

# Comparison of Uterine Artery Dynamics in Normotensive and Hypertensive Pregnancies on Doppler Ultrasound

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## ABSTRACT

**Background:** Hypertension during pregnancy is a common disease that can alter the health of both mothers and fetus. It is a leading cause of maternal, fetal, and neonatal death, as well as an increased risk of having an undesirable pregnancy outcome.

**Objective:** To compare uterine artery dynamics in normotensive and gestational hypertensive pregnancies on Doppler ultrasound.

**Methodology:** A cross-sectional case control study was carried out in Radiology department of District Head Quarter (DHQ) hospital, Faisalabad. Written consent was taken from all patients before the ultrasound examination. The calculated sample size was 98. Patients were assessed for eligibility in inclusion criteria. Confirmation of intrauterine living pregnancy and gestational age was done with routine obstetric ultrasound. Enrolled pregnant patients both normal and hypertensive were assessed for uterine artery Doppler ultrasound examination.

**Results:** Ninety eight women, forty-nine with hypertension and forty-nine normal women participated in the investigation. The comparison of data showed that pre pregnancy weight and mean blood pressure were significantly high in hypertensive group when compared to the normotensive group ( $P < 0.05$ ). Doppler ultrasound also showed that the values of uterine artery parameters such as S/D Ratio, PI, RI was significantly high in hypertensive group when compared to the normotensive group ( $P < 0.05$ ).

### Conclusion:

The Uterine artery Doppler parameters are significantly higher in hypertensive patients as compared to normotensive patients. According to the findings of our study, notching on the right, left, or bilateral, as well as Pulsatility index and Resistivity Index, are diagnostic parameters for evaluating the complications before they worsen.

**Keywords:** Uterine artery, Gestational hypertension, Doppler Ultrasound, Doppler Indices, Pre-Eclampsia

## INTRODUCTION

Hypertension during pregnancy is a common disease<sup>1</sup> that can alter the health of both mothers and fetus.<sup>2</sup> It is a leading cause of maternal, fetal, and neonatal death, as well as an increased risk of having an undesirable pregnancy outcome. It was revealed that people with hypertension all through pregnancy are considerably more likely than normal pregnant women to deliver a fetus to with birth-weight, and the probability of a reduced neonatal rate is higher.<sup>3</sup> Gestational hypertension continues to be a major health concern in both developed and emerging nations, going to contribute to maternal and neonatal morbidity and mortality.<sup>4</sup> Gestational hypertension is a widespread medical condition that influence 20% to 30% of the adult population and much more over 5% to 8% of all pregnancies around the world.<sup>5</sup> Hypertension during pregnancy is thought to account for 15–20 percent of maternal mortality in the United States.<sup>6</sup> Pakistan currently ranks third in the world in aspects of fetal, maternal, and child mortality<sup>7</sup> as per a 2007 report, 1/3 of maternal deaths in women admitted to a tertiary hospital in Pakistan occurred during child birth were due to pregnancy-related hypertension. In Pakistan, one out of every 89 women dies from maternal causes; with preeclampsia and eclampsia being two of the most common causes.<sup>8</sup> Maternal deaths occur in approximately 10%–25% of these cases.<sup>9</sup> Early detection and treatment of preeclampsia can result in better maternal and fetal results. Over the last two decades, there has been a lot of focus on the risk prediction of preeclampsia as well as preeclampsia-related disorders. Women at significant risk of preeclampsia benefit from low-dose aspirin before 16 weeks of pregnancy.<sup>10,11</sup> Considering Doppler sonography's recognized role in assessing human vascular hemodynamics, it is reasonable to presume that the effects of hypertension in pregnancy on the fetus may be predicted and monitored using this approach. In fetal monitoring, the RI, PI, and S/D ratio of the UtA are seen as being more sensitive and specific than those of the umbilical artery. The

purpose of the study is to estimate the range, mean and standard deviation of PI, RI and S/D ratio of the UtA in second trimester of normotensive and gestational hypertensive pregnancies on Doppler ultrasound in order to find out the fetal status. This study aims to determine the prognostic value of UtA Doppler in hypertension for prevention and regulation of maternal-fetal morbidity and mortality rate that is associated with pre-eclampsia and to find the predictive values of bilateral uterine artery notching in pregnant females to reduce the chances of adverse pregnancy results.

## MATERIAL AND METHODOLOGY

This is a Cross-sectional case control study conducted in Department of Radiology District Headquarter Hospital (DHQ) Faisalabad. Non-probability Purposive sampling was conducted at the time of enrollment of the patient. The calculated sample size was 98. The sample size was calculated at 95% confidence level and 7% margin of error. 49 normotensive and 49 gestational hypertensive pregnant females were included. The **inclusion criteria include** single pregnant women, women with 20<sup>th</sup> to 26<sup>th</sup> week of gestational period, patients of 20-40 years of age and patients with normal and hypertensive pregnancy. **Exclusion Criteria include** multiple gestations like twins, triplets etc., women with gestational diabetes, congenital anomalies of fetus, women with cardiovascular and cerebrovascular disease before pregnancy, females with previous history of cesarean, low birth rate and premature birth. Patients were assessed for eligibility in inclusion criteria. Non-consented individuals and patients not meeting the inclusion criteria were excluded. Enrolled individuals were assessed for the uterine artery dynamics on Doppler ultrasound. After obtaining a midsagittal segment of the uterus and cervical canal, the transducer was moved laterally till the paracervical vessels were visible. CW Doppler was applied. The UtA were observed as aliasing vessels all along cervix's side.

