

Prediction of Poor Fetal Outcome by Mid-Trimester Uterine Artery Doppler Velocimetry in Women with Gestational Hypertension

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ABSTRACT

Objective: to correlate the importance of late second trimester uterine artery doppler indices and waveform with the probabilities of adverse outcomes.

Study Design: Correlation study.

Place and Duration of Study: The study was conducted at the Department of Radiology, in collaboration with Department of Gynecology and Obstetrics at Pakistan Institute of Medical Sciences hospital, Islamabad, Pakistan, from Jan 2018 to Dec 2018.

Methodology: Fifty Patients labeled with pregnancy induced hypertension were included in the study. Doppler ultrasound assessments were performed at 20 -2 4weeks of gestation. Pulsatility Index, Resistive Index and Systolic Diastolic ratio were calculated.

Results: Out of 50 patients, 36(72%) had normal and 16(28%) had abnormal Pulsatility index on right side, 34(68%) had normal and 16(32%) abnormal on left side, collectively 27(54%) normal, 13(26%) unilaterally abnormal and 10(20%) bilaterally abnormal. Among the patients with raised Pulsatility Index, 23(74%) had poor fetal outcome, whereas among those with normal Pulsatility Index 22(81.4%) patients had normal fetal outcome and only 5(18.5%) had poor fetal outcome. Results of current study show highly significant correlation between abnormal Pulsatility index and poor fetal outcome ($r=0.56$, p -value <0.001). Also significant association (OR-8.25 and $p=0.001$) was seen between abnormal pulsatility index and abnormal fetal outcome.

Conclusion: The uterine artery Doppler velocimetry should be used as a primary tool for fetomaternal surveillance in hypertensive pregnancies because the changes in uterine circulation strongly correlate with pregnancy outcome.

Keywords: Fetal outcome, Mid trimester, Pregnancy induced Hypertension, Uterine artery Doppler.

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INTRODUCTION

Pregnancy induced hypertension is defined as onset of new hypertension (systolic blood pressure over 145 or diastolic blood pressure over 95 mmHg) after 20 weeks' gestation (in the absence of any signs of pre-eclampsia i-e protein in urine or seizure complaints). It has come across as the major cause of perinatal morbidity and mortality (preterm birth and IUGR) affecting 6-8% of pregnant women.^{1,2} Hypertensive disorders are accounted for representing one of the most common medical complications of pregnancy with at least 7% of pregnancies being affected by arterial hypertension which leads to increased risk of prenatal complications including death of a mother or a child.^{3,4} Globally it accounts for a reported incidence of 12% of maternal deaths. Demise of a woman during pregnancy or within 6weeks postpartum is referred to as maternal

mortality. At Lady reading hospital Peshawar, a retrospective, analytical study was conducted over a period of seven years to search for the direct causes of maternal mortality. The results indicated that pregnancy-induced hypertension, hemorrhage and uterine rupture were the most common causes of maternal mortality.⁵

Pathologically development of pregnancy induced hypertension appears to occur at maternal-fetal interface due to impaired trophoblastic invasion of spiral arteries. Due to inadequate spiral arteries invasion, increased vascular resistance develops causing hindrance to the blood flow. This results in poor flow of blood into the placenta leading to ischemic changes in utero-placental circulation.⁶

The fetus of pregnancies affected by gestational hypertension are under an increased threat of developing IUGR i-e fetal weigh below 10th percentile for given gestational age, stillbirth i-e in-utero death of a fetus after 28th week of pregnancy, preterm birth i-e at least 3weeks early delivery as per dates, and

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placental abruption more so when it occurs prematurely.⁷ The chances of developing pre-eclampsia and eclampsia, a condition which encompasses hypertension, proteins in urine and seizures, are increased in pregnancies who develop gestational hypertension. According to a study 15% of maternal deaths are caused by Pregnancy induced Hypertension, thus making it the second most common cause of maternal mortality.⁸

Uterine artery Doppler provides a quick, easy and precise means to detect any resistance developing in the utero-placental blood flow.⁶ The current study was carried out keeping in view the advantages of uterine artery Doppler performed in mid trimester. Doppler indices and wave form were recorded and later correlated with the fetal outcome.

