Original Article

# Diagnostic Accuracy of Pulsatility Index Umbilical Artery and Middle Cerebral Artery in Detecting Intra Uterine Growth Restriction

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## Abstract

Objective: To determine the diagnostic accuracy of sensitivity and specificity of the PI-UA and MCA in detecting IUGR by comparing it with the Birth weight.

Methodology: This cross sectional study was done from 01-07-2017 to 01-012018 After approval f the ethical committee on 14-06-2017. The sampling technique was non probability consecutive sampling technique.Total327 pregnant women with IUGR in the third trimester were included in the study. The exclusion criterion was multiple pregnancies, Unwilling patients/ un-cooperative patients, fetal structural anomaly. There was no risk to the patient as ultrasonography is a non-invasive technique. Patients were followed up till delivery by their contact numbers. PI values of all the fetal MCA and UA were noted.

Results: The mean age was ±25 years, with a minimum of 16 and a maximum of 37 years. Maximum patients (13%) were in age 21, mean age was 25.8 ± 4.51 years. Out of all the Ultrasound diagnosed IUGR, 228 (69.7%) were having birth weight
The sensitivity of PI UA and MCA were 95.14% and 79.73%, respectively. The specificity of PI UA and MCA were 37% and 90%, respectively.

Conclusion: The raised PI value of UA is highly sensitive of IUGR, whereas the lower PI value of MCA is highly specific of IUGR and grave sign of fetal demise.

Keywords: IUGR, Doppler US, PI, Middle cerebral artery, Umbilical artery.

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## Introduction

Intrauterine Growth Retardation (IUGR) is defined as a rate of growth of a fetus that is less than normal for the growth potential of the fetus (for that particular gestational age.[1] The common risk factors are maternal causes (hypertension, diabetes, cardiopulmonary disease, anemia, malnutrition, smoking, drug use), fetal causes like aneuploidy, congenital malformations, fetal infection, multiple pregnancies[4],or placental causes (placental insufficiency[3]/infarction and may be multifactorial.[2] Symmetrical IUGR is caused by congenital infections and chromosomal abnormalities, whereas asymmetrical IUGR is caused by utero-placental abnormality and maternal malnutrition.[3] Its incidence is 9.5% in pre-eclamptic patients in contrast to an incidence of 1.36% in normal controlled subjects.[4]

Current challenges in the clinical management of IUGR include accurate diagnosis of the truly growth-restricted fetus, selection of appropriate fetal surveillance, and optimizing the timing of delivery.[6,7] Despite the potential for a complicated course, antenatal detection of IUGR

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and its antepartum surveillance can improve outcomes. So, the correct detection of the compromised IUGR fetus to allow for timely intervention is a main objective of antenatal care.[8]

Assessment of the umbilical artery Doppler velocimetry provides information on the blood perfusion of the feto-placental unit. Normally there is very little impedance against blood flowing through the umbilical arteries. As the placenta matures and the pregnancy advances, more tertiary villi is formed, which directly leads to an increase in the end-diastolic flow. Umbilical artery Doppler reflects downstream placental vascular resistance, strongly correlated with intrauterine growth restriction and the multisystem effects of placental deficiency. Abnormalities in the umbilical artery waveforms are progressive with reduction, loss and finally reversal of the diastolic flow.[9]

The Doppler waveform is beneficial in patients having IUGR fetus with abnormal umbilical artery indices.[10] In extreme waveform abnormality, there is reversed end diastolic flow (REDF) or absent end diastolic flow (AEDF) which is considered to be a very ominous sign of placental compromise and is associated with high perinatal mortality rates.[6] Reversed end-diastolic flow in the umbilical arterial circulation represents an advanced stage of placental compromise and has been associated with obliteration of >70% of arteries in placental tertiary villi.[11,12]

Although there are other quantitative assessments of umbilical artery Doppler (e.g., resistance index) available, the systolic to diastolic (S/D) ratio and pulsatility index (PI) are commonly used and either may be sufficient to manage most cases of suspected IUGR. When end-diastolic flow is absent, the S/D ratio is immeasurable and PI may be used.[13]

In clinical practice, Doppler waveforms of the umbilical artery can be obtained from any segment along the umbilical cord. Waveforms obtained near the placental end of the cord reflect downstream resistance and show higher end diastolic flow velocity than waveforms obtained near the abdominal cord insertion.

