

DIAGNOSTIC ACCURACY OF UTERINE ARTERY RESISTANCE INDEX IN THE PREDICTION OF INTRAUTERINE GROWTH RETARDATION IN PREECLAMPSIA

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PJR January - March 2021; 31(1): 12-16

ABSTRACT

BACKGROUND: Intrauterine growth restriction (IUGR) results from placental insufficiency. Preeclampsia is one of the major risk factors responsible for placental insufficiency. Early identification of the IUGR helps in reducing perinatal morbidity and mortality. Doppler flow velocity waveform analysis in the uterine arteries has proved to be a useful method for evaluation of uteroplacental insufficiency and hence prediction of IUGR. **OBJECTIVES:** To determine the diagnostic accuracy of uterine artery resistance index (RI) in the prediction of IUGR in preeclampsia taking neonatal weight at birth as gold standard. **METHODS:** A Cross sectional study was conducted at Radiology Department, Khyber Teaching Hospital, Peshawar over a period of 6 months (17th January 2019 to 16th June 2019). 281 patients diagnosed with preeclampsia underwent Doppler ultrasound to calculate uterine artery RI. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of the uterine artery RI in the prediction of IUGR was calculated. **RESULTS:** 281 pre-eclamptic patients underwent Doppler ultrasound for determination of uterine artery RI in order to predict IUGR. Sensitivity, specificity, positive predictive value, negative predictive value of the uterine artery RI in the prediction of IUGR was found to be 78.99%, 89.51%, 87.90%, 81.53% respectively. The diagnostic accuracy of uterine artery RI taking birth weight as gold standard was found to be 84.34%. **CONCLUSION:** Uterine artery RI determination can help in detection of IUGR in pre-eclamptic patients and hence timely intervention can be made possible.

Keywords: Doppler ultrasound, intrauterine growth restriction, placental insufficiency, uterine artery resistance

Introduction

Intrauterine growth restriction (IUGR) is a common problem in developing countries such as Pakistan where its prevalence is 15-20%.¹ According to Lubchenco classification, newborns having weight less than 2500 grams are classified as cases of intrauterine growth retardation.² IUGR denotes a fetus whose weight is below 10th percentile for gestational age per se growth charts.

Intrauterine growth retardation is a result of improper placental development and function. Poor trophoblastic conversion of the spiral arterioles leads to increased utero-placental artery resistance causing reduced utero-placental bed perfusion which eventually results in IUGR.³ Preeclampsia comprises the high risk group for placental insufficiency which

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Submitted 25 December 2020, Accepted 19 February 2021

is the most common cause of IUGR. It is important to recognize placental insufficiency early so that its hazards can be reduced if not prevented. The early identification of the IUGR fetus allows for timely intervention which is the main objective of antenatal care.

Doppler ultrasound is noninvasive modality that has become an established method of clinical surveillance in high-risk pregnancies.¹ It can detect changes of hypoxia at least a week before the non-stress test or the biophysical profile and has therefore become the gold standard in the management of the growth-restricted fetus.⁴ Doppler flow velocity wave form analysis in the uterine arteries performed by a continuous wave Doppler analysis has proved to be a useful method for evaluation of utero-placental insufficiency.³ Uterine artery resistance index (RI) has been shown to detect changes in fetomaternal and utero-placental circulation accurately which seems to correlate strongly with the pregnancy outcome. It helps to monitor fetal well-being, take timely action, plan the management and prevent adverse fetal outcome in high risk pregnancies.

In order to detect IUGR, serial ultrasound examinations are done at least three weeks apart to calculate abdominal circumference which has a specificity of approximately 90% for identifying IUGR. Biophysical profile is also calculated which follows a distinctive pattern in IUGR babies with disappearance of reactivity followed by fetal respiration movements, tone and lastly oligohydramnios.⁵ Doppler velocities give information about maternal, placental & fetal circulations simultaneously.

Preeclampsia is a multifaceted disease resulting in various unpredictable clinical manifestations. If it isn't managed on time, life threatening convulsions and coma can occur, hence known as eclampsia. It can also cause intracranial hemorrhage, pulmonary edema, coagulation abnormalities & cardiac, renal, liver failure thus increasing maternal morbidity & mortality. In fetuses, it can lead to still birth,⁶ placental abruption, intrauterine growth retardation and preterm delivery.

