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ORIGINAL ARTICLE

Diagnostic accuracy of middle cerebral artery Doppler findings in intrauterine growth restriction taking biophysical profile as gold standard.

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ABSTRACT… Objective: To find the diagnostic accuracy of middle cerebral Artery Doppler findings in Intrauterine Growth Restriction taking Biophysical Profile as Gold Standard. **Study Design:** Cross Sectional study. **Setting:** Department of Radiology, Allied Hospital Faisalabad. **Period:** 11 February 2021 to 30 April 2022. **Material & Methods:** A cross-sectional study of 161 pregnant women was conducted at the radiology department of allied hospital Faisalabad. The Inclusion Criteria were 114 pregnant women with abnormal biophysical profile and with a history of previous IUGR fetus pregnancy. All women's ultrasounds were performed on color Doppler. Data was analyzed by using IBM-SPSS version 25. **Results:** In our study age ranged from 18-42 years with mean age of 27.2547 ± 6.46363 years. The RI of MCA ranged from 0.30-0.90 % in the IUGR patients with the mean value 0.5330 ± 0.16134, and the RI of MCA ranged from 0.60-0.70 % in the normal was 0.6632 ± 0.4828. Similarly the PI of MCA ranged from 1.00-2.00 % in the IUGR patients with the mean value 1.9825 ± 0.13187, and the PI of MCA ranged from 2.00-2.00 % in the normal was 2.0000 ± 0.00000. The biophysical profile scoring of MCA_PI with range from 0.5-0.6 was 8 in two patients while with range from 0.6-7.98 was 6 in 32 patients, and was 8 in 127 patients. **Conclusion:** In conclusion, the diagnostic accuracy of Color Doppler of umbilical and cerebral pulsatility is very excessive in diagnosing IUGR.

Keyswords: Biophysical Profile, Doppler Ultrasound, IUGR.

INTRODUCTION

Intrauterine growth restriction (IUGR) or fetal growth restriction (FGR) defines an embryo that fails to have a genetic predisposition. Naturally, fetal growth restriction is defined in terms of average fetal weight, or birth weight, less than 10th centile for age and gender. Such embryos are often at greater risk of stillbirth or birth defects.[1] IUGR affects more than 10% of pregnancies globally and has a major impact on the short and long-term being of the baby. FGR is strongly related to baby birth, premature birth and for surviving newborns, it increased the risk of developing newborns. Fetal growth restriction is also contributing factor in the development of neurodevelopment sequelae in babies.[2]

IUGR is the most complicated research area for obstetricians today. It is considered a major contributor to illness and death during childbirth and has been described as a natural cause of about 50% of premature births and 20% of the time. Growth disability is associated with postpartum depression and metabolic acidosis, which in turn contributes to cerebral palsy and hypoxic encephalopathy. In addition, there is growing evidence of an association between infant mortality and IUGR and metabolic syndrome in adulthood.[3]

Fetal growth and its capability are pathologically inhibited due to the intrauterine growth restriction (IUGR). Fetal growth restriction and stillbirth have a strong affiliation among them. The hazard elements for IUGR and stillbirth largely overlap with their etiology. These situations are induced

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because of complicated pathology attributable to a recognizable interaction between hormonal regulation, maternal situations, and placental disorder. For instance, the expanded threat of stillbirth and fetal growth restriction is related to the black race, superior maternal age, low educational level, nulliparity, and maternal smoking.[4] The equal is the case for maternal medical conditions which includes pre and gestational diabetes, thyroid issues, systemic lupus erythematosus, gestational hypertensive issues, and continual renal sickness. The previous delivery of a growth-restricted infant is amongst the most substantial risk factors for stillbirth proves the sturdy association of IUGR with stillbirth, and it's comparable to the records of preceding stillbirth.[5]

The number one techniques for fetal evaluation in intrauterine growth restrict (IUGR) are Doppler surveillance and Biophysical profile scoring. These techniques offer perception into various facets of these fetal responses, as the fetus adapts by way of revolutionary reimbursement while placental insufficiency worsens. Biophysical profile scoring (BPS) contains the non-stress test (NST), dynamic fetal variables (respiratory, tone, movement), and amniotic fluid volume into a composite scoring system.[6] A composite rating of all variables is a great predictor at the same time as individual components show correlation with the status of fetal. This composite score represents the fetal fame that is validated through fetal in addition to the neonatal outcome. The great development of quick- and long-time period results can be accomplished by applying these principles in the management of excessive-danger pregnancies.[7]

