SENSITIVITY AND SPECIFICITY OF PULSATILITY INDEX UMBILICAL ARTERY AND MIDDLE CEREBRAL ARTERY IN DETECTING INTRA UTERINE GROWTH RESTRICTION

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ABSTRACT

Objective: To determine the sensitivity and specificity of the pulsatile index in umbilical artery (PI-UA) and pulsatile index in middle cerebral artery (PI-MCA) in detecting IUGR by comparing it with the birth weight.

Study Design: Validation study.

Place and Duration of Study: Study was conducted in Department of Radiology, Military Hospital and Combined Military Hospital Rawalpindi, which was equipped with the (Aloka SSD-5500) using 3.5 MHz transducer after seeking permission from hospital ethical committee from 1st January 2010 to 10th July 2010.

Subjects and Methods: Two hundred and fifty pregnant women with IUGR in third trimester were included in the study. Ultrasound estimation of fetal weight (using fetal biometry) below 10th percentile for that gestational age was labeled as IUGR. PI-MCA value of less than 11 was labeled as abnormal. PI-UA value of more than 1.451 was labeled as abnormal. Birth weight was taken as gold standard.

Results: Sensitivity of PI-UA and PI-MCA were 94.8% and 79.8%, respectively. Specificity of PI-UA and PI-MCA were 36.8% and 90.7%, respectively.

Conclusion: Raised PI value of UA is highly sensitive of IUGR; lower PI value of MCA is highly specific of IUGR and grave sign of fetal demise.

INTRODUCTION

Intrauterine growth restriction (IUGR) is very common in developing countries; its prevalence in Pakistan is 15-20%[1]. It is amongst those conditions where close antenatal follow up can significantly lower the perinatal morbidity and mortality. Doppler ultrasound examination has become an established method of clinical surveillance in high-risk pregnancies[2].

The correct detection of the compromised IUGR fetus to allow for timely intervention is a main objective of antenatal care. The important issue is not the identification of small fetus, but rather the "fetus at risk" for compromise. Since IUGR fetuses are the major sufferer of perinatal mortality and morbidity, rationale of this study is to correctly and timely diagnose the fetus at risk and so that intervention can be done. Doppler has proved to be useful modality and many studies have been undertaken in this regard. However In contrast to most previous studies, birth weight has been used to compare sensitivity and specificity of PI-UA and PI-MCA for detecting IUGR.

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PATIENTS AND METHODS

This study was cross sectional validation study. Study was conducted at department of Radiology, Military Hospital and Combined Military Hospital Rawalpindi, which was equipped with the Aloka SSD-5500 using 3.5 MHz transducer, after seeking permission from hospital ethical committee. Sample size was calculated by using WHO sample size calculator taking specificity 64%[3] and sensitivity 82%[3] for PI-UA, prevalence of 20%[1] for IUGR, desired precision of 14% and confidence level 95% sample size was 231 patients. Sampling was non probability consecutive. All 3rd trimester pregnancies with IUGR on USG were included in the study. Patients with, multiple pregnancies, unwilling patients/ un-cooperative patients, fetal structural anomaly were excluded from the study.

Cases were collected from OPD of Radiology and Gynecology/Obstetrics departments of MH and CMH Rawalpindi. Written informed consent was obtained from the cases who were included

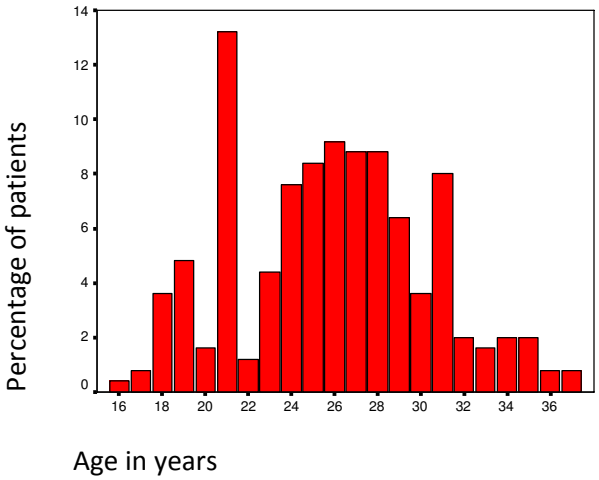

Figure-1: Age distribution of patients under study (in years).

in this study. Doppler ultrasound was performed by using a 3.5 MHz probe of Aloka SSD 5500 in a dimly lit room with a comfortable temperature (22—24^{0}C) 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 were taken in a plane slightly closer to 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 mean was recorded. There was no risk to the patient as ultrasonography is a non-invasive technique. All the findings were confirmed by the supervisor/second radiologist. Patients were followed up till delivery by their contact numbers. Birth weights of all the neonates were recorded.