In normal pregnancies, by the end of the second trimester, uterine spiral arteries are lined entirely by cytotrophoblast, and endothelial cells are not present in the endometrial or superficial myometrial regions. This remodeling leads to establishment of a low

resistance arteriolar system resulting in dramatic increase in blood supply to the developing fetus. From 6 to 12 weeks, uterine artery flow velocity wave forms are characterized by a high systolic and low diastolic component, and early diastolic notch. As the pregnancy progresses, the diameter of uterine arteries enlarge,⁷ the vascular resistance falls with resultant increase in systolic peak velocity and volume flow rates.⁸⁻¹⁰ Inappropriate trophoblast invasion in preeclampsia results in a reduction in uteroplacental perfusion, with the placenta becoming progressively ischemic as gestation progresses because the transition from high vascular resistance to low vascular resistance does not take place in uterine arteries. Women at risk of developing pre eclampsia must undergo uterine artery Doppler study at 20-24 weeks.¹¹ It is a vital noninvasive investigation which provides information about any abnormality in uteroplacental / fetal circulation and thus helps in diagnosis of adverse fetal outcome enabling timely management.¹²

If uterine artery Doppler is abnormal with persistent early diastolic notch, it indicates defective perfusion of fetoplacental unit resulting in intrauterine growth retardation.¹³ Elevated RI, PI or S/D ratios and the presence of early diastolic notch are considered as abnormal uterine artery Doppler flow velocity waveforms.

Materials and Methods

It was a Cross sectional (Validation) study that was conducted at Radiology department, Khyber Teaching Hospital, Peshawar over a period of 06 months (17th January 2019 to 16th June 2019). Study was approved by hospital ethical committee. Our study included 281 antenatal patients in their third trimester of pregnancy who were diagnosed with preeclampsia by the obstetrician and referred to Radiology department for Doppler ultrasound for assessment of fetoplacental circulation. The exclusion criteria included multiple gestations, premature rupture of membranes, preterm labor, fetus with structural anomalies and gestational diabetes. These conditions acted as confounders and if included would have introduced bias in the study results. The study was conducted after approval from hospital's research and ethical committee. An

informed written consent was obtained from all patients after explaining them the purpose and benefits of the study. All patients were subjected to Doppler ultrasound to evaluate the uterine artery resistance index to predict IUGR. The Doppler ultrasounds were performed by single expert radiologist fellow of CPSP using SIEMENS Sonoline having high resolution B-mode & Doppler flow imager apparatus. The patient was placed in semi recumbent position with the ultrasound probe placed in iliac fossae of the abdomen. Sagittal section of the uterus and cervical canal was obtained and color flow was introduced till the uterine artery was visualized as it crossed the external iliac artery. Uterine artery resistance index was then calculated using pulsed Doppler gate. After that all patients were referred back to the obstetrics and gynaecology department and careful followup of all patients was donetill delivery of the fetus to detect IUGR by taking neonatal birth weight. The collected data was entered into SPSS version 2.0 and analyzed through its statistical package. Frequency and percentages were calculated for categorical variables like IUGR. Mean \pm SD was calculated for numerical variables like age, uterine artery RI and birth weight. Sensitivity, specificity, positive predictive value and negative predictive value were determined by 2x2 table while keeping birth weight as gold standard.

Results

Of the total of 281 participants in the study, the mean age of all the participants in years was 29.13 ± 7.38 with the minimum age being 20 and maximum age being 45.

On the basis of uterine artery resistance index, IUGR was predicted in 124 out of total 281 participants which make up 44.1% of the total. While in 157 patients which make up 55.9% of the total, no IUGR was detected. On the other hand, IUGR was found at birth in 138 out of total 281 participants which make up 49.1% of the total. While in 143 patients which makes up 50.9% of the total, no IUGR was detected.

Moreover, the mean uterine resistance artery index was 0.51 ± 0.07 , median was 0.52 and mode was 0.48. (Fig.1) demonstrates abnormal uterine artery

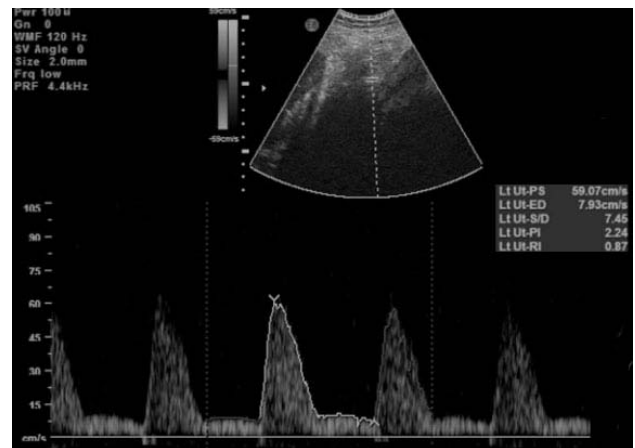


Figure 1: Abnormal uterine artery doppler waveform with high resistance flow

Doppler waveform with high resistance flow. Mean birth weight (in grams) was 2878 ± 499 , median was 2800 and mode was 2350.