The flow of the blood from the placenta to the baby is assessed with the aid of using Doppler, it's a non-invasive test. Worsen situation like absence or reduced flow of blood to baby is detected via Doppler to take a selection to intervene by assessing the abnormal end result of Doppler studies that end in bad infant consequences.[8] The information about intra-uterine environment can also be gained by Doppler studies. Vessels including umbilical artery, ductus venosus, middle cerebral artery, and uterine artery are used to assess blood flow to baby and baby growth in Doppler studies. The pulsatility index (PI) of the middle cerebral artery (MCA) and umbilical artery (UA) is considered an awesome predictor of child outcome. In 88% of cases, MCA and UA are determined to be better for the prediction of neonatal final results and monitoring of fetal growth.[9]

This research will provide data based on the statistical analysis of two groups i.e. normal fetus and IUR fetus which would help the medical practitioners to assess the degree and severity of IUGR through the Doppler assessment of middle cerebral artery and biophysical assessment of normal and IUGR fetuses. It will also provide data of IUGR fetus vs normal fetus to categorize the IUGR into different classification. It will sonographically correlate diagnostic features of Middle Cerebral Artery and biophysical profile to rule out IUGR and will help the practitioners to plan the management of any complications that come along with IUGR.

MATERIAL & METHODS

A cross-sectional study of 161 pregnant women was conducted at the Radiology Department of Allied Hospital Faisalabad from February 2021 to April 2022. All women's ultrasounds were performed on color Doppler Xario-100 and GE S-8 equipment with both convex probe (3,5Mhz) and linear probe (9, 15 MHz). The inclusion Criteria was 114 pregnant women with abnormal biophysical profile and with a history of previous IUGR fetus pregnancy and 47 Patient with normal middle cerebral artery Doppler and biophysical profile. The exclusion Criteria was hypertensive pregnant women, cigarette smokers, and women with previous clinical evidence of stroke and heart failure. The USG of all women included in this study was performed by a highly qualified and trained radiologist. During ultrasound examination different component of BPS was assigned. Pregnancy dating based on the last menstrual period gives incorrect estimates of gestational age. Therefore, in clinical settings where the first or first-trimester scan policy is used, it seems more appropriate to use fetal biometrics

to present pregnancy and to confirm reliable age tests for multiple purposes. Overall MCA RI, MCA PI, and SD ratio values were calculated in diagnosing IUGR, taking the Biophysical profile as gold standard. Data was analyzed by using IBM-SPSS version 25. Mean and standard deviation values were calculated for different variables and Biophysical profile (MCA RI, MCA PI, and SD ratio). This study was approved by local IBR (February 2021, Approval number: UOL-FAHS/818).

RESULTS

A total of 161 patients were included in which the age of 114 patients with intrauterine growth restriction (IUGR) was ranged from 18-42 years with the mean and standard value of 27.5088 ± 6.79829 years. At the same time, the age of 47 patients with normal biophysical profile was ranged from 18-41 years with the mean and standard value of 26.6383 ± 5.58891 9 years (Table-I).

The Resistive index (RI) of MCA in the IUGR patients has the mean and standard value 0.5330 ± 0.16134, and the Resistive index (RI) of Middle cerebral artery (MCA) in the in normal was 0.6632 ± 0.4828. Similarly the Pulsative index (PI) of MCA in the IUGR patients has the mean and standard value 1.9825 ± 0.13187, and the Pulsative index (PI) of MCA in the in normal was 2.0000 ± 0.00000 (Table-II). The mean and standard value of the biophysical profile was 7.6025 ± 0.80062 (Table-III).

Descriptive statistics of MCA RI in total 161 patient ranged from 0.30-0.90 % with mean and standard value 0.5710 ± 0.15027 and of MCA PI was ranged from 0.50-7.98 % with mean and standard value 1.4154 ± 1.34914 (Table-IV).

The biophysical profile scoring of MCA PI with range from 0.5-0.6 was 8 in two patients while with range from 0.6-7.98 was 6 in 32 patients, and was 8 in 127 patients (Table-V). The biophysical profile scoring of MCA RI with range from 0.3-0.6 was 6 in 24 patients, and 8 in 79 patients while with range from 0.6-0.9 was 6 in 8 patients, and 8 in 50 patients (Table-VI).

