examination

Parameters	Number (n)	Percentage (%)
Uneventful	38	38
Adverse	62	62

Table 5: Assessment of the perinatal outcomes in study subjects

Doppler index	Sensitivity	Specificity	PPV	NPV	Diagnostic accuracy
MCA/ Umb PI	88	78	88	78	86
MCA PI	60	84	86	54	70
Umb PI	84	80	88	74	84
UA RI	86	54	78	66	76
UA diastolic notch	84	70	84	70	80

Table 6: Comparison of perinatal outcomes to the indices of Color Doppler in study subjects