METHODOLOGY

This correlational study was carried out on 50 patients labelled with Pregnancy Induced Hypertension. Written informed consent was obtained from all study participants. Approval for the study was obtained from the institution's ethics committee. The study was conducted at the Department of Radiology, PIMS in collaboration with Department of Gynecology and Obstetrics from January 2018 to December 2018. Sample size was calculated with help of CPSP by keeping sensitivity of 91.23%, specificity of 99.06% and prevalence of 91% and confidence interval of 95%.⁹ Consecutive sampling technique was adopted.

Inclusion Criteria: Patients with blood pressure \geq 130/90 after 20weeks of gestation were included in the study.

Exclusion Criteria: Women with multiple pregnancies, chronic hypertension, fetus with congenital abnormalities, history of antepartum hemorrhage and patients with hepatic, renal or cardiac disease were excluded from the study.

Doppler ultrasound assessments were performed at 20 -24weeks gestation. After proper exposure and positioning of the patient, antenatal scan of each subject was performed. Thorough evaluation was performed to rule out any congenital fetal anomalies. Fetal weight was calculated using the Hadlock formula. All these studies were carried out on Xario 200 Ultrasound Machine. The fetus was classified as preterm if the birth takes place at least 3 weeks before the estimated due date and IUGR if the fetal weight is below the 10th percentile for given gestational age.

Uterine arteries were identified by placing the transducer in the lower quadrant of abdomen. Doppler analysis of uterine arteries was performed at their crossover point with the external iliac artery. Keeping in mind easy reproducibility of results, readings were taken 1cm distal to the point of crossover. Three consecutive reading were obtained from each side by placing the pulsed Doppler gate in the middle of the vessel. Angle of insonation was kept 60 or below in all the studies. Auto trace method was used to calculate RI (resistance to blood flow caused by micro vascular bed), PI (Difference between maximum and minimum blood flow velocity) and Mean \pm SD ratios (comparison of systolic and diastolic flow and resultant resistance in placental vasculature). The presence or absence of persistent early diastolic notch was noted. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) for Windows version 16. Mean and standard deviation was calculated for quantitative variables. Correlation was checked via Spearman correlation. For risk assessment, relative risk and Odd's ratio was calculated.

RESULTS

Fifty patients with singleton pregnancy and labeled with gestational hypertension were included in the study. Mean age of these patients was 29.36 \pm 4.3 years. The study was carried out in mid-trimester i-e 24 - 28weeks gestational age.

Patients with blood pressure 130/100 to 140/100 were included in Group I, patients with blood pressure 140/100 to 150/110 were included in Group II, patients with blood pressure 150/110 to 160/110 were included in Group III. Number of patients falling in group I, II and III were 24(48%), 19(38%) and 07(14%) respectively. Keeping in view the outcome of patients, patients in group III had higher probability of poor fetal outcome. Out of a total of 7 patients in group III, 2 patients had abnormal outcome (30%) (Table-1).

Indices for bilateral Uterine arteries were taken. Among right uterine artery 36 patients had normal values while 14 had deranged values. On left, 34 had normal while 16 had abnormal readings. Out of 50 patients 10 patients had abnormal indices bilaterally.

Among the 22 patients with normal fetal outcome 6 patients had unilateral abnormal PI and 2 had bilateral abnormal indices. Out of 5 IUGR cases 2 patients had normal PI value, 2 had unilateral and 1 had bilateral abnormal PI values. Among 6 preterm

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cases, 2 had normal PI value, 3 had unilateral and 1 had bilateral abnormal indices. In the preterm with IUGR category out of 3 patients one had normal PI value, 1 with unilateral and 1 with bilateral abnormal PI indices was seen. In the IUGR with IUD cases there was one patient who had bilateral abnormal indices. In the preterm followed by perinatal demise group, out of 5 patients one had unilateral and 4 had bilateral abnormal PI indices (Table-2).

Table-I: Blood Pressure Versus Fetal (n=50)

Outcome	Blood Pressure			Total
	130/100	140/100	150/110	
	-	-	-	
	140/100	150/110	160/110	
Normal	17(34%)	9(18%)	4(8%)	30(60%)
IUGR	3(6%)	2(4%)	0(0%)	5(10%)
Preterm	3(6%)	2(4%)	1(2%)	6(12%)
Preterm+Intra Uterine Growth Retardation	0(0%)	2(2%)	1(1%)	3(3%)
Intra Uterine Growth Retardation+ Intrauterine Death	0(0%)	0(0%)	1(2%)	1(2%)
Preterm + Death	1(2%)	4(8%)	0(0%)	5(5%)
Total	24(48%)	19(38%)	7(14%)	50(100%)