Similarly, IUGR according to uterine artery resistance Index was also stratified with respect to age groups. In age group 20-25, IUGR was predicted in 34 patients. In age group 26-30, IUGR was predicted in 26 patients. In age group 31-35, IUGR was predicted in 26 patients. In age group 36-40, 15 patients were expected to have IUGR at birth and in age group 41-45, 23 patients were labeled as IUGR. It has been found

		IUGR according to birth weight		Total	
		Yes	No		
IUGR according to uterine artery resistance index	Yes	Count	109 (a)	15 (b)	124
		% within IUGR according to uterine artery resistive index	87.9%	12.1%	100.0%
		% within IUGR according to birth weight	79.0%	10.5%	44.1%
	No	Count	29 (c)	128 (d)	157
		% within IUGR according to uterine artery resistive index	18.5%	81.5%	100.0%
		% within IUGR according to birth weight	21.0%	89.5%	55.9%
Total		Count	138	143	281

a = True Positive, b = False Positive, c = False Negative, d = True Negative

Sensitivity = $(a / a+c) \times 100 = (109/109+29) = 78.99\%$

Specificity = $(d / b+d) \times 100 = (128/15+128) = 89.51\%$

Positive predictive value (PPV) = $(a / a+b) \times 100 = (109/109+15) = 87.90\%$

Negative predictive value (NPV) = $(d / c+d) \times 100 = (128/29+128) = 81.53\%$

Diagnostic accuracy = $(d+a) / \text{overall patients} = (128+109/281) = 84.34\%$

Table 1: Sensitivity, specificity, PPV, NPV and diagnostic accuracy of uterine artery resistance index with respect to birth weight (n = 281)

that with increasing age more percentage of the patients were predicted to have IUGR.

In Cross (Tab.1), sensitivity and specificity of the uterine artery resistance index with respect to birth weight was found to be 78.99% and 89.51% respectively. The positive predictive value (PPV) was 87.90% while the negative predictive value was 81.53%. The diagnostic accuracy of uterine artery resistance Index taking birth weight as gold standard was found to be 84.34%.

Discussion

Intrauterine growth restriction (IUGR) is a common problem in developing countries such as Pakistan.¹ It results from placental insufficiency and preeclampsia is one of the major risk factors responsible for it. Early identification of IUGR helps in timely intervention hence reducing perinatal morbidity and mortality. Doppler flow velocity waveform analysis in the uterine arteries has proved to be a useful method for evaluation of uteroplacental insufficiency.³

The present study was done to determine diagnostic accuracy of uterine artery resistance index in the prediction of intrauterine growth retardation in pregnant women with preeclampsia. The mean age of patients was 29.13 ± 7.38 years. Resistance index of above 0.53 was taken as abnormal with mean being 0.51 ± 0.07 . On the basis of uterine artery resistance index, IUGR was predicted in 44.1% patients and at birth 49.1% babies were IUGR. According to this study, the sensitivity and specificity of uterine artery resistance index were 78.99% and 89.51% respectively having positive predictive value (PPV) of 87.90% and negative predictive value (NPV) of 81.53%. The diagnostic accuracy turned out to be 84.34%.

In a study done by Singh S et al,¹⁴ the sensitivity and PPV of uterine artery resistance index in the prediction of IUGR were 84.6% and 90.2% which were slightly higher than those determined by our study. Their specificity and NPV were slightly lower than ours at 82.9% and 74.4%. According to their study, the diagnostic accuracy of uterine artery resistance index was 84% which was almost similar to our study's diagnostic accuracy being 84.34%.

The study conducted by Florjanski J et al¹⁵ showed specificity and NPV of 97% for both which was higher

than the values determined in our study. Sensitivity and PPV were 52% and 54% respectively, which were lower as compared to our study.

According to a study conducted by Barati M et al,¹⁶ sensitivity and PPV of abnormal uterine artery Doppler in the prediction of IUGR were lower than those of our study being 57% and 23.5% while on the other hand, specificity and negative predictive values were 96.5% and 99.2% respectively, which were higher than ours.

Crossen JS et al¹⁷ determined sensitivity and specificity values of uterine artery resistance index in the prediction of IUGR, which being 74% and 68% respectively were lower than those calculated in our study.

Conclusion

IUGR is a major cause of increased perinatal morbidity and mortality in our country and it is the top most adverse outcome associated with preeclampsia. Doppler ultrasonography is one of the most important clinical tools for fetomaternal surveillance in high-risk pregnancies such as preeclampsia. Uterine artery resistance index should be assessed in preeclamptic patients so that early detection of intrauterine growth retardation can be done and those patients can be booked for delivery at the hospital in order to make it possible for timely management.

Conflict of Interest: Declared None

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