ORIGINAL ARTICLE

Diagnostic Accuracy of Umbilical Artery and Middle Cereberal Artery Doppler in Detection of Intrauterine Growth Restriction

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ABSTRACT

Objective: To determine the diagnostic accuracy of umbilical artery and middle cerebral artery Doppler in detection of intrauterine growth restriction among pregnant women.

Study Design: Descriptive cross-sectional study.

Place and Duration of Study: The Department of Gynecology and Obstetrics, Fauji Foundation Hospital, Rawalpindi, over a period of six months from May 2019 to October 2019.

Materials and Methods: Study participants were 159 pregnant women presented to antenatal clinics. The inclusion criteria were gestational age more than 30 weeks with singleton pregnancies, sure last menstrual period, period of gestation confirmed by dating ultrasonography, small for dates or clinical suspicious of intrauterine growth restriction, and women who provided informed consent. Doppler scan was performed in all those women.

Results: Mean age of all the enrolled women was 26.8 (± 6.6) years. Out of 159 women, 32 (20 percent) were nulliparous. On Doppler scan, 29 (18.2 percent) women had intrauterine growth restriction. The mean gestational age at the time of delivery was 35.3 (± 0.95) weeks. Caesarean section was performed in 131 (82.5 percent) of the deliveries. At birth, 24 (15.1 percent) had intrauterine growth restriction. The sensitivity, specificity, positive and negative predictive values of Doppler scan to detect intrauterine growth restriction were 83.3 percent, 93.3 percent, 69.0 percent, and 96.9 percent respectively. The diagnostic accuracy of Doppler scan was 91.8 percent.

Conclusion: Our study shows a high sensitivity and specificity of Doppler scan in detecting intrauterine growth restriction.

Key Words: *Intrauterine Growth Restriction, Middle Cerebral Artery, PulsatilityIndex, Pregnant Women, Resistive Index, Umbilical Artery.*

Introduction

Intrauterine growth restriction (IUGR) is a condition in which a fetus is unable to attain its genetically predetermined growth potential.[1] Fetuses with intrauterine growth restriction are at higher risk of perinatal mortality, neurological abnormalities, and poor performance at school.[2] It is also one of the major problems in developing countries like Pakistan with incidence of 25%, more than World Health Organization criteria for taking public health action.[3] IUGR may be caused by maternal, fetal, placental, and external factors.[4]

Early detection of compromised IUGR fetuses and timely intervention is among the major objectives of current prenatal care services.[5] Abnormal findings of fetal size, weight and symmetry ultrasound leads to suspicion of IUGR. Various methods used to determine IUGR comprise of abdominal palpation to measure symphysis-fundal height, fetal ultrasound biometry and ultrasound Doppler flow velocimetry.[6] However, symphysis-fundal height measurements have inadequate accuracy to diagnose an IUGR fetus. However, abdominal circumference and estimated fetal weight are the more accurate sonographic diagnostic measurements to predict IUGR.[7] Nevertheless, recent research has shown that ultrasound Doppler flow velocimetry is the best tool to detect IUGR.[8]

However, variations in sensitivity and specificity of Doppler ultrasonography in detecting IUGR have

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Funding Source: NIL; Conflict of Interest: NIL
Received: January 12, 2021; Revised: September 17, 2021
Accepted: September 21, 2021

been reported worldwide.[9] Therefore, use of Doppler ultrasonography as a predictive test to detect IUGR in our clinical settings is questionable. Hence, the aim of the present study was to determine the diagnostic value of Doppler in detecting the IUGR among the pregnant women in our clinical settings. This study would help to determine the diagnostic value of Doppler ultrasonography in detecting intrauterine growth restriction in our setup for better management of IUGR fetuses. Early diagnosis and timely management will help in reduction of perinatal mortality in these fetuses.

Materials and Methods

A Descriptive cross-sectional study was conducted in Obstetrics and Gynecology Department, Fauji Foundation Hospital, Rawalpindi, over a period of six months from May 2019 to October 2019. A total of 159 pregnant women were selected using nonprobability purposive sampling technique. Women having gestational age more than 30 weeks, visiting antenatal clinics were included in the study. The sample size was estimated by using the World Health Organization (WHO) sample size calculations. The confidence interval level was considered at 95 percent and absolute precision was taken as 10 percent. By choosing the sensitivity of 89 percent[9], specificity of 92 percent[9] and prevalence of 24 percent[10], the required sample size was 159 pregnant women who underwent Doppler scan to detect IUGR. Women having singleton pregnancies beyond 30 weeks of gestation, sure about last menstrual period (LMP) and dates confirmed by ultrasonography in second trimester (before 22 weeks of gestation) and Small for date or clinical suspicious of IUGR (more than 2 weeks difference between gestational age and ultrasound parameters) were included in the study. Women having multiple pregnancies, presence of fetal congenital anomalies, unsure about last menstrual period or no dating scan available were excluded. Data was collecting on a predesigned proforma after taking informed verbal consent from the study participants.

A brief demographic and clinical history including age, parity, socio-economic status and about the previous obstetric details, and duration of gestation were asked to every enrolled woman. Doppler scan was performed in all women who were diagnosed to have IUGR based on ultrasonography findings. An umbilical artery Doppler abnormality was defined when the resistive index (RI) was above the 95th centile for gestational age or the presence of an absent end-diastolic flow (AEDF) or reversed end-diastolic flow (REDF). Middle section of the MCA and free loop of umbilical artery were chosen for measurement during periods of fetal apnea. The values of pulsatility indexes (PI) of the MCA and umbilical artery Doppler were calculated. The measurements were taken on weekly basis when doppler values were not normal or fortnightly with growth scan. The measurement before delivery was taken for the analysis. At a minimum, three measurements were obtained, and the mean values were used. All the enrolled women whether with normal or abnormal Doppler findings were followed till the time of delivery to observe the neonatal outcomes for the diagnosis of IUGR based on birth weight (below the 10th percentile for its gestational age and a term neonate with birth weight less than 2,500 grams). All this information was collected on pre-designed proforma.

Data was analyzed using Statistical tests for Social Sciences (SPSS) version 21. Means and standard deviations were calculated for continuous variables while proportions and frequencies were calculated for categorical variables. Results were presented in the form of tables. To examine the accuracy of Doppler scan in detection of IUGR, we calculated the values of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy (DA) by using the following 2x2 table (Table-I).[11]

Table I: Calculation of Diagnostic Accuracy of Doppler Scan in Detecting IUGR

	Neonatal Birth Weight	
	IUGR	Normal
IUGR	A	B
Normal	C	D

- Sensitivity = a/ a+c X 100
- Specificity = d/ b+d X 100
- Positive predictive value = a/ a+b X 100
- Negative predictive value = d/ c+d X 100

Results

This study was conducted on 159 participants. Mean (SD) age of all the enrolled women in our study was

26.8 (SD = ± 6.6) years.

Table II: Age Distribution of Enrolled Women (n=159)

Variables	Mean	Range	Standard Deviation (SD)
Age in years	26.8	16-38	± 6.6

Out of 159 women, 32 (20 %) were nulliparous and 127 (80%) were parous (Table-III). The mean (SD) gestational age at the time of delivery was 35.3 (± 0.95) weeks, 18 (11.3 %) women were delivered by normal vaginal whereas a great majority, 131 (82.5 %) women were delivered by C-section. In 10 (6.2 %) women, forceps were applied during the delivery time. Values of normal, absent, and reverse diastolic flow in middle cerebral artery are given in Table III.

Table III: Descriptive Statistics (n=159)

Parity	Nulliparous	32	20%
	Parous	127	80%
Gravidity	Primigravida	24	15%
	Multigravida	135	85%
Diastolic flow in middle cerebral artery of enrolled women	Normal	99	63.2%
	Absent	22	13.8%
	Reverse	38	23.9%

Doppler findings (Umbilical artery and MCA) of all the enrolled women (n=159) are given in Table IV.

Table IV: Doppler Findings (Umbilical Artery and MCA) of all the enrolled women (n=159)

Values	Doppler findings					
	UA			MCA		
	RI	PI	S/D	RI	PI	S/D
Mean	0.66	1.05	3.48	0.77	1.40	3.61
Standard deviation	0.12	0.28	1.87	0.04	0.20	0.50
Median	0.63	0.95	2.58	0.79	1.58	3.44
Minimum	0.54	0.74	2.18	0.71	1.17	3.09
Maximum	0.86	1.51	6.94	0.81	1.67	4.05

Note: UA, Umbilical Artery; MCA, Middle Cerebral Artery, RI, Resistance Index; PI, Pulsatility Index; S/D, Systolic to Diastolic Ratio.

