

Doppler Assessment Of Umbilical Blood Flow In 2nd And 3rd Trimester Pregnancies Of Women With Primary Hypertension

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Abstract

Background: Primary hypertension during pregnancy is a significant risk factor for adverse maternal and fetal outcomes. Doppler ultrasound assessment of umbilical blood flow and amniotic fluid index (AFI) provides information regarding fetoplacental hemodynamics and fetal well-being.

Objective: To evaluate Doppler assessment of umbilical blood flow in second- and third-trimester pregnancies of women with primary hypertension.

Methods: A cross-sectional comparative study included 120 pregnant women between 20 and 39 weeks of gestation, divided equally into a primary-hypertension group (n=60) and normotensive controls (n=60). Umbilical artery RI, PI, S/D ratio and AFI were assessed using Doppler ultrasound.

Results: Mean AFI was lower in the hypertensive group (9.38 ± 0.89) than controls (12.84 ± 1.23 ; $p < 0.001$). Umbilical artery RI, PI and S/D ratio were higher in hypertensive pregnancies: 0.72 ± 0.07 vs 0.58 ± 0.05 , 2.81 ± 0.64 vs 1.24 ± 0.38 , and 3.58 ± 0.48 vs $2.46 \pm$

0.38 , respectively; all were statistically significant.

Conclusion: Primary hypertension was associated with reduced AFI and elevated umbilical artery Doppler indices, consistent with increased fetoplacental vascular

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resistance.

Introduction

Primary hypertension, also known as essential hypertension, is a chronic condition characterized by persistently elevated blood pressure without an identifiable underlying cause. The thesis describes it as the most common form of hypertension and discusses multifactorial contributors to its pathogenesis (Rahimi et al., 2021; Ameer, 2022).

Adequate utero-placental circulation is essential for normal pregnancy. Impaired placentation is associated with fetal growth restriction, perinatal morbidity and mortality, and adverse neurodevelopmental outcomes. Doppler assessment of placental circulation can help identify abnormal vascular resistance and fetuses at risk of compromise (Ekholm, 2017; Grunewald, 2017; Muresan et al., 2016).

Umbilical artery Doppler ultrasound is an established non-invasive method of assessing fetoplacental circulation. The principal indices resistive index (RI), pulsatility index (PI), and systolic/diastolic (S/D) ratio are derived from the umbilical artery velocity waveform and provide indirect information about downstream placental vascular resistance (Su, 2015; Widnes et al., 2018; Mone et al., 2016; Oros et al., 2019).

During normal pregnancy, maturation of the placental vascular bed results in progressive reduction in umbilical artery impedance. Consequently, RI, PI and S/D ratio generally decrease with advancing gestation (Acharya et al., 2005; Lorigo et al., 2018; Ferdous et al., 2019).

Abnormal umbilical artery Doppler findings are particularly relevant in pregnancies complicated by placental dysfunction, fetal growth restriction and hypertensive disease. Doppler surveillance is widely used in high-risk pregnancies because it can identify abnormal fetoplacental resistance and fetal compromise (Alfirevic et al., 2017; Frusca et al., 2018; Vayssi re et al., 2011).

The rationale for the present study was therefore to assess umbilical artery blood-flow indices and AFI in second and third trimester pregnancies with primary hypertension and compare these measurements with normotensive pregnancies.

Objective

To evaluate Doppler assessment of umbilical blood flow in second- and third-trimester pregnancies of women with primary hypertension.

Methodology:

A cross-sectional analytical/comparative study was conducted in the Radiology Department of University of Lahore Teaching Hospital, Lahore, Pakistan, over a period of nine months. The study included a total of 120 participants, comprising 60 women with primary hypertension and 60 normotensive controls. The study included women with singleton pregnancies in the second or third trimester, with and without gestational hypertension. Women with confirmed intrauterine growth restriction (IUGR), ruptured membranes, active labour, or vaginal bleeding were excluded. Ultrasonographic assessment was performed using a Voluson GE 730 Pro V ultrasound system equipped with a 2.0–5.0 MHz convex transducer.

Results:

The mean $\pm$ SD age and gestational age of participants was 31.8 ± 3.8 years and 28.1 ± 4.4 weeks respectively. The mean $\pm$ SD amniotic fluid index in participants with and without primary hypertension was 9.38 ± 3.8 and $12.8 \pm$

1.2 respectively (Table 1). A statistical significance was seen between amniotic fluid index in participants with and without primary hypertension ($P < 0.000$). The mean $\pm$ SD of gestational age in participants with and without primary hypertension was 27.7 ± 4.19 weeks and 28.5 ± 4.7 weeks respectively

Table 1: Independent Samples Test AFI

	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
								Lower Upper
Equal variances assumed	9.287	.003	-	118	.000	-3.45333	.19627	-3.842013.06466
Equal variances not assumed	-	-	-	107.47	.000	-3.45333	.19627	-3.842403.06427

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The mean $\pm$ SD umbilical artery resistive index in participants with and without primary hypertension was 0.72 ± 0.68 and 0.58 ± 0.04 respectively (Table 2). A statistical significance was seen between umbilical artery resistive index in participants with and without primary hypertension ($P < 0.05$).