Final Diagnosis	N	Mean	STD. Deviation
IUGR	114	27.5088	6.79829
Normal	47	26.6383	5.58891
Total	161	27.2547	6.46363

Table-I. Distribution of patients according to age (n=161).

Table-II has shown the RI and PI value of MCA in normal and IUGR patients.

Final Diagnosis		MCA RI	MCA PI
IUGR	N	114	114
	Mean	0.5330	1.9825
	Std. Deviation	0.16134	0.13187
Normal	N	47	47
	Mean	0.6632	2.0000
	Std. Deviation	0.04828	0.00000
Total	N	161	161
	Mean	0.5710	1.9876
	Std. Deviation	0.15027	0.11111

Table-II. Resistive index and Pulsative index value of Middle cerebral artery in normal and intrauterine growth restriction patients (n=161).

Values of RI and PI of MCA of fetus were calculated, the mean as well as standard deviation.

Final Diagnosis	Mean	Std. Deviation
Age	27.2547	6.46363
Biophysical profile	7.6025	0.80062
MCA RI	0.5710	0.15027
MCA PI	1.4154	1.34914
SD ratio	6.2835	1.11188

Table-III. Resistive index and Pulsative index value of Middle cerebral artery of fetus, the mean as well as the standard deviation (n=161).

Table-IV has shown illustrative interpretation of PI and RI of Middle cerebral Artery. Mean and standard deviation of RI and PI was also calculated.

Descriptive Statistics					
	N	Mini-mum	Maxi-mum	Mean	Std. Deviation
MCA RI	161	0.30	0.90	0.5710	0.15027
MCA PI	161	0.50	7.98	1.4154	1.34914

Table-IV. Descriptive statistics of Resistive index and Pulsative index of Middle cerebral artery, the mean as well as the standard deviation of values (n=161).

Table-V shows the cross tabulation between PI value of MCA and BP.

MCA PI Biophysical Profile Cross Tabulation				
		Biophysical Profile (BP)		Total
		6.00	8.00	
MCA PI	0.50-0.60	0	2	2
	0.61-7.98	32	127	159
Total		32	129	161

Table-V. Cross tabulation between Pulsative index value of Middle cerebral artery and biophysical profile (n=161).

Table-VI shows the cross tabulation between RI value of Middle Cerebral Artery and biophysical profile.

RI Biophysical Profile Cross Tabulation				
		Biophysical Profile		Total
		6.00	8.00	
RI	0.30-0.60	24	79	103
	0.61-0.90	8	50	58
Total		32	129	161

Table-VI. Cross tabulation between Resistive index value of Middle cerebral artery and biophysical profile (n=161).

DISCUSSION

Intrauterine growth retardation or intrauterine growth restriction (IUGR) may be diagnosed by means of using Doppler studies at a very the advanced degree through evaluation of limited blood waft to fetus this is a lot more powerful method than scientific evaluation and use of ultrasound which provide facts about IUGR at very overdue stage 8. In our study age ranged from 18-42 years with mean and standard value of 27.2547 ± 6.46363 years (Table-I) that is less than age range from 18 to 35 years with mean and standard value of 28.755±2.04 years reported by Sanaullah et al[10] and from 18-40 years with mean and standard value of 30.26 ± 4.67 years reported by Mehdi et al.[11]

All the patients included in this study have been speculated to go through color Doppler Ultrasonography of the umbilical arteries and cerebral middle arteries. Out of 161 (100 %) patients, Color Doppler Ultrasonography revealed the IUGR in 114 (70.80 %), whereas 47 (29.19 %) patients showed no IUGR. Overall MCA RI, MCA PI, and SD ratio in diagnosing IUGR, taking the Biophysical profile as the gold standard was 0.5710 ± 0.15027, 1.4154 ± 1.34914, and 6.2835 ± 1.11188 respectively (Table-III).