The study was conducted to determine the diagnostic accuracy of the PI-UA and PI-MCA in detecting IUGR by keeping actual Birth weight as gold standard and the importance of Doppler ultrasound to assess sensitivity and specificity of PI UA and MCA in IUGR pregnancies.

## Methodology

This cross sectional study was done on 327 women 3rd-trimester pregnancies with intrauterine growth restriction suspected based on advanced placental grade, elevated femur length/abdominal circumference ratio, low total intrauterine volume, small bi-parietal diameter and low estimated fetal weigh on ultrasound as compared to fetal age estimated on the earliest scan. They were selected by non- probability consecutive sampling technique. Patients with multiple pregnancies, unwilling patients/ un-cooperative patients, fetal structural Anomaly and unsure of dates were excluded from the study.

Permission was sought from the Hospital Ethical Committee. Cases were registered from the OPD of radiology and Gynecology and Obstetrics department of CMH Quetta. Written informed consent was obtained from the Cases that were included in this study. Doppler ultrasound was performed by me 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 middle cerebral artery pulsatility index and umbilical artery pulsatility index was taken in a plane slightly closer to the base of skull and umbilicus, respectively. UA velocity waveform was analyzed in a position considered equidistant from abdominal and placental insertion points. 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 the mean was recorded. There was no risk to the patient as ultrasonography is a non-invasive technique. Patients were followed up till delivery by their contact numbers. Birth weights of all the neonates were recorded including findings.

Mean and Standard deviation were calculated for quantitative variables. Frequency and Percentages were calculated for qualitative variables. SPSS version 15 was applied to analyze the data. 2x2 Table was generated and sensitivity, specificity were measured.

## Results

The mean age was ± 25 years, with a minimum of 16 and a maximum of 37 years. Maximum patients (13%) were in age 21, mean age was 25.8 years ±4.51 years. Out of all the Ultrasound diagnosed IUGR, 228 (69.7%) were having birth weight below the 10th percentile, while 99 (30.27%) were having normal birth weight according to gestational age.

All 327 cases were recorded for PI MCA. Out of 327 cases 191 (58.4%) were diagnosed as having abnormal PI MCA value, whereas 136 (41.6%) were having normal values. Sensitivity of PI MCA is calculated to be 79.73% and specificity 90%. Out of 327 cases 181 were true positive, 90 were true negative, 46 were false negative and 10 were false positive.

All 327 cases were recorded for PI UA values. Out of 327, 279 (85.32%) cases were giving abnormal PI UA values in favor of IUGR and 48 (14.67%) were giving normal values. The sensitivity of PI UA is shown to be 95.14% and specificity 37% as shown in table. Out of 327 cases 216 were true positive, 37 were true negative, 11 were false negative and 63 were false positive.

## Discussion

Intrauterine growth restriction (IUGR) is quite common in developing countries. It is a common cause of perinatal morbidity and mortality.[15] My study showed a sensitivity of PI UA in IUGR patients was 94% and specificity of 36%, whereas MCA sensitivity was 79% and specificity of 90%. Previous studies mentioned the sensitivity and specificity of PI_UA 82 % and 64 % respectively[16], whereas for PI_MCA its sensitivity, specificity is 41.6% and 90.9% respectively.[17]

In another similar study, on the umbilical artery alone, the mean umbilical artery PI values were higher in the fetal growth restriction group, while the middle cerebral artery values were lower as compared to fetuses with no growth restriction.[18]

The effects of Doppler ultrasound in high-risk pregnancies on obstetrical care and fetal outcomes were reviewed. The use of Doppler in pregnancies complicated by hypertension or presumed impaired fetal growth was associated with a trend in reduction of perinatal deaths.

Simanaviciute D, et al[19] said that normal MCA/uterine artery PI ratio decreases with gestational age. Abnormally low MCA/ uterine artery PI ratios are related to unfavorable pregnancy outcome. Baschat AA, et al[4] noted that Growth restricted fetuses with abnormal venous flow have worse perinatal outcome compared to those where flow abnormality is confined to the umbilical or middle cerebral artery. In fetuses with low middle cerebral artery pulsatility, venous Doppler allows detection of further deterioration.

