

Evaluation of Doppler Indices for Umbilical Artery in Hypertensive Women in Third Trimester of pregnancy

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ABSTRACT

Background: The hypertensive disorders affect pregnant women and can create complications for the women in last trimester of pregnancy. To assess the impact of high hypertension, doppler scan is recommended in the third trimester.

Objective: Present explores values of PSV, EDV, S/D ratio, RI and PI among normotensive and hypertensive pregnant women during third trimester of pregnancy in Islamabad, Pakistan.

Material and Methods: A Cross-sectional study was conducted at PIMS hospital Islamabad with objectives to evaluate doppler indices in fetal umbilical artery among hypertensive pregnant women in the third trimester of pregnancy. Data were collected from 1st February 2022 to 15th May 2022. A total of 93 pregnant women were recruited from already registered at maternal child health care center of PIMS and recommended for doppler indices scan. Toshiba Aplio 300 Ultrasound System was used for the assessment. Data about S/D ratio, RI and PI was analyzed by using IBM SPSS® software platform.

Results: Mean Age of pregnant women in our study conducted was 26.722 ± 4.133 . Also the mean gestational week for pregnant women was 32.163 ± 2.35 . Doppler indices were significantly raised in hypertensive women as compared to normotensive women. Doppler indices i.e. Pulsatility Index (Mean 1.049 ± 0.312 vs 1.360 ± 0.421), Resistivity Index (Mean 0.631 ± 0.114 vs 0.743 ± 0.01), Systolic/Diastolic flow (Mean 2.672 ± 0.512 vs 3.818 ± 0.986) were increased in third trimester of hypertensive women as compared to normotensive patients.

Conclusion: In this study, among doppler indices pulsatility index and resistivity index were identified as significant after applying null hypothesis test. Doppler ultrasound should be used to identify vascular resistance and evaluating degree of fetoplacental blood flow in hypertensive pregnant women.

Keywords: Umbilical Artery, Doppler Ultrasound, Obstetrics, Hypertension

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INTRODUCTION

Doppler ultrasound has opened the field of obstetrics which can improve the risk assessment. The placenta is to transport oxygen and nutrients among maternal and fetal circulation system and creation of chemicals through the umbilical cord ¹. The normal umbilical cord contains two arteries and one vein, the blood vessels are surrounded by Wharton's jelly, which protects them from injury ². The rudimentary umbilical cord is formed during the 4th to 8th weeks of gestation (calculated from the first day of the last menstrual cycle) by the expanding amnion enveloping tissue from the body stalk, the omphalomesenteric duct, and the umbilical coelom. Blood flow is established within the umbilical cord by the end of the 5th week of gestation ². At mid-gestation, the percentage of umbilical blood in fetal circulation is approximately 30% of fetal cardiac output ³. Umbilical blood flow decreases significantly during the last trimester of pregnancy, becoming inversely proportional

to fetal weight measured in kilograms. During the final trimester, this percentage drops significantly, eventually falling below 20%. The umbilical vein enters the fetus's abdominal region⁴. The umbilical arteries transport deoxygenated blood from the fetus to the placenta. The umbilical vein carries oxygenated blood from placenta and drains into the left portal vein⁵. Sufficient amount of blood (supplements and oxygen) is necessitated for the legitimate development of the embryo during pregnancy. The uterine and umbilical arteries provide most of the blood to the uteroplacental and fetoplacental circulation⁶. One of the most prevalent complications that affects human pregnancy is hypertensive disease that effects on pregnancy⁷. It is a primary cause of maternal and neonatal death and morbidity⁸. Up to 10% of pregnancies are complicated by hypertensive problems⁹. According to the American college of obstetricians and gynaecologists' guidelines for blood pressure during pregnancy Normal: Less than 120/80 mm Hg, Elevated: Systolic between 120 and 129 mm Hg and diastolic less than 80 mm Hg¹⁰.