Using PW Doppler, flow velocity waveforms from the ascending branch of the UtA at the point closest to the internal os was obtained, with the Doppler sampling gate set at 2 mm. To obtain the maximum systolic and end-diastolic velocities, the smallest angle of insonation (30°) was used. The PI was calculated after obtaining three similar consecutive waveforms. The mean PI was calculated by adding the average readings from each side. The presence or absence of UtA unilateral or bilateral notching was noted. The S/D ratio PI and RI for hypertensive patients were calculated in Figure 1.



Figure 1: Multiparous hypertensive with gestational age 26 weeks. Figure shows UtA notch with PI and RI were 1.17 and 0.78 respectively. Calculated S/D Ratio was 4.46.

The S/D ratio PI and RI for normotensive patients were calculated in Figure 2.

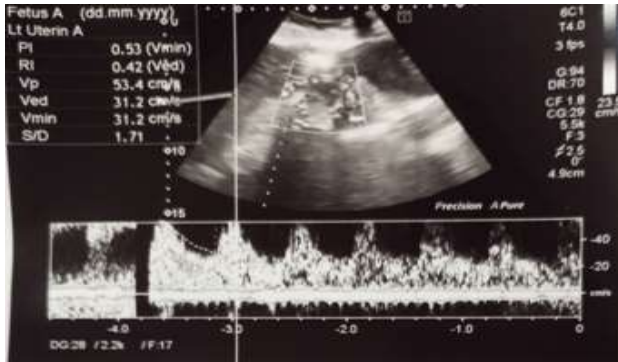


Figure 2: Multiparous normotensive with gestational age 25.3 weeks. Figure shows normal UtA Doppler with PI and RI were 0.53 and 0.42 respectively. Calculated S/D Ratio was 1.71

**RESULTS**

This was a Cross-sectional case control study of 98 pregnant women at second trimester. Among those cases, the mean patient age was 28.7 years and the mean GA was 22.6 weeks in hypertensive group while 30.9 and 22.4 weeks was in control groups.

Table 1: Percentage of UtA Notching among the hypertensive and normotensive group

UtA Notching	Frequency	Percentage (%)
Right UtA Notch	19	19.4
Left UtA Notch	18	18.4
Bilateral Notching	20	20.4
Absent Notch	41	41.8
Total	98	100

Table 1 represents among 98 women of normal and hypertensive group the doppler analysis shows 19.4% right notch, 18.4% left UtA notching, 20.4% pregnant females doppler bilateral notching of uterine artery. Remaining 41.8% shows absent notch during Doppler ultrasound of gestational age 18-26 weeks.

Table 2: Comparison of Pulsatility Index in Right and Left Uterine Artery among the hypertensive and normotensive group.

Group		Systolic-diastolic ratio	Resistivity Index	Pulsatility Index
Case	Mean	2.94	0.6304	1.09
	N	49	49	49
	Std. Deviation	0.84	0.10	0.39
	Minimum	1.49	0.33	0.39
	Maximum	4.72	0.81	1.93
Control	Mean	1.83	0.4398	0.59
	N	49	49	49
	Std. Deviation	0.32	0.08	0.16
	Minimum	1.45	0.31	0.35
	Maximum	2.72	0.63	0.95
Total	Mean	2.39	0.53	0.84
	N	98	98	98
	Std. Deviation	0.85	0.13	0.39
	Minimum	1.45	0.31	0.35
	Maximum	4.72	0.81	1.93

Table 2 represents that in 49 hypertensive women the minimum S/D Ratio in UtA was 1.49 and maximum S/D Ratio in UtA was 2.94 (SD= 0.84) while in 49 normotensive women the minimum S/D Ratio in UtA was 1.45 and maximum S/D Ratio in UtA was 2.72 with the mean for S/D Ratio in UtA was 1.83 (SD= 0.32).

In hypertensive group the minimum RI in UtA was 0.33 and maximum RI in UtA was 0.81 with the mean for RI in UtA was 0.63 (SD= 0.10) while in normotensive group the minimum RI in UtA was 0.31 and maximum RI in UtA was 0.63 with the mean for RI in UtA was 0.43 (SD= 0.88).

In 49 hypertensive group the minimum PI in UtA was 0.39 and maximum PI in UtA was 1.93 with the mean for PI in UtA was 1.09 (SD= 0.39) while in normotensive group the minimum PI in UtA was 0.35 and maximum PI in UtA was 0.95 with the mean for PI in UtA was 0.59 (SD= 0.16)

Table 3: Comparison of T-Test among UtA Doppler Parameters among hypertensive and normotensive group.

