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COMPARISON OF DUCTUS VENOSUS DOPPLER WAVEFORM IN HYPERTENSIVE AND NON-HYPERTENSIVE PREGNANCIES

Khawaja Ruman Ahmad[1], Dr. Muhammad Adnan Hafeez[2], Kainat Arshad[3], Naveed Hussain[4]

[1]Medical Imaging Technologist, Masters in Medical Imaging Technology Superior University, Raiwind Road, Kot Araian, Lahore, Email: iamrumanahmad@gmail.com
[2]Assistant Professor, Department of Human Nutrition and Food Technology, Superior University, Raiwind Road, Kot Araian, Lahore
[3]Sonographer, Indus Hospital, Jubilee Town, Lahore
[4]Lecturer, UIRSMIT The University of Lahore, Lahore

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Corresponding Author: Khawaja Ruman Ahmad, Medical Imaging Technologist, Masters in Medical Imaging Technology Superior University, Raiwind Road, Kot Araian, Lahore.
Email: iamrumanahmad@gmail.com

ABSTRACT

Objective: To rule out DV Doppler variations in HDP and assess their clinical utility.
Methodology: Across-sectional study involved 110 subjects, 55 hypertensive while the other 55 were normotensive and in their second or third trimesters. The assessment was based on Doppler study of the fetal vessels in the pregnant women. The level of significance (p) was to be set at less than 0.05.
Results: In hypertensive pregnancies, there was significantly higher resistance as shown by increased S/D ratio ($p = 0.003$), PI ($p = 0.001$), and RI ($p = 0.037$). The flow velocities associated with them were also reduced. These results were also associated with higher incidence of excessive amniotic fluid ($p = 0.032$).
Conclusion: Ductus Venosus Doppler is a reