Original Article

Comparison of Middle Cerebral Artery and Uterine Artery Doppler in Evaluation of Intra Uterine Growth Restriction Pregnancy

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Abstract

Objective: To determine the diagnostic accuracy of middle cerebral artery and uterine artery Doppler in diagnosis of intra uterine growth restriction, taking delivery outcome as the gold standard.

Methodology: This cross sectional study was conducted in the department of Obstetrics and Gynecology, Holy Family, Hospital, Rawalpindi, from 1st May 2019 to 31st October 2019. A total of 192 women with clinical diagnosed intrauterine growth restriction were included in the study. Doppler velocimetry was performed on the uterine artery and the middle cerebral artery close to the transducer. The diagnosis of IUGR by Middle cerebral artery and uterine artery was made as. After delivery, the birth weight (immediately within 6 h) was measured.

Results: Middle cerebral artery doppler test has shown sensitivity of 61.3%, specificity 93%, diagnostic accuracy by 76%, PPV 91.5% and NPV 66.1% (p=0.000) for diagnosis of Intra uterine growth restriction. Uterine artery doppler test has shown sensitivity of 28.3%, specificity 90.7%, diagnostic accuracy by 56%, PPV 78.9% and NPV 50.6% (p=0.001) for diagnosis of Intra uterine growth restriction.

Conclusion: The high variability in diagnostic efficacy of different markers is not suitable for prediction of IUGR.

Keywords: Intra uterine growth restriction, Middle cerebral artery, Uterine artery doppler, Diagnostic accuracy.

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Introduction

When fetus fails to reach the maximum genetically determine growth is referred to fetal growth restriction (FRG). Pregnancies accounts with FRG are 5-10%. FGR is associated with certain fetal and maternal risks like intrauterine fetal death, intrapartum fetal morbidity, and operative deliveries. In case of preterm FGR, iatrogenic preterm delivery is a risk. Certain neonatal risks are also related with FGR including respiratory difficulties, polycythemia, hypoglycemia, intraventricular hemorrhage, and hypothermia. In the long-term, cerebral palsy, developmental delay, behavioral dysfunction, adult metabolic syndrome can occur in FGR babies. Small for gestational age (SGA) babies must be differentiated from FGR fetuses, as SGA babies are not at any risk like FGR babies.

Doppler use to assess the blood flow through placenta to baby, it's a non-invasive test. Doppler can detect worsening of situation including reduced or absent blood flow to baby, there by decision to intervene can be taken if Doppler studies shows abnormal result. Abnormal Doppler studies leads to poor baby outcomes.[1] Increased fetal risks in growth restricted babies as compare to SGA babies.[2,3] Doppler studies provide information about intra-uterine environment.

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Vessels used in Doppler studies to assess baby growth and blood flow to baby are uterine artery (Ut. A), umbilical artery (UA), middle cerebral artery (MCA) and ductus venosus (DV). Umbilical and middle cerebral artery pulsatility index (PI) is found to be better predictor of baby outcome. Ductus venosus impairment indicates fetal demise in utero. Sequence of abnormal flow is noted in UA, MCA, and then DV. UA and MCA are considered to be better for monitoring fetal growth and to predict neonatal outcome in 88% of cases.[4] Cerebro-placental ratio is found to be a better predictor as compare to MCA PI or UA PI alone.[5]

In a study by Khanduri S and his colleagues has found that sensitivity of the (Umblical artery Pulsatility index >1.42) was 73.8 %, specificity 75.9%, PPV 87.7 %, and negative predictive value 55.4%. In diagnosing IUGR the diagnostic accuracy of test was 75%.

MCA showed sensitivity of 35.7 %, specificity of 92.6 %, positive predictive value of 91.8 %, and negative predictive value of 38.2 %.[6] In a study by Cnossen JS, et al. has found that sensitivity of the uterine artery doppler in evaluation of intra uterine growth restriction was 18 % and specificity was 95 %.[7]

IUGR can be diagnosed with use of ultrasound and clinical assessment at very late stage 8 whereas with use of Doppler studies IUGR can be detected at much earlier stage, so that effective intervention can be done inform of early delivery of affected fetus. The color Doppler tells about vascular resistance indirectly give information regarding blood flow to fetus

No such study has been done before in our population. Therefore I have planned to determine the diagnostic accuracy of Middle cerebral artery and uterine artery doppler in diagnosis of intra uterine growth restriction in our population. My study will pave the way for further research in this topic and help us in detection of IUGR early in our population.

Methodology

It was a cross sectional study conducted at Obstetrics and Gynaecology unit one, Holy Family, Hospital, Rawalpindi, from 1st May 2019 to 31st October 2019. After taking permission from ethical committee and research, base line demographic information of patients (age, parity, gestational age, weight) was taken. Informed consent was taken, ensuring confidentiality.

Total 177 cases were included in the study by following WHO sample size calculator details; Sensitivity = 73.8%[6], Specificity = 75.9%[6], Prevalence = 25%[9], Confidence interval = 95%, Precision for sensitivity 13%, for specificity = 10%. Non-Probability Consecutive Sampling for the purpose of data collection. Clinical diagnosis of Intrauterine Growth Restriction was defined as when fetal weight will below the 10th percentile for gestational age through an ultrasound. Diagnosis of intra uterine growth restriction by Middle cerebral artery was defined as when Middle cerebral artery Pulsatility index <1.5 on doppler ultrasound. Diagnosis of intra uterine growth restriction by uterine artery was defined as when Uterine artery Pulsatility index >1.42 on doppler ultrasound. Diagnosis of intra uterine growth restriction on delivery was defined as when baby Ponderal Index of <2 calculated after delivery. PI= (Body weight in grams) X100 / Length (cm)3, Baby Body weight will be measured by weighing machine and length by measuring tape. Women of age 18-35 years, singleton pregnancy on ultrasound, gestational age > 28 weeks on LMP, women parity 0-4 and clinical diagnosed intrauterine growth restriction were our inclusion criteria whereas fetal growth restriction due to chromosomal anomalies, congenital anomalies on medical record and those patients who refused the informed consent were considered as exclusion criteria. All the patients were subjected to Doppler waveform analysis on a Color Doppler machine using 3.5 MHz probe by two radiologists. To use Doppler velocimetry, patients were first scanned in the routine fashion using B-mode. Then, the vessels of interest were confirmed by color Doppler. The Doppler signal was then obtained by placing the Doppler gate directly over the vessel of interest. Doppler velocimetry of the uterine artery was performed in a free-floating loop of the mid-portion of the umbilical cord away from the placental and fetal cord insertion. The Middle cerebral artery was visualized in a plane immediately caudal to the trans-thalamic plane. After delivery, the birth weight (immediately within 6 h) was measured on an electronic weighing machine and length by measuring tape. IUGR was confirmed by baby Ponderal Index of <2 calculated after delivery as per operational definition. All the data was recorded on the designed proforma.

Data was analyzed through IBM-SPSS version 22. Mean ± standard deviation was calculated for all quantitative variables like age, gestational age and weight of mother. For qualitative variables like age groups and parity frequency (%) was calculated. Sensitivity, specificity, Positive predictive value, Negative predictive value and diagnostic accuracy for Middle cerebral artery/uterine

artery doppler test against delivery outcome was calculated by using following formulas;
Sensitivity=(a/a+c)x100,

Specificity=(d/b+d)x100,

Positive Predictive Value =(a/a+b)x100,

Negative Predictive Value = (b/c+d)x100.

p ≤0.05 was considered statistically significant.

Results

Age range in this study was from 18 to 35 years with mean age of 28.755±2.04 years, mean gestational age 32.958±2.01 weeks and mean weight was 63.843±7.42 kg. Middle cerebral artery doppler test diagnosed 37%, uterine artery doppler test 19.8% and delivery outcome diagnosed 55.2% patients with Intra uterine growth restriction as shown in Table I.