Mean and Standard deviation were calculated for quantitative variables i.e. age, US age. Frequency and percentages were calculated for qualitative variables i.e. PI-UA and PI-MCA. SPSS version 15 was applied to analyze the data. 2x2 Table was generated and sensitivity, specificity were measured.

RESULTS

The study population included 250 patients

Figure-2: Normal umbilical artery doppler.

Figure-3: Reverse end diastolic flow umbilical artery.

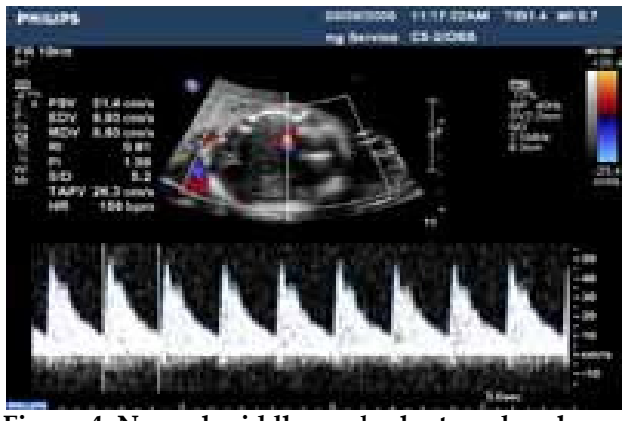

Figure-4: Normal middle cerebral artery doppler.

fulfilling the inclusion and exclusion criteria. Age

distribution is shown in Figure-1. Mean age was 25.8 years (SD=4.51), with minimum of 16 and maximum of 37 years. Out of all the ultrasound diagnosed IUGR, 174 (69.6%) were having birth weigth below 10th percentile, while 76 (30.4%) were having normal birth weight according to gestational age.

All 250 cases were recorded for PI-MCA. Out of 250 cases 146 (58.4%) were diagnosed as having abnormal PI-MCA value, whereas 104 (41.6%) were having normal values. Sensitivity of PI-MCA is calculated to be 79.8% and specificity 90.7%. Detail of false positive and negitive cases is given is table-1.

All 250 cases were recorded for PI-UA values. Out of 250, 213 (85.2%) cases were giving abnormal PI-UA values in favour of IUGR and 37 (14.8%) were giving normal values. Sensitivity of PI-UA is shown to be 94.8% and specificity 36.8% as shown in table-2. Normal UA doppler findings with an abnormal one are shown in Figure 2 and 3. Normal MCA doppler and MCA waveform in IUGR are shown in figure 4 and 5.

DISCUSSION

Intrauterine growth restriction (IUGR) is quite common in developing countries. It is a common cause of perinatal morbidity and mortality[4]. The study showed sensitivity of PI UA in IUGR patients was 94.8% and specificity of 36.8%, whereas MCA sensitivity was 79.8% and specificity of 90.7%. Previous studies mentioned sensitivity and specificity of PI-UA 82% and 64% respectively[5], whereas for PI-MCA its sensitivity, specificity is 41.6% and 90.9% respectively[6-7].

Borowski et al[8] and Simanaviciute et al[9] noted that decompensate of the brain sparing effect is closely related to increased perinatal mortality.

Baschat et al[10] , Cheema et al[11] and Ozeren et al[12] had noted that both abnormal umbilical Doppler indices and MCA-umbilical ratio were strong predictors of IUGR and of adverse perinatal outcome in preeclampsia. The combination of umbilical and fetal cerebral Doppler indices may increase the utility of doppler ultrasound in pre eclamptic subjects.

Severi et al[13] 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.

Li et al[14] 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 which was also observed in my study.