Our study shows the diagnostic accuracy of middle cerebral Artery Doppler findings in Intrauterine Growth Restriction. We take Biophysical Profile as Gold Standard as it shows the RI of MCA ranged from 0.30-0.90 % in the IUGR patients, and the RI of MCA ranged from 0.60-0.70 % in the in normal. Similarly the PI of MCA ranged from 1.00-2.00 % in the IUGR patients, and the PI of MCA ranged from 2.00-2.00 % in the in normal (Table-II). Similarly, a study conducted by Srikumar et al[12] displayed that the reaction of the fetal to unusual placental characteristic is defined via the MCA Doppler research. There is an adaptive phenomenon referred to as “brain-sparing impact” reasons the cerebral vasodilation of the blood glide from the periphery to the mind of fetus which occurs first of all for a while. Throughout normal pregnancy, the values of PI and RI of MCA remain alternate. In this observation, an exact pattern turned into accompanied through MCA and UA Doppler indices of fetus that rely on the gestational age. In the initial and later a part of pregnancy fetal mind calls for multiplied deliver of blood that become indicated through a parabolic curve of PI and RI of MCA.

In their study, Cohen et al[13] concluded that functional and structural modifications of the cerebral circulation are caused because of persistent prenatal hemodynamic disturbances and intrauterine hypoxia. At least in the initial few days of life, the cerebral circulation of IUGR neonates is not like their as it should be appropriately grown (AGA) peers due to the fact those intrauterine variations stay persist postnatally. There is a scarcity of literature on this subject matter and plenty of controversies are proven by using the prevailing literature. There is little information on control techniques and most appropriate cerebral tracking for IUGR fetuses and neonates due to poorly understood

clinical results concerning the altered cerebral hemodynamics so, it has grown to be hard to wager which fetuses are at the highest danger of opposite outcomes. To improve the care of the preterm IUGR populace, a worldwide initiative addressing these troubles might be of extremely good significance.

In another study, Baschat et al[14] reported that maximum precision of fetal assessment is won with the aid of combining BPS and Doppler. The multiple patterns of cyclicity engage with underlying fetal repute is a confounding aspect in IUGR to produce very variable compensatory responses and variable behavior. It's far regarded that a combination of multivessel Doppler including middle cerebral artery, inferior vena cava, umbilical artery, free umbilical vein, and ductus venosus with multiple timeframes of BPS components addresses these concerns. The instruction for delivery (appropriate transport, neonatology consultation, antenatal steroids) is authorized by using the face of renovation of ordinary biophysical behavior, 'BPS = 10/10', and intense Doppler deterioration while the imperative delivery is certain whilst both systems fail.

In our study, the biophysical profile scoring for Pulsative index of MCA is was 8/10 with range from 0.5-0.6 in two patients while is 6/10 in 32 patients, and 8/10 in 127 patients with range from 0.6-7.98 (Table-V). Similarly, the biophysical profile scoring for Resistive index of MCA is 6/10 in 24 patients, and 8/10 in 79 patients with range from 0.3-0.6 while is 6/10 in 8 patients, and 8/10 in 50 patients with range from 0.6-0.9 (Table-VI). Baschat et al[15] reported that the long-term high-quality of life and the perinatal outcome can be enhanced if the purpose of fetal surveillance is met. The selection for delivery is primarily based on distinct gold standards in step with distinct viewpoints. They also mentioned that each Doppler and BPS are critical for this selection but still want to increase a brand new gold standard incorporating both testing modalities.

Although the patients with intrauterine growth restriction (IUGR) have a reduced value of pulsative index (PI) and resistive index (RI) of middle cerebral artery (MCA) as compared to normal patients in our study however a significant distinction became now not been determined for resistive index amongst IUGR and normal patients. No doubt, the motive for this loss of distinction is a small sample size but it also appears that it may be because of the relative insensitivity of RI that is used as an alternative marker for the prognosis of hypoxia in IUGR patients.

CONCLUSION

In conclusion, the diagnostic accuracy of Color Doppler of umbilical and cerebral pulsatility is very excessive in diagnosing IUGR. Our study suggests that the mean and standard value of PI and RI of middle cerebral artery in IUGR patients was less than in normal patients, which shows that uterine artery Doppler and the use of MCA is a vital device to assess fetal hypoxia through figuring out growth restrained. Its a secure and economically sound technique.

