

DOPPLER ULTRASOUND FOR ASSESSMENT OF PULSATILITY INDEX VARIATION OF MIDDLE CEREBRAL ARTERY IN INTRAUTERINE GROWTH RETARDATION

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ABSTRACT

Objective: To assess variation of pulsatility index of middle cerebral artery (MCA-PI) in intrauterine growth retardation (IUGR).

Study Design: Descriptive study.

Place and Duration of Study: The study was conducted in department of Radiology, Combined Military Hospital Lahore, from March 2006 to September 2006.

Patients and Method: A total 100 patients with IUGR in third trimester were selected. Ultrasound estimation of fetal weight (using fetal biometry) below 10th percentile for that gestational age was labeled as IUGR. MCA-PI value of less than 0.751 was labeled as abnormal.

Result: Abnormal values of PI-MCA were found in 79% of IUGR cases while 21% had normal values.

Conclusion: PI-MCA is a sensitive modality of assessing IUGR.

Keywords: Pulsatility index middle cerebral artery (PI-MCA), Intrauterine growth retardation (IUGR).

INTRODUCTION

Intrauterine growth retardation (IUGR) is a leading cause of perinatal death, especially in developing countries. Prevalence of IUGR in Pakistan is 15-20%¹. Early diagnosis is key to its successful management. IUGR fetuses are at higher risk, reason being poor nutrition either from placental source. Whenever a fetus is diagnosed as IUGR, close surveillance is started with follow up biometric measurements and also Doppler evaluation from time to time. Doppler indices of middle cerebral artery (MCA) are important in detecting brain sparing effect especially when brain sparing effect is lost, it requires urgent cesarean, as any further delay will result in intra-uterine demise.

This study is important in this aspect as the last compensatory phenomenon of fetal brain sparing can only be detected from middle cerebral artery Doppler indices.

PATIENTS AND METHODS

This was a descriptive cross sectional study. It was conducted at the department of Radiology, Combined Military Hospital Lahore, which is equipped with Aloka SSD-5500, using

3.5 MHz transducer. Sample size was 100 patients, sampling was non probability consecutive. All 3rd trimester pregnancies with IUGR on ultrasonography (USG) were included in the study. Patients with multiple pregnancies, unwilling / un-cooperative patients, fetal structural anomaly were excluded from the study.

Cases were collected from OPDs of Radiology, Gynecology and Obstetrics departments of CMH Lahore. Written informed consent was obtained from the cases planned to be included in the study. Doppler USG was performed by using a 3.5 MHz probe of Aloka SSD 5500 in a dimly lit room with a comfortable temperature (22—24C) after an adaptation period of at least 15 minutes rest in supine position. Flow measurements of fetal MCA-PI were taken in a plane slightly closer to base of skull. MCA was insonated at the level of the greater wings of the sphenoid. Recordings were made in the absence of fetal body or breathing movements. Three recordings of spectral waveform of every case were taken and mean was recorded. There was no risk to the patient as USG is a non-invasive technique. All the findings were confirmed by the supervisor/second radiologist.

Study variables measured were the pulsatility index of the middle cerebral artery in

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Received: 31 Jan 2013; Accepted: 23 Sep 2013

intrauterine growth retardation. SPSS version 12 was applied to analyze the data. Descriptive statistics included mean.

RESULTS

The study population included 100 patients who were in their 3rd trimester with USG assessment of IUGR (i.e. estimated fetal weight less than 10th percentile for that gestational age). Cases with multiple pregnancies, structural malformations and those who were un-willing were excluded from the study. Mean age was 27.3 years. Figure 1 shows PI values in MCA of all patients under study. Mean PI was 0.68 (table).

PI less than 0.75 was considered as abnormal. Thus out of a total of 100 patients having IUGR, 79 patients showed decreased PI in MCA, whereas 21 patients had normal PI in MCA. Thus abnormal values of PI in MCA in 100 IUGR patients in 3rd trimester were seen in 79%, whereas 21% of IUGR had normal PI-MCA values. Mean value of PI-MCA was 0.68.