Hypertension is the most common cause of maternal death, intrauterine growth retardation (IUGR), and fetal preterm¹¹. Traditionally, the third trimester is defined as the antenatal period between 28 and 42 weeks of gestation¹². Ultrasound evaluations in the third trimester can be used to assess fetal well-being and prevent fetal morbidity and mortality. Poor umbilical blood flow can lead to a baby experiencing growth restriction¹³. Doppler ultrasound can detect reduced placental perfusion due by vascular anomalies before any clinical signs of Hypertension¹⁴. The utilization of Doppler ultrasound in pregnancy to assess the umbilical arteries is a significant clinical tool for detecting obstetric complications because of uteroplacental inadequacy, which might expand the danger of an unfavorable impact on both the mother and the baby during pregnancy and delivery. Doppler Ultrasound gives a non-invasive technique to investigate the maternal and fetal hemodynamic in pregnancy. Some studies consider the umbilical artery to be a relevant vessel in the Pre- eclampsia evaluation¹¹. The Doppler ultrasound of the umbilical artery is frequently used to assess a fetus suspected of being at risk of complications during pregnancy, such as growth limitation, decreased amniotic fluid or movement, preterm delivery, or stillbirth. End-diastolic velocity (EDV), peak systolic velocity (PSV), pulsatility index (PI), resistance index (RI), and systolic to diastolic ratio (S/D ratio) are Doppler metrics used in obstetrics to assess blood flow in these vessels⁷. Because of the increased arterial blood flow during pregnancy, the umbilical systolic/diastolic ratio declines steadily as the pregnancy progresses. The

aberrant umbilical artery flow velocity waveform is characterized by lower diastolic velocities relative to the systolic peak, as well as the absence or reversal of blood flow in diastole in extreme cases¹⁴. In this study, we needed to determine the PSV, EDV, S/D ratio, RI and PI values among normotensive and hypertensive pregnant women in third trimester of pregnancy.

LITERATURE REVIEW

Doppler indices for fetal development assessment has been identified as significant tool by several researchers and have completed studies in this regard. U Gupta and A Qureshi et al⁸ in 2008 worked on the uterine and umbilical artery doppler velocimetric indices in normotensive and hypertensive pregnancy, he concluded that with increasing gestational age, the values in both groups gradually declined. In the hypertensive group, the mean SD ratio declined from 6.15 at 32-34 weeks to 3.06 at 38-40 weeks, while in the normotensive group, it reduced from 2.04 at 32-34 weeks to 1.64 at 38-40 weeks¹⁵. However, Adekanmi et al⁶ in 2019 reported that in pregnancy-induced hypertension, the umbilical artery indices are not significantly higher than in normal pregnancy. Differences were found to be minor as well, even though they were higher at 37-40 weeks. He concluded that the fall in readings as the pregnancy progresses is attributed to a decrease in placental vascular resistance. Muhammad Wasim et al¹⁴ in 2015 Hypertensives pregnant women had a pulsatility index of 0.7- 2, whereas normotensives had a pulsatility index of 0.6 to 1.7. In hypertensives, the variable resistivity index was 0.6-0.9, while in non-hypertensives,

it was between 0.5 and 0.7. In hypertensives, the variable Systolic/Diastolic ratio ranged from 3 to 7.6, while in normotensives, it ranged from 2.4 to 4.5. The systolic/diastolic ratio and the pulsatility index were not significant in this investigation, but the resistivity index was calculated¹⁴. Muhammad Yousaf in 2018 stated that from 37 to 40 weeks of pregnancy, the S/D ratio was less than 3 and the mean PI was less than 1 in 100 normal singleton women. He concluded that our population's umbilical artery Doppler indices are comparable to the majority of published reference values from other parts of the world. He recommended that more research with a larger sample size, encompassing several classes of gestational age from the second trimester to term, is needed¹⁶. Lopez, Mendez et al in 2013 completed a study with total of 102 pregnant Mexican women (65 PE women and 37 normotensive women) were involved in a control study. Conclusion was that the N from uterine vessel, RI from umbilical artery, and PI from umbilical and middle cerebral arteries in their individual form, may be considered as tools to determine hemodynamic repercussion caused by PE⁹. Rana, Amanullah and Farooq in 2005 completed a doppler study for fetal growth management. There were five perinatal deaths (17.8%), all in babies with abnormal umbilical artery doppler. It is thus concluded that the doppler study allows a noninvasive assessment of uteroplacental insufficiency and is an accurate method for diagnosis and management of fetal growth retardation¹⁷. The study has been carried out to assess the umbilical artery using doppler US parameters (resistance index (RI), pulsatility index (PI), and S/D ratio) in normotensive and hypertensive pregnant women in third trimester of pregnancy and assessment of doppler indices of umbilical artery in normotensive and hypertensive women in third trimester.

MATERIAL AND METHOD:

A cross sectional study was conducted with sample size of 93 pregnant women in 3rd trimester. The respondents were the patients registered at Pakistan Institute of Medical Sciences Ultrasound section at Mother Child Healthcare departments, Islamabad from 1st

February 2022 to 30th May, 2022. The respondents were selected by using of systemic random sampling technique. Sampling frame was the ultrasound section register of the section. Permission was obtained from the Hospital Ethical Committee. All respondents were recruited after taken written informed consent.