REFERENCES

1. Malhotra A, Ditchfield M, Fahey MC, Castillo-Melendez M, Allison BJ, Polglase GR, Wallace EM, Hodges R, Jenkin G, Miller SL. **Detection and assessment of brain injury in the growth-restricted fetus and neonate.** Pediatr Res. 2017; 82(2):184-193. Doi:10.1038/pr.2017.37

2. Miller SL, Huppi PS, Mallard C. **The consequences of fetal growth restriction on brain structure and neurodevelopmental outcome.** J Physiol. 2016; 594(4):807-823. Doi: 10.1113/JP271402

3. Carrera JM, Figueras F, Meler E. **Ultrasound and Doppler management of intrauterine growth restriction.** Donald School Journal of Ultrasound in Obstetrics and Gynecology, July-September 2010; 4(3):259-274.

4. Bukowski R. **Stillbirth and fetal growth restriction.** Clin Obstet Gynecol. 2010; 53(3):673-680. Doi:10.1097/GRF.0b013e3181eba0db

5. Imdad A, Yakoob MY, Siddiqui S, Bhutta ZA. **Screening and triage of intrauterine growth restriction (IUGR) in general population and high risk pregnancies: A systematic review with a focus on reduction of IUGR related stillbirths.** BMC Public Health. 2011; 11 Suppl 3(Suppl 3):S1. Published 2011 Apr 13. Doi:10.1186/1471-2458-11-S3-S1

6. Mandruzzato G, Antsaklis A, Botet F, Chervenak FA, Figueras F, Grunebaum A, Puerto B, Skupski D, Stanojevic M, & WAPM. **Intrauterine restriction (IUGR).** J Perinat Med. 2008; 36(4):277-281. Doi:10.1515/JPM.2008.050

7. Afsar R, Arshad N, Naeem MA, Farooq SY, Ali A. Assessment of Doppler indices and fetal survival in pregnancy complicated by intra uterine growth restriction. Ophthalmology Update. 2021 Sep 18; 19(4):51-5.

8. von Beckerath AK, Kollmann M, Rotky-Fast C, Karpf E, Lang U, Klaritsch P. **Perinatal complications and long-term neurodevelopmental outcome of infants with intrauterine growth restriction.** Am J Obstet Gynecol. 2013; 208(2):130.e1-130.e1306. Doi:10.1016/j.ajog.2012.11.014

9. Unterscheider J, Daly S, Geary MP, Kennelly MM, McAuliffe FM, O'Donoghue K, Hunter A, Morrison JJ, Burke G, Dicker P, Tully EC, Malone FD. **Predictable progressive Doppler deterioration in IUGR: Does it really exist?** Am J Obstet Gynecol. 2013; 209(6):539.e1-7. Doi: 10.1016/j.ajog.2013.08.039.

10. Sanaullah Z,Nazir R, Azam H, Malik A. **Comparison of middle cerebral artery and uterine artery Doppler in evaluation of intra uterine growth restriction pregnancy.** J Soc Obstet Gynaecol Pak. 2021; 11(4):242-245.

11. Mehdi S, Bukhari H, Dogar IH, Bukhari H. **Diagnostic accuracy of Color Doppler of cerebral and umbilical pulsatality in diagnosing IUGR, taking birth weight as gold standard.** Professional Med J 2020; 27(3):651-659. DOI: 10.29309/TPMJ/2020.27.3.4309

12. Srikumar S, Debnath J, Ravikumar R, Bandhu HC, Maurya VK. **Doppler indices of the umbilical and fetal middle cerebral artery at 18-40 weeks of normal gestation: A pilot study.** Med J Armed Forces India. 2017; 73(3):232-241. Doi:10.1016/j.mjafi.2016.12.008

13. Cohen E, Baerts W, van Bel F. **Brain-Sparing in Intrauterine growth restriction: Considerations for the neonatologist.** Neonatology. 2015; 108(4):269-276. Doi:10.1159/000438451

14. Baschat AA, Gembruch U, Harman CR. **The sequence of changes in Doppler and biophysical parameters as severe fetal growth restriction worsens.** Ultrasound Obstet Gynecol. 2001; 18(6):571-577. Doi:10.1046/j.0960-7692.2001.00591.x

15. Baschat AA, Harman CR. **Antenatal assessment of the growth restricted fetus.** Curr Opin Obstet Gynecol. 2001; 13(2):161-168. Doi:10.1097/00001703-200104000-00011

AUTHORSHIP AND CONTRIBUTION DECLARATION

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2	Syed M. Yousaf Farooq	Concept or design.	
3	Mehreen Fatima	Statistical analysis of data.	
4	Ali Arslan	Critical revision of important.	