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
Right systolic-diastolic ratio	Case	49	2.9484	.84577	.12082
	Control	49	1.8319	.32614	.04707
Right Resistivity Index	Case	49	.6304	.10350	.01479
	Control	49	.4398	.08898	.01284
Right Pulsatility Index	Case	49	1.0906	.39591	.05656
	Control	49	.5935	.16186	.02336

Table 4 showing a significant difference was found in S/D ratio of UtA in hypertensive and normotensive group where the mean difference is 1.116 as the p-value < 0.000. A significant difference was found in RI of UtA in hypertensive and normotensive group where the mean difference is 0.19 as the p-value < 0.000. A significant difference was found in PI of UtA in hypertensive and normotensive group where the mean difference is 0.49 as the p-value < 0.000.

Table 4: Comparison of Independent Samples Test of UtA Doppler Parameters among hypertensive and normotensive group.

	Levene's Test for Equality of Variances		t-test for Equality of Means				t-test for Equality of Means	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference

									Upper	Lower
Systolic-diastolic ratio	Equal variances assumed	35.16	.000	8.544	95	.00	1.116	0.130	0.857	1.375
	Equal variances not assumed			8.610	62.21	.00	1.116	0.129	0.857	1.375
Resistivity Index	Equal variances assumed	.134	.715	9.718	95	.00	0.190	0.019	0.151	0.229
	Equal variances not assumed			9.733	93.43	.00	0.190	0.019	0.151	0.229
Pulsatility Index	Equal variances assumed	27.95	.000	8.063	95	.00	0.497	0.061	0.374	0.619
	Equal variances not assumed			8.123	63.87	.000	0.497	0.061	0.374	0.619

## DISCUSSION

It was a cross-sectional case control study of 98 pregnant women in second trimester which include 49 hypertensive and 49 normal pregnant women. This study evaluated the use of UtA Doppler parameters at the second trimester of pregnancy to predict the adverse maternal and fetal complications. The collected data results showed that there is a significant difference between the case and control group.

The pre-pregnancy weight and mean Blood pressure were significantly high in the hypertensive group than in the normal group ( $P < 0.05$ ). According to Ehrenthal et al., the incidence of hypertension during pregnancy increased as pre-pregnancy BMI increased, although this was not linked to other obesity-related problems.<sup>12</sup>

In order to support the needs of fetal growth and development during pregnancy, the UtA provide the blood and nutrition to the fetus. The UtA PI would decline during normal pregnancy, resistance would gradually decrease, and both would revert to pre-pregnancy levels six weeks after delivery.<sup>13</sup> Doppler ultrasonography can be used to determine the hemodynamic parameters of the UtA. The present study results shows that the S/D, PI and RI were significantly high in the hypertensive group than in the normal group ( $P < 0.05$ ), showing that abnormal uterine artery is corresponded to the symptoms of hypertension. With the worsen of hypertension during pregnancy, the RI of the UtA would be increase, and the fetus's survival rate could be substantially impacted, contribute to adverse effects.

Doppler parameter has been used to predict pregnancy problems in a variety of studies.<sup>14-16</sup> The reliability of the Doppler scan in second trimester to detect maternal and fetal problems was also tested in this study. The mean UtA PI as well as the mean uterine S/D ratio and were found to be the strongest predictors of maternal problems and adverse prenatal complications in the second trimester, respectively.

Likewise, Cnossen et al.<sup>17</sup> found that in both low-risk and high-risk individuals, an elevated PI in the second trimester significantly predicted total maternal problems. Kleinrouweler et al.<sup>18</sup> also found that the strongest predictor of unfavorable pregnancy problems is a combination of mean RI or PI and presence of bilateral notching. All of these findings support the findings of this study, which show that a combination of Doppler parameters is more accurate in predicting unfavorable pregnancy problems.

Most studies including Harman and Baschat et.al showed that UtA notch detected on doppler ultrasonography in the second trimester is effective in diagnosing the pre-eclampsia condition,<sup>19</sup> and our study confirms that this is accurate because our findings also predict that preeclampsia will occur in those women who have notch in the second trimester doppler ultrasound. In our study 19.4% (19 women) showed right UtA notch, 18.4 % (18 women) showed left UtA notch while 20.4% (20 women) showed bilateral notching. In 41.8% (41 women) patients no notch is seen.

According to a study employing a Doppler scan to predict fetal difficulties in the second trimester showed that S/D ratio greater than 2.6 and a notch in the UtA waveform may suggest that the pregnancy is complicated by stillbirth, early birth, IUGR, and maternal preeclampsia.<sup>20</sup> Our findings in the study from the

Doppler parameter shows that PI greater than 1.09 and S/D ratio greater than 2.82 in the second trimester can be used to predict adverse maternal, and adverse fetal results.

In summary, UtA Doppler ultrasonography, which is conducted at 20 to 26 weeks of gestation, may be effective as an adequate tool for identification of high-risk pregnancy-related issues such as IUGR, intrauterine fetal death, and PE.

## CONCLUSION

The Uterine artery Doppler parameters are significantly higher in hypertensive patients as compared to normotensive patients. According to the findings of our study, notching on the right, left, or bilateral, as well as Pulsatility index and Resistivity Index, are diagnostic parameters for evaluating the complications before they worsen.

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