On Doppler ultrasound, IUGR was present in 29 (18.2 %) pregnant women whereas in 130 (81.8 %) pregnant women IUGR was not detected (Table-V). At birth, 24 (15.1 %) babies were low birth weight whereas in 135 (84.1 %) babies had normal birth weight (no IUGR). So, 20 (12.5%) women had IUGR on Doppler ultrasound and had low birth weight on delivery. The sensitivity, specificity, positive and negative predictive values of Doppler scan to detect intrauterine growth restriction were 83.3 percent, 93.3 %, 69.0 % and 96.9 % respectively. The diagnostic accuracy of Doppler scan was 91.8 % (Table-V).

Table-V: Diagnostic value of Doppler scan to detect IUGR among all the enrolled women (n=159

		Neonatal birth weight		
		Low birth weight	Normal	Total
Doppler scan Findings	**IUGR**	20	9	**29**
	Normal	4	126	**130**
	Total	24	135	**159**
Sensitivity		83.3%		
Specificity		93.3%		
Positive predictive value		69.0%		
Negative predictive value		96.9%		
Diagnostic accuracy		91.8%		

Discussion

Every fetus has a specific growth potential that is inherited from parents. Intrauterine growth restriction (IUGR) may be due to abnormal genetic makeup of the fetus or placental development, maternal medical disorders and environmental factors like toxins and viral infections[12].

IUGR is linked with substantial perinatal morbidity and mortality. Its long-term complications in childhood include cerebral palsy due to permanent brain damage, while in adult life it is found to be associated with noninsulin-dependent diabetes mellitus and hypertension.

Diagnosis of intrauterine growth restriction becomes problematic sometimes[13]. Most SGA fetuses are normal, but much unnecessary intervention can be done if they are mistaken as cases of IUGR. On the other hand, growth retarded fetuses may not be SGA[14]. Doppler velocity measurement has been widely used in antenatal diagnosis of IUGR for more than twenty years. Fetal wellbeing is predicted through blood flow in many vessels, particularly in the umbilical artery.[15]

In our study, 159 pregnant women with mean age of 26.8 years were enrolled. Out of 159 pregnant women, IUGR was detected in 29 (18.2 %) pregnant

women on Doppler scan, while based on birth weight 24 (15.1 %) babies were declared as IUGR. The results are like another study where color Doppler Ultrasonography showed the IUGR in 73 (56.59%) patients and birth confirmed IUGR in 71 (55.04%) cases where as 58 (44.96%) patients revealed no IUGR[16]. In our study, the sensitivity, specificity, positive and negative predictive values of Doppler scan to diagnose IUGR were 83.3 percent, 93.3 percent, 69.0 percent, and 96.9 percent respectively. The diagnostic accuracy of Doppler scan was 91.8 percent. In another study, Umbilical artery Doppler ultrasound had sensitivity 85.3%, specificity 72.5%, positive predictive value 84.1%, negative predictive value 74.4% and diagnostic accuracy of 80.1%. Our study showed a substantially high sensitivity and specificity of Doppler scan in detection of IUGR in our clinical settings and our findings are comparable with other similar studies around the world.

Similar to our study, a recent study has been carried out in our neighboring country, India, where the diagnostic accuracy of UA and MCA Doppler scan was used in detecting IUGR in their study population. The investigators enrolled 90 pregnant women between gestational ages of 30 weeks and above having fetuses with intrauterine growth restriction, similar to our study population. The diagnostic accuracy of Doppler scan in detecting IUGR in their study population was lower than what we have found in our study.[17] Quite similar to our findings, in United Kingdom, a study enrolled 52 women for Doppler studies of IUGR fetuses, the authors reported a sensitivity and specificity of 96 percent and 84 percent respectively.[18]

There are several reasons that our study found a higher sensitivity and specificity than what they found. However, the most common reason is that in our study we conducted Doppler scan after 30 weeks of gestation while many studies reported have conducted Doppler in first or second trimester of pregnancy.

In a recent study, Doppler studies have been used to detect early onset IUGR in first two trimesters, with detection rates of about 50 percent with false positive rate of 7 percent. However, its use as an isolated screening tool had low sensitivity and positive predictive value if used alone as a screening tool to detect IUGR in first and second trimesters.[19]

In fetuses with IUGR, blood flow is redistributed from periphery towards the brain. Umbilical artery (UA) Middle cerebral artery (MCA) is the most studied fetal arteries for Doppler studies due to its easy accessibility.[20]

Conclusion

Findings of our study suggest high sensitivity and specificity of Doppler scan in detecting IUGR in our study population. However, there is a need to conduct large scale, multicenter randomized controlled trials to determine the diagnostic accuracy of fetal Doppler ultrasonographies in detecting IUGR in our local population.

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