Table-II: Outcome versus Pulsatility Index(n=50)

Outcome	Pulsatility Index			Total
	Normal	Unilateral Abnormal	Bilateral Abnormal	
Normal	22	6	2	30
Intra Uterine Growth Retardation	2	2	1	5
Preterm	2	3	1	6
Preterm + Intra Uterine Growth Retardation	1	1	1	3
Intra Uterine Growth Retardation+ Intra Uterine Death	0	0	1	1
Preterm + Death	0	1	4	5
	27	13	10	50

The normal pulsatility index was PI <1.4. Pulsatility index of >1.4 was taken as an abnormal finding. Out of 50 patients, 36 had normal and 16 had abnormal Pulsatility index. Among the patients with raised PI, 76% had poor fetal outcome, whereas among

those with normal PI 81% patients had normal fetal outcome and only 19% had poor fetal outcome. Results of current study show highly significant correlation between abnormal Pulsatility index and poor fetal outcome ($r=0.56$, $p\text{-value}<0.001$). Also significant association (OR-8.25 and $p=0.001$) was seen between abnormal pulsatility index and abnormal fetal outcome.

The normal resistive index was taken as less than 1. Out of 50 patients, 34 had normal while 16 had abnormal resistive index. Majority of the patients with abnormal RI had poor fetal outcome. Out of 16, 11 had abnormal fetal outcome which makes a significant 68.75% of patients Correlation coefficient of RI with outcome came out to be ($r=0.54$, $p\text{-value}<0.001$).

The normal S/D ratio was taken as 1.9 ± 0.35 as normal value. No significant correlation ($r=0.23$, $p\text{-value}=0.12$) was seen between the abnormal fetal outcome and abnormal S/D ratio.

Persistent diastolic notch was noted in eight patients, two of them showing unilateral left sided and rest demonstrate bilateral Persistent diastolic notch pattern (Figure-1). All the patients with Persistent diastolic notch had abnormal fetal outcome. Each patient showed a spectrum of abnormalities ranging from IUD, IUGR, Preterm and Post-natal expiry. This signifies its importance since it strongly predicts the outcome.

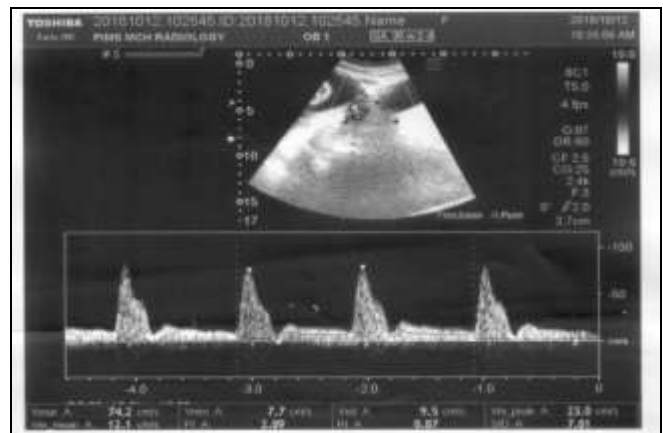


Figure-1: Ultrasound Image of Persistent Diastolic Notch

The overall fetal outcome included 60% normal fetus with no co-morbid, 12% preterm, 10% IUGR, 10% preterm followed by fetal demise, 6% preterm and IUGR and 2% IUGR and IUD (Figure-2).

Patients with poor pulsatility indices and persistent diastolic notch have higher risk of poor fetal

outcome (RR=2.8, $p=0.001$) than the ones with normal uterine artery Doppler Pulsatility index.

Our study indicated significant correlation between patients with normal and abnormal uterine artery dopplers in terms of poor fetal outcomes. In the current study poor fetal outcome was seen in 40 % of patients with raised Pulsatility index /persistent diastolic notch.