Table 2: Group Statistics Umbilical artery Resistive Index

Primary Hypertension	N	Mean	Std. Deviation	Std. Error Mean
Yes	60	.7240	.06813	.00880
Umbilical artery RI No	60	.5858	.04608	.00595

Independent Samples Test
Levene's Test for Equality of Variances
t-test for Equality of Means

Umbilical artery RI	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	6.737	.011	13.01	118	.000	.13817	.01062	.11714	.15919
Equal variances not assumed	-	-	-	-	-	-	-	-	-
			13.01	103.636	.000	.13817	.01062	.11711	.15922

not
assumed

The mean $\pm$ SD umbilical artery pulsatility index in participants with and without primary hypertension was 2.81 ± 0.63 and 1.24 ± 0.38 respectively (Table 3). A statistical significance was seen between umbilical artery pulsatility index in participants with and without primary hypertension ($P < 0.05$).

Table 3: Group Statistics Umbilical Artery Pulsatility Index

		Primary Hypertension	N	Mean	Std. Deviation
Umbilical artery PI	Yes		60	2.8128	.63622
	No		60	1.2450	.38096

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
						95% Confidence Interval of the Difference		
						Lower	Upper	
Umbilical artery PI	Equal variances assumed	4.691	.032	16.371	118	.000	1.56783	.09573
	Equal variances not assumed			16.379	6.489	.000	1.56783	.09573

The mean $\pm$ SD umbilical artery S/D ratio in participants with and without primary hypertension was 3.58 ± 0.47 and 2.4 ± 0.37 respectively (Table 4). A statistical significance was seen between umbilical artery resistive index in participants with and without primary hypertension ($P < 0.05$).

Table 4: Group Statistics Umbilical Artery S/D Ratio

Primary Hypertension		N	Mean	Std. Deviation
Umbilical artery S/D Ratio	Yes	60	3.5880	.47760
	No	60	2.4588	.37621

Independent Test

Levene's Test for Equality of Variances					t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
								Lower Upper
Umbilical artery SD Ratios	Equal variance assumed	7.326	.008	14.318	.000	1.12917	.07849	.97374 1.28460
	Equal variance not assumed			14.318	.000	1.12917	.07849	.97365 1.28468

Discussion:

The present study demonstrated altered fetoplacental hemodynamics in hypertensive pregnancy, with significantly lower AFI and higher umbilical artery RI, PI and S/D ratio than in normotensive pregnancies. The lower AFI is consistent with the source thesis discussion, which attributes reduced amniotic fluid to impaired placental perfusion and consequent reduction in fetal urine output (Smith et al., 2018; Lopez et al., 2017; Singh et al., 2019).

The increased RI in the hypertensive group is consistent with Udo et al. (2017), who found higher umbilical artery RI and PI in pregnancy-induced hypertension, and with Hashemi et al. (2019), who reported significantly higher RI, PI and S/D ratios in hypertensive pregnancies. Ayyuba et al. (2015) also found abnormal RI to be associated with adverse pregnancy outcomes.

The present PI findings are directionally consistent with Rasool et al. (2022), who reported higher PI, RI and S/D values in hypertensive women, and with Awan (2015), who found higher PI, RI and S/D values in hypertensive pregnancies in the second trimester. The magnitude of Doppler abnormalities varied across studies, supporting the influence of gestational age and disease characteristics.

The elevated S/D ratio in the present study is consistent with findings from Udo et al. (2017), Hashemi et al. (2019), and Anjum et al. (2020). Anjum et al. (2020) reported that an S/D ratio threshold of 2.3 had useful sensitivity and specificity for identifying IUGR in pregnancy-induced hypertension.

Hazra et al. (2019) reported abnormal umbilical artery Doppler velocimetry in 76% of their PIH cohort and found associations between abnormal S/D ratios and adverse outcomes such as pre-eclampsia, IUGR and NICU admission. Khalid et al. (2021) similarly reported abnormal umbilical artery flow in hypertensive pregnancies and associations with IUGR and intrauterine death.

Alfirevic et al. (2017) found that although Doppler abnormalities can indicate poor prognosis, evidence for improvement in several clinical outcomes is variable. Doppler indices can differ according to the sampling site along the umbilical cord. Studies by Khare et al. (2019), Arduini et al. (2021), Gur et al. (2020), and Cohen et al. (2024) demonstrate site-dependent variation in umbilical artery Doppler measurements and support standardized sampling techniques. Overall, the findings of the present study are consistent with the literature cited in the thesis existing literature

Conclusion: Primary hypertension was associated with reduced AFI and elevated umbilical artery Doppler indices, consistent with increased fetoplacental vascular resistance.