DISCUSSION

Doppler ultrasound is currently employed in almost every medical discipline to study blood flow in diseases where an alteration of this dynamic system is anticipated^{2,3}. In 1983, Campbell published the assessment of the utero-placental circulation and that high resistance waveforms were obtained in pre-eclampsia^{4,5}.

The MCA is the vessel of choice to assess the fetal cerebral circulation^{6,7} because it is easy to identify. When the fetus is hypoxic, the cerebral arteries tend to become dilated in order to preserve the blood flow to the brain. In the MCA, the systolic to diastolic (A/B) ratio will decrease (due to an increase in diastolic flow) in the presence of chronic hypoxic insult to the fetus^{8,9}. This increase in blood flow can be evidenced by Doppler USG of the MCA. This effect has been called "brain sparing effect" and is demonstrated by a lower value of the pulsatility index (fig 2). In fetuses with intrauterine growth retardation (IUGR) a PI below the normal range indicates a greater risk of adverse perinatal outcome. The brain sparing effect may be temporary, as reported during prolonged hypoxemia in animal experiments,

and the overstressed human fetus can also lose the brain sparing effect^{10,11}. The disappearance of the brain sparing effect is a critical event for the fetus, and appears to precede fetal death^{12,13}.

Simanaviciute and Gudmundsson¹⁴ said that normal MCA/uterine artery (UA) PI ratio decreases with gestational age. Abnormally low MCA/ uterine artery PI ratios are related to

Table: Pulsatility index of MCA in IUGR.

	Valid		
	Normal	Abnormal	Total
Frequency	21	79	100
Percent	21.0	79.0	100.0
Valid Percent	21.0	79.0	100.0
Cumulative Percent	21.0	100.0	

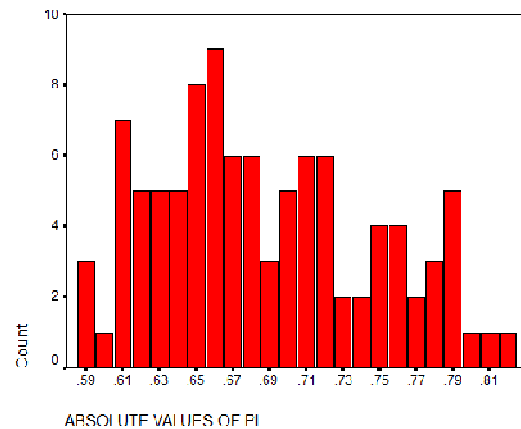


Figure-1: Absolute values of PI-MCA.

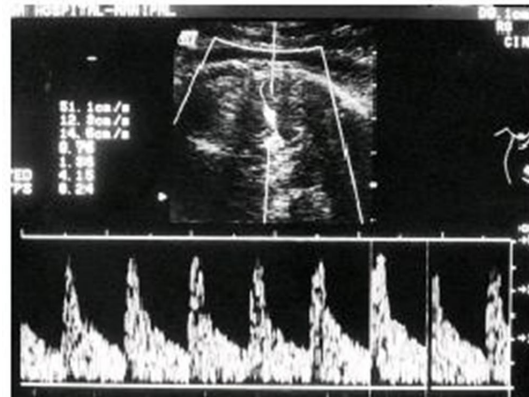


Figure-2: MCA waveform in IUGR.

unfavorable pregnancy outcome. Cheema, et al¹⁶ observed that a clear correlation exists between increasing placental vascular impedance and brain sparing in the MCA. Preterm pregnancies express the greatest deviation from the mean MCA-PI. Abnormal

umbilical Doppler indices and abnormal cerebral-umbilical ratio are strong predictors of IUGR and of adverse perinatal outcome in preeclampsia¹⁷. Miković, et al¹⁸ observed that the change in MCA values is a result of hypoxic-ischemic CNS insult. As a consequence of hypoxia, ischemia occurs by two mechanisms: decrease in local vasodilatory agents production, or due to the brain edema¹⁹.