All pregnant women were examined by a color doppler scanner machine Toshiba Aplio 300 Ultrasound System. Doppler examination was performed in the supine position for each hypertensive patient in quite respiration. Initially umbilical vessels/artery was identified, and then various parameters were identified for those vessels. Data was collected for umbilical artery for mid-cord level. All data was collected by a single doctor during this period to avoid bias in all values. Data was filled by researcher in designated Performa and images were taken of the patient's history card issued by the PIMS hospital and doppler ultrasound imagery of each patient. Complete descriptive statistics of age of patients and their gestational age is to be identified for further research and data analysis for the project. Same is calculated for the doppler indices in the umbilical artery as per collected data for normotensive and hypertensive pregnant women. Statistical analysis was done using IBM SPSS® software platform.

DATA ANALYSIS AND RESULTS

Doppler indices were taken for 93 pregnant women were included in this study in which 40 women were normotensive and 53 women were hypertensive in which 2 samples were rejected because of presence of other diseases in pregnant women. In this data collection there were 3 dependent variables i.e. Resistance index (RI), Pulsatility index (PI), and Systolic/Diastolic ratio (S/D ratio) and two covariates i.e. age and gestational week of pregnant women. Statistical analysis was done using IBM SPSS® software platform. As per figure 2, Mean Age of pregnant women in our study conducted was 26.722 ± 4.133 . Also, the mean gestational week for pregnant women was 32.163 ± 2.35 .

Table (1): Descriptive Statistics for Dependent variables.

	N	Minimum	Maximum	Mean	Std. Deviation
PINORM	40	.61	2.18	1.0490	.31219
PIHYPER	51	.78	2.51	1.3604	.42107
RINORM	40	.45	1.00	.6308	.11382
RIHYPER	51	.55	1.00	.7425	.09956
SDNORM	40	1.81	4.11	2.6718	.51225
SDHYPER	50	2.24	6.48	3.8172	.98576
Valid N (listwise)	39				

Table (1) shows the results of descriptive statistics for data collected for 3 dependent variables i.e. PI, RI and S/D ratio. PINORM and PIHYPER Shows statistics analysis for Pulsatility index values for normotensive women and hypertensive women respectively. RINORM and RIHYPER Shows statistics

analysis for Resistivity index values for normotensive women and hypertensive women respectively. SDNORM and SDHYPER Shows statistics analysis for S/D ratio values for normotensive women and hypertensive women respectively.

Table (2): Crosstabulation of PI, RI, S/D ratio normotensive and hypertensive group of pregnant women.

PI Values Range	Normo-tensive	Hyper-tensive	RI Values Range	Normo-tensive	Hyper-tensive	S/D Values Range	Normo-tensive	Hyper-tensive
0.6-0.7	2	0	0.3-0.4	0	0	1.51-2.00	6	0
0.71-0.8	1	2	0.41-0.5	6	0	2.0-2.5	9	6
0.81-0.9	13	3	0.51-0.6	12	7	2.51-3.0	17	2
0.91-1.00	4	1	0.61-0.65	11	1	3.01-3.5	5	11
1.01-1.1	10	6	0.66-0.70	5	9	3.51-4.0	2	11
1.11-1.2	5	11	0.71-0.8	4	23	4.01-4.5	1	10
1.21-1.3	2	7	0.81-0.85	0	7	4.51-5.00	0	3
1.31-1.4	0	5	0.85-0.90	0	0	5.01-5.5	0	5
1.41-1.5	1	4	0.90-1.0	2	4	>5.5	0	2
1.51-1.8	2	6	1.01-1.1	0	0			
>1.8	0	6						