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Figure 1: Ultrasound image of umbilical artery RI 0.5, PI 0.86 and SD ratio 2.22

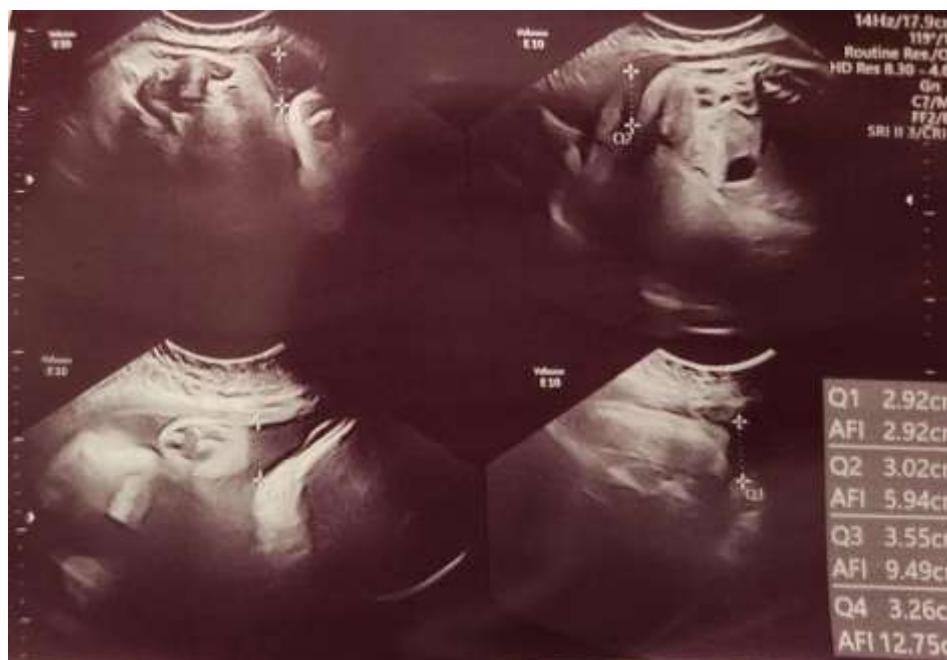


Figure 2: Ultrasound image of Amniotic fluid measuring 12.75 cm

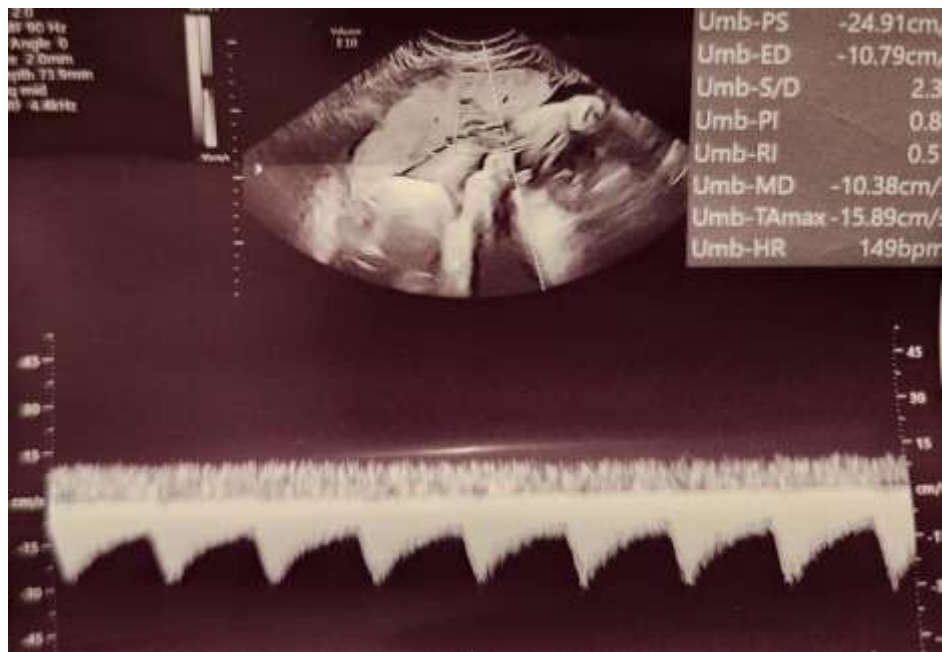


Figure 3: Ultrasound image of umbilical artery RI 0.5, PI 0.8 and SD ratio 2.3



Figure 4: Ultrasound image of Amniotic fluid measuring 12.92 cm