Table I: Overall results of Middle cerebral artery doppler test, uterine artery doppler test and delivery outcome for diagnosis of intra uterine growth restriction

Intra uterine growth restriction	Middle cerebral artery doppler test	Uterine artery doppler test	Delivery outcome (Gold Standard)
Positive	71 (37 %)	38 (19.8%)	106 (55.2%)
Negative	121 (63%)	154 (80.2%)	86 (44.8%)
Total	192 (100%)	192 (100%)	192 (100%)

Middle cerebral artery doppler test has shown sensitivity of 61.3%, specificity 93%, diagnostic accuracy by 76%, PPV 91.5% and NPV 66.1% (p=0.000) for diagnosis of Intra uterine growth restriction are shown in Table-2 and 3 respectively. Uterine artery doppler test has shown sensitivity of 28.3%, specificity 90.7%, diagnostic accuracy by 56%, PPV 78.9% and NPV 50.6% (p=0.001) for diagnosis of Intra uterine growth restriction are shown in Table II , III and IV respectively.

Table II: Comparison of Middle cerebral artery doppler test versus delivery outcome for diagnosis of intra uterine growth restriction

Middle cerebral artery doppler test	Delivery outcome (Gold Standard)		Total	p-value
	Yes	No		
Yes	65 (TP)	6 (FP)	71	
No	41 (FN)	80 (TN)	121	
Total	106	86	192	0.000

Discussion

The term intrauterine growth retardation is used mostly used instead of intrauterine growth restriction. Ultrasonographic examination of fetus is used for evaluating IUGR babies. A study conducted by Rhee et al concluded that Doppler can be used for determining intra-uterine fetal growth and IUGR fetuses[11] Another study conducted by Baschat et al found uterine and MCA abnormalities in Doppler studies are more associated with IUGR babies.[12]

Table III: Comparison of uterine artery doppler test versus delivery outcome for diagnosis of intra uterine growth restriction

uterine artery doppler test	Delivery outcome (Gold Standard)		Total	p-value
	Yes	No		
Yes	30 (TP)	8 (FP)	38	
No	76 (FN)	78 (TN)	154	0.001
Total	106	86	192	

Table IV: Sensitivity, Specificity, Diagnostic Accuracy, PPV, NPV of uterine artery doppler & Middle cerebral artery doppler test for diagnosis of intra uterine growth restriction

	Middle Cerebral Artery Doppler	Uterine Artery Doppler
Sensitivity	61.3%	28.3%
Specificity	93.0%	90.7%
Diagnostic accuracy	76.0%	56.0%
PPV	91.5%	78.9%
NPV	66.1%	50.6%

Similar results are shown in study conducted by Mari et al that suggests the middle cerebral artery is useful for evaluating IUGR fetuses.[13] In their study, Sohn et al suggested that abnormal results of fetus Doppler sonography is an effective tool for detection of IUGR fetuses.[14] This study found use of MCA and uterine artery dopller is effective to pick growth restricted babies facing fetal hypoxia. it's a safe and economical method.

In our study, the middle cerebral artery doppler test had a sensitivity of 61.3%, specificity of 93%, diagnostic accuracy of 76%, PPV 91.5%, and NPV 66.1% [p = 0.000] for the diagnosis of intra uterine growth restriction, whereas the uterine artery doppler test had a sensitivity of 28.3%, specificity of 90.7%, diagnostic accuracy of 56%, PPV 78.9%. Study conducted by Khanduri S and his colleagues has concluded MCA sensitivity of 35.5%, specificity of 92.6 %, positive predictive value of 91.8 %, and negative predictive value was 38.2%.[6]

Another study conducted by Cnossen JS, et al has shown that the sensitivity of the uterine artery doppler in evaluation of intra uterine growth restriction was 18 % and specificity was 95 %.[7]

Ferrazzi et al concluded IUGR neonates has lower PO2 and PH level as compare to normal growth babies.15 Another study conducted by Weiner and Robillard showed that PO2, PH and SPO2 is less in IUGR babies while PCO2 levels were much higher as compared to the control group.[16] Yoshiwura et al also suggested that Doppler studies are effective for timely diagnosis of IUGR.[17]

Conclusion

My study has concluded that middle cerebral artery doppler test has 61.3% sensitivity and specificity 93% and uterine artery doppler test show less sensitivity of 28.3% and specificity of 90.7% for diagnosis of Intra uterine growth restriction. The high variability in diagnostic efficacy of different markers is not suitable for prediction of IUGR.

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