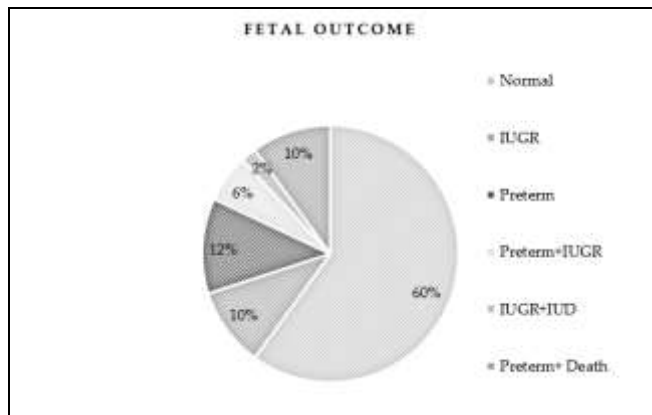


Figure-2: Overall Fetal Outcome in Form of Pie Chart

DISCUSSION

Study carried out by Papageorgiou *et al.*, verified that the outcome of fetal growth retardation and perinatal demise was significantly linked with increased resistance to flow in the uterine arteries. The probability for development of fetal growth restriction is about 4 in women due to aggravation in resistance to flow in second trimester in comparison to 0.8 in those with normal Doppler studies. Like our study the risk of poor fetal outcome in patients with abnormal Doppler result is about 2.5 times higher than the background risk.¹⁰

The group of women at risk of delivering a growth retarded or preterm baby can be recognized with uterine artery Doppler studies as shown in study by Harrington *et al.* According to this study persistent diastolic notch and qualitative assessment of the Doppler waveform were more sensitive parameters for screening when compared to RI or S/D alone. Similar to our study the prediction for determining the poor outcome can be confidently made by the presence of bilateral notching. In their study they highlight that if the uterine artery Doppler indices remained high or the bilateral notch persists by 24weeks than significant problem developed in placental growth and these patients were considered in high risk group.¹¹

In order to meet the gestational demands the spiral arteries are modified into distended low resistance channels that are able to provide increased blood supply to the fetoplacental unit, which reaches to about 10 times that of non-pregnant uterus by the third trimester.

The normal phenomenon during pregnancy is the transformation of spiral arteries into dilated vessels to increase the capacity of blood flow through them which is the requirement as the fetus reaches term period. The increase in caliber results in approximately 10 times raise in blood supply as compared to the non-pregnant uterus. This physiologic phenomenon relies on the trophoblastic invasion of the spiral arteries. This breach occurs gradually, beginning with stuffing of the distal ends of the arteries followed by relocation into the decidual segments and, after several weeks' delay, into the myometrial segments. These changes occur in two steps with the first stage lapsing between the first 8 - 10 weeks and second stage from 14 - 24 weeks.¹¹

Another study by Martin has mentioned that the sensitivity of raised PI of uterine artery doppler in determining the fetus at risk of developing fetal growth retardation was greater when the Doppler study was carried out at 22 -24 weeks rather than at 11-14 weeks. Albaiges G *et al.*, have found out that the probability of detecting a fetus at risk for developing growth retardation was better depicted by uterine artery Doppler carried out at 22-24 weeks rather than at 11 - 14 weeks.¹³

Van den Elzan *et al.*, studied 352 women in late first trimester and concluded that when the group of patients with highest and lowest PI were compared, former group had the increased risk for developing Pregnancy induced hypertension and fetal growth retardation by a factor of 4 and 2 respectively.¹⁴

Doppler ultrasound is used to measure the blood flow velocity in uterine arteries in cases where placental perfusion is compromised. Inadequate trophoblastic invasion is labelled when persistence of early diastolic notch after 2nd trimester or abnormal Doppler indices are recorded. V Dascauet al have shown in their study that there is a six fold increased risk of preeclampsia in pregnancies affected by abnormal uterine artery Doppler indices during second trimester (High pulsatility index and /or persistent early diastolic notch).¹⁵ M Baratiet al have highlighted a very important aspect in terms of managing high

risk patients with history of preeclampsia in their previous pregnancy. According to this study normal uterine artery Doppler indices provide excellent negative predictive values.¹⁶

Sharma et al and Poon *et al.*, mentioned in their study that uterine artery Doppler in late second trimester has significantly high predictive value for early detection of pregnancy induced hypertension and pre-eclampsia.^{17,18}

CONCLUSION

The results of this study clearly indicate that uterine artery Doppler can be used as an effective tool in detecting fetus at risk of preterm birth and developing growth retardation. Therefore, it should be routinely practiced in women with gestational hypertension. It can prove useful in reducing fetal and maternal morbidity and mortality.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SS & SZ: Data acquisition, data analysis, critical review, approval of the final version to be published.

SZS & RR: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

UA & SS: Conception, data analysis, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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