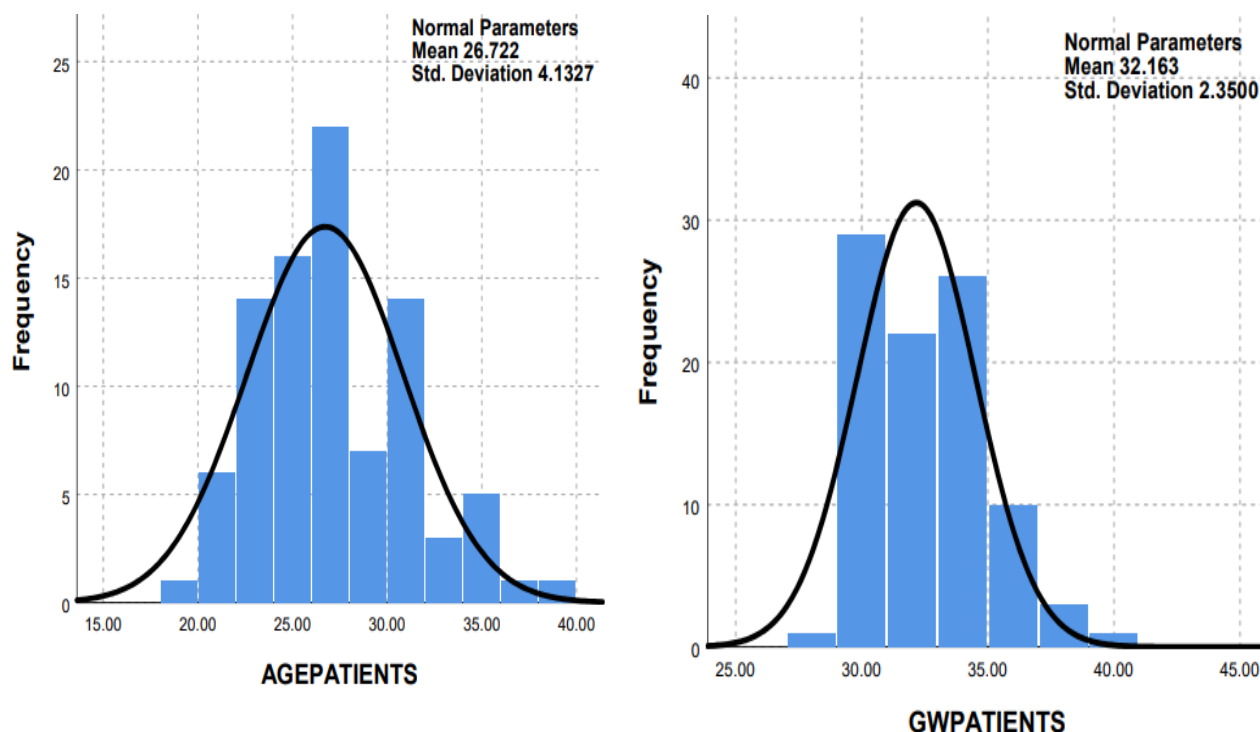
Crosstabulation for Pulsatility index, Resistivity index and S/D ratio is shown in table (2). Table (2) depicts the ranges for each doppler index against which values of those indices fall in. PI values for normotensive controls mostly fall in range of 0.81-1.2 and for hypertensive pregnant women range is from 1.01-1.5. RI values for normotensive controls

mostly fall in range of 0.4-0.7 and for hypertensive pregnant women range is from 0.5-0.85. Finally, S/D ratio values for normotensive controls mostly fall in range of 1.51-3.51 and for hypertensive pregnant women range is from 3.0-4.5.

Table (3): Results of hypothesis testing and level of significance for hypertensive and normotensive patients.

	Null Hypothesis	Test	Sig.	
1	The distribution of SDHYPER is normal with mean 3.82 and standard deviation .98576.	One-Sample Kolmogorov-Smirnov Test	.093 ^a	Retain the null hypothesis.
2	The distribution of RIHYPER is normal with mean .74 and standard deviation .09956.	One-Sample Kolmogorov-Smirnov Test	.028 ^a	Reject the null hypothesis.
3	The distribution of SDNORM is normal with mean 2.67 and standard deviation .51225.	One-Sample Kolmogorov-Smirnov Test	.200 ^{a,b}	Retain the null hypothesis.
4	The distribution of RINORM is normal with mean .63 and standard deviation .11382.	One-Sample Kolmogorov-Smirnov Test	.013 ^a	Reject the null hypothesis.
5	The distribution of PIHYPER is normal with mean 1.36 and standard deviation .42107.	One-Sample Kolmogorov-Smirnov Test	.000 ^a	Reject the null hypothesis.
6	The distribution of PINORM is normal with mean 1.05 and standard deviation .31219.	One-Sample Kolmogorov-Smirnov Test	.000 ^a	Reject the null hypothesis.

Table (3) depicts the results of null hypothesis tests independently for all data collected during this study. As shown in the table (3), null hypothesis is rejected for PI and RI values for normotensive and hypertensive patients respectively which means that variation from mean value is significant. However, for values of S/D ratio, both hypertensive and normotensive patients have non-significant variation from mean values in the collected data. Figure (1) represented a descriptive statistics for dependent variables .