Ozeren M, et al[17] noted that both abnormal umbilical Doppler indices and cerebral-umbilical ratio are strong predictors of IUGR and adverse perinatal outcome in preeclampsia. The combination of umbilical and fetal cerebral Doppler indices may increase the utility of Doppler ultrasound in

Miković Z, et al[18] 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: local vasodilatatory agents production decrease, or due to brain edema. This also supports my study results. Fu J, et al[21] showed that when UA-PI increased, the MCA-PI still decreased but DV flow velocity parameters remained unchanged during uterine contractions in IUGR fetuses.

Severi FM, at al [19] concluded that SGA fetuses with normal umbilical artery Doppler waveforms and abnormal uterine arteries and fetal middle cerebral artery 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.

**Table I: Pulsatility index of Middle cerebral artery and umbilical artery.**

| | | Birth weight | | Total |
|---|---|---|---|---|
| | | Positive | Negative | |
| **PI middle cerebral artery** | Positive | 181 | 10 | 191 |
| | Negative | 46 | 90 | 136 |
| Total | | 227 | 100 | 327 |
| **PI Umbilical artery** | Positive | 216 | 63 | 279 |
| | Negative | 11 | 37 | 48 |
| Total | | 227 | 100 | 327 |

*Sensitivity= 181/(181+46)x100 = 79.73%* - *Specificity= 90/(10+90)x100 = 90 %*
*Positive predictive value=216/(216+63)=77%* - *Negative predictive value=137/(11+137)=92%*
*Diagnosticaccuracy=216+137/(216+63+11+137)=82%* - *Sensitivity = 216/(216+11)x100 = 95.14%*
*Specificity= 37/(37+63)x100 = 37%*

Li H, et al[20] 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 umbilico placental blood flow, and the brain-sparing flow is more pronounced than in un-compromised fetuses which was also observed in my study.

Zha C[21], et al showed that MCA PI were significantly lower in IUGR fetuses than that of normal fetuses. UA PI and UA PI/MCA PI ratio were higher in IUGR group than that of the normal group. 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 J[22], et al concluded that MCA and ACA PI were both significantly lower in the brain-sparing flow group during basal conditions. The MCA-to-ACA PI ratio remained unchanged in both groups. de novo brain-sparing flow calculations revealed no preferential flow to any cerebral artery. Cerebral circulatory responses to acute hypoxemia were synchronized in the middle and anterior cerebral arteries without any preferential regional flow distribution.

Piazze J[23], et al noticed that MCA PI of fetuses with growth restriction should be assessed. The UA PI/MCA ratio is predictive of a nonreactive computerized cardiotocography trace and prolonged neonatal hospitalization. Siristatidis C, et al 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. UA Doppler flow is a key parameter for the diagnosis and surveillance of fetuses with IUGR secondary to placental insufficiency.

Once IUGR has been diagnosed weekly UA Doppler examination is suggested to determine the pattern of progression. After the initial 14 days, the rapidly progressive severe disease will be revealed by the definitive deterioration of UA Doppler and the emergence of additional vessel abnormalities. For the remainder, a less fulminant course is expected. If there is still no change over the next 2 weeks then venous Doppler monitoring is unlikely to yield abnormal results. Of interest, this non-progressive subset may show isolated increased cerebral diastolic blood flow near term. The significance of this isolated Doppler finding in near-term IUGR has been emphasized previously and merits further study. Those fetuses that do progress in subsequent intervals require frequent, serial, arterial and venous testing, but often may gain many weeks of valuable maturation time before delivery. Further study needs to address whether there are additional factors such as UA Doppler status or the development of pregnancy-induced hypertensive disorders that impact on this anticipated progression.

There are certain limitations to my study. Firstly, the sample size is small. Secondly, i did my study on patients of a particular section of society (high-risk patients referred to tertiary care hospital), so results have to be correlated in this context. In particular, the use of pulsed Doppler involves the use of higher intensities compared to diagnostic ultrasound and may cause significant tissue heating and other thermal effects. These thermal effects depend on. the presence of a tissue/air interface and may therefore not be clinically significant in obstetric ultrasound examinations.

## Conclusion

Doppler investigation of the fetal circulation may play an important role in differentiating SGA from IUGR and also monitoring IUGR on verge of compromise. Thereby may help to determine the optimal time and mode of delivery. PI UA derangement precedes the PI MCA derangement and is thus more sensitive of diagnosing IUGR. However, the development of deranged PI MCA is very specific of IUGR and a grave sign of fetal demise.

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