Zha et al[15], FU and Olofsson[16] 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 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%,

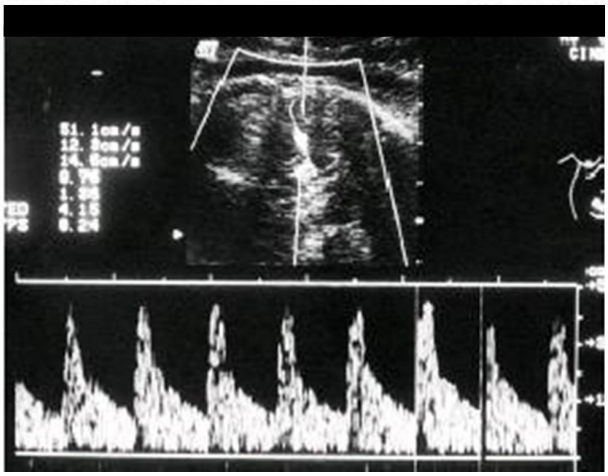

Figure-5: Middle cerebral artery waveform in intrauterine growth restriction.

88.90% and 97.61% respectively.

Piazze et al[17] and Mari et al[18] noticed that MCA PI of fetuses with growth restriction should be assessed. The UA PI/MCA-PI ratio is predictive of a nonreactive computerized cardiotocography trace and of prolonged neonatal hospitalization.

Siristatidis et al[19] observed that during active labor the fetus maintains oxygen supply to the brain by redistributing blood flow. UA Doppler flow is a key parameter for the diagnosis and surveillance of fetuses with IUGR secondary to placental insufficiency[20]. Prediction of IUGR has been a major clinical and research issue for the past 20 years[21]. So far, the best test for predicting IUGR at 20–24 weeks of gestation is uterine artery doppler examination, with reported sensitivities for these conditions ranging from 30 to 80%[22-23]. Early-onset pre-eclampsia is commonly associated with IUGR, abnormal uterine and umbilical artery doppler evaluation, and adverse maternal and neonatal outcomes[24-25].

As IUGR worsens, doppler parameters also deteriorate[26-27], suggesting a sequential pattern of disease progression. Relationships between fetal doppler findings and perinatal risks have been defined in numerous cross-sectional studies[28]. Numerous cross-sectional studies have shown association between abnormal doppler findings and adverse outcomes in IUGR that help frame delivery decisions[29,30].

Different studies have shown that the degree of growth delay mirrors the increase in UA pulsatility[31-33]. Several studies have shown that cerebral blood flow abnormalities become more prevalent as growth restriction progresses[34].

Once IUGR has been diagnosed, weekly UA Doppler examination is suggested to determine the pattern of progression[35]. After the initial 14 days, rapidly progressive severe disease will be revealed by definitive deterioration of UA Doppler and the emergence of additional vessel abnormalities[36]. 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[37]. The significance of this isolated Doppler finding in near-term IUGR has been emphasized previously[38-39] 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

Table-1: Pulsatile index (PI) in middle cerebral artery.

Test		Birth weight		Total
		Positive	Negative	
PI middle cerebral artery	Positive (<1)	139	7	146
	Negative (>1)	35	69	104
Total		174	76	250

Sensitivity= 139/ (139+35) x100 = 79.88%, Specificity= 69/ (7+69) x100 = 90.78%

Table-2: Pulsatile index (PI) in umbilical artery.

Test		Birth weight		Total
		Positive	Negative	
PI Umbilical artery	Positive (>1.45)	165	48	213
	Negative(<1.45)	9	28	37
Total		174	76	250

Sensitivity = 165/ (165+9) x100 =94.8%, Specificity= 28/ (28+48) x100 =36.8%

hypertensive disorders that impact on this anticipated progression.

There were certain limitations to this study. Firstly, the sample size was small. Secondly, it was conducted on a particular section of society (families of Armed Forces and their relatives), so results have to be correlated in this context. The safety of Doppler ultrasound remains a concern. 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. Combined use of UA and MCA Doppler indices can help making accurate and timely diagnosis. PI-UA derangement precedes the PI-MCA derangement and is thus more sensitive of diagnosing IUGR. However, development of deranged PI-MCA is very specific of IUGR and a grave sign of fetal demise. Hence, the use of above doppler protocol provides quick and timely information that is not obtainable from more conventional fetal well being tests. It therefore has an important role to play in the management of the growth-restricted fetus.

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