**Figure (1): Descriptive Statistics for Dependent variables.**

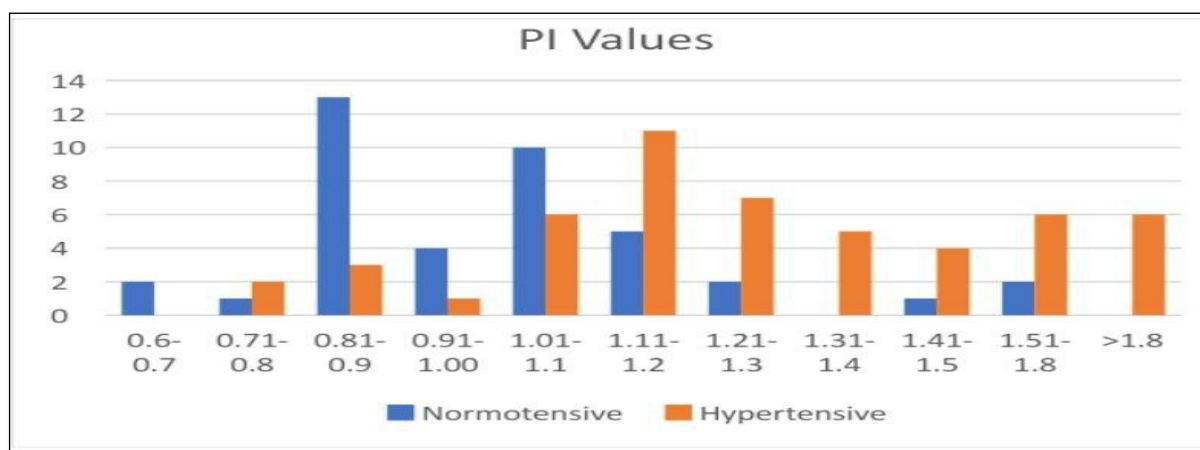


Figure (2): PI values for Normotensive and Hypertensive pregnant women.

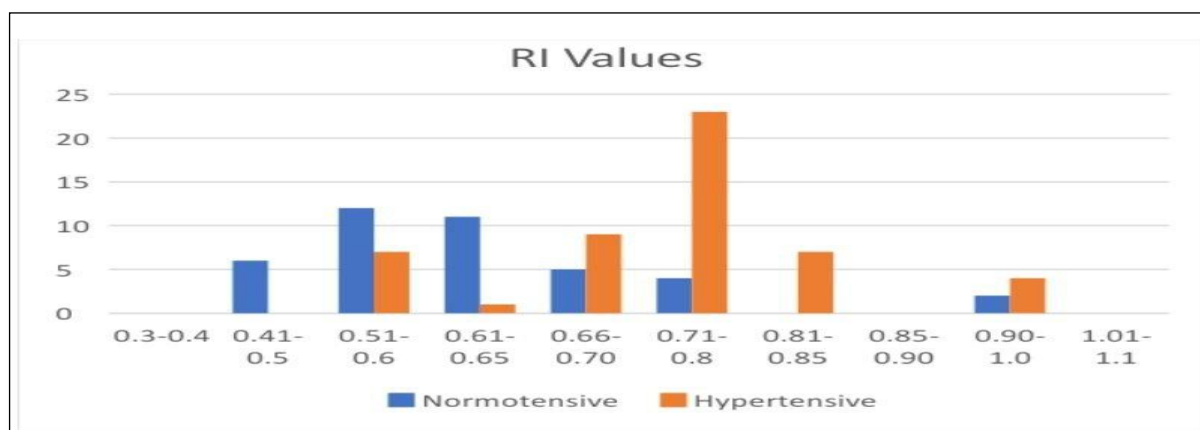


Figure (3): RI values for Normotensive and Hypertensive pregnant women.