Severi, et al²⁰ concluded that SGA fetuses with normal umbilical artery Doppler waveforms and abnormal uterine arteries and fetal MCA waveforms have an increased risk of developing distress and being delivered by emergency cesarean section. Particularly, when both uterine and fetal cerebral waveforms are altered at the same time, the risk is exceedingly high (86%) and delivery as soon as fetal maturity is achieved seems advisable. On the other hand, when both vessels have normal waveforms, the chances of fetal distress are small (4%) and expectant management is the most reasonable choice.

Harrington, et al²¹ noted that fetal Doppler indices, in particular ratios that include measurements obtained from the cerebral circulation, help in the recognition of the small fetus that is growth-retarded. Li, et al²² noted that during acute hypoxic stress, changes towards a centralization of blood flow to the brain develop in imminently compromised fetuses at an expense of the umbilicoplacental blood flow, and the brain-sparing flow is more pronounced than in un-compromised fetuses.

Zha, et al²³ showed that MCA-PI were significantly lower in IUGR fetuses than that of normal fetuses ($p < 0.01$). UA PI and UA PI/MCA-PI ratio were higher in IUGR group than that of normal group ($p < 0.01$). The sensitivities of MCA-PI, UA-PI and UA PI/MCA-PI ratio for predicting IUGR were 80.64%, 70.96% and 87.09% respectively at the cut off level with 2 standard deviation (SD). The specificities were 94.05%, 88.90% and 97.61% respectively.

Fu, et al^{24,25} concluded that MCA and anterior cerebral artery (ACA) PI were both significantly lower in the brain-sparing flow group ($n=8$) during basal conditions p (or $=0.01$). Takahashi, et al^{26,27} showed that growth-

restricted fetuses which suffered from the state of breakdown of the brain-sparing effect were delivered early with severe growth restriction and mild metabolic acidosis. The change from decreased to increased MCA-PI along with increasing UA-PI may predict a severely growth-restricted infant.

Madazli, et al²⁸ observed that birth weight and umbilical vein pH at birth significantly decreased and perinatal mortality rates significantly increased with the worsening of the diastolic flow in the umbilical artery ($p < 0.01$). Increased umbilical artery PI was significantly associated with increased thoracic aorta PI and decreased middle cerebral artery PI ($r=0.75$ and -0.55 , $p < 0.01$ respectively). Piazzze, et al²⁹ noticed that the MCA PI of fetuses with growth restriction should be assessed. The UA PI/MCA ratio is predictive of a nonreactive computerized cardiotocography trace and of prolonged neonatal hospitalization.

Mari, et al³⁰ noticed that in IUGR fetuses, the trends of the MCA-PI and MCA-peak systolic velocity (PSV) provide more clinical information than does one single measurement. A high MCA-PSV predicts perinatal mortality better than does a low MCA-PI.

Siristatidis, et al³¹ observed that during active labor the fetus maintains oxygen supply to the brain by redistributing blood flow. In cases of hypoxia this is feasible for only 2 min. A strong correlation is noted between fetal pulse oximetry, Doppler velocimetry of the MCA and UA, and fetal morbidity.

It is worth emphasizing that, screening is only worthwhile if an effective preventive treatment is available. If one could identify the 'at-risk' fetus using the Doppler ultrasound in order to apply clinical interventions, it could result in reduced perinatal deaths and unnecessary obstetric interventions. In many cases, the management consists of early delivery when the fetus is mature or specific interventions for conditions such as preeclampsia.

There are certain limitations to this study. Firstly, the sample size is small. Secondly, it was conducted on patients of particular section of society (predominantly families of armed forces

and limited civilian, so results have to be correlated in this context.

CONCLUSION

PI of MCA plays a key role in detecting IUGR. In this study, PI values of MCAs in IUGR patients were found reduced. Therefore, Doppler investigation of the fetal cerebral circulation may play an important role in monitoring the growth retarded fetus and thereby may help to determine the optimal time for delivery. Hence, the use of Doppler provides information that is not readily obtained from more conventional tests of fetal well-being. It, therefore, has a crucial role in management of growth retarded fetuses.

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