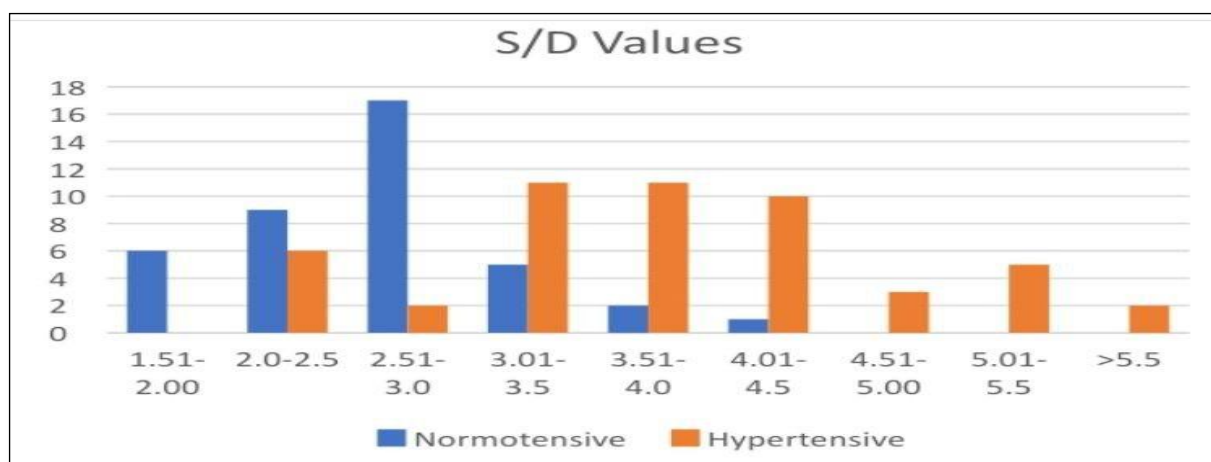


Figure (4): S/D Ratio values for Normotensive and Hypertensive pregnant women

Furthermore, graphical representation in figure 2, 3 and 4 depicts the comparison between normotensive and hypertensive pregnant women for doppler indices values i.e. PI, RI and S/D ratio. Figure shows the correlation of doppler indices values for hypertensive and normotensive pregnant women in their third trimester of pregnancy for umbilical artery.

Figure 2, 3 and 4 also illustrate the increase in values of PI, RI and S/D ratio for hypertensive women as compared to normotensive pregnant women. Also figure 2, 3 and 4 shows the correlation for the same dependent variables for two groups of people.

DISCUSSION:

The main objective of this study was to compare doppler indices between normotensive and hypertensive pregnant women in third trimester with no other disease shown in the medical history of the patient. Doppler ultrasound has created a major opportunity in the medical field to analyze the most critical parameters for assessment of fetal growth during pregnancy. Now as per our study there was a significant increase in values of doppler indices for hypertensive pregnant women as compared to normotensive women. Sensitivity index for PI was 22.8%, for RI it was 15.04% and for S/D ratio it was 30%. This shows that S/D ratio had the most increase in values for hypertensive patients whereas RI values were the least affected by the hypertensive condition. U Gupta and A Qureshi et al in 2008 concluded that in the normotensive group, it was 2.04 at 32-34 gestational week¹⁵. Whereas our research has concluded that for

gestational weeks 32.163 ± 2.35 S/D ratio for normotensive women is 2.67 and for hypertensive women is 3.81. Which corresponds to Gupta et al research. Also values in this research corresponds to the previous research done by Muhammad Wasim et al¹⁴ for hypertensive women in their second trimester, considering the S/D ratio values were insignificant in both researches. In another previous research Muhammad Yousaf in 2018 stated that the mean PI was less than 1 in 100 normal singleton women for 37-40 Gestational week which is true for our research as well¹⁶. Rana, Amanullah and Farooq in 2005 completed a doppler study for fetal growth management. There were five perinatal deaths (17.8%), all in babies with abnormal umbilical artery doppler. It is thus concluded that the doppler study allows a noninvasive assessment of uteroplacental insufficiency and is an accurate method for diagnosis and management of fetal growth retardation which is also the prognosis of this research¹⁷.

CONCLUSION

Doppler indices are a vital indicator when it comes to highlighting any underlying health condition such as hypertension, disturbed blood flow to fetus etc. for a pregnant woman which does not appear till inducing a complication in pregnancy. This research has further concluded that there is a significant increase in doppler indices values for hypertensive patients. This study will create awareness and highlight the importance as well as effectiveness of Doppler ultrasound, which allows a non-invasive assessment for detection of fetal well-being in hypertensive pregnancies, which is safe and convenient as compared to other invasive methods for fetal growth analysis.

RECOMMENDATIONS

However, it is recommended that further studies are to be conducted for other common underlying conditions in pregnant women in different trimesters to amplify the awareness of doppler ultrasound. Also, doppler diagnostic values for uteroplacental velocimetry is to be

analyzed using further research work in our population.

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Ethics Approval: The ethical approval was obtained from the Hospital Ethical Committee. The subject of the study were ensured no harm during the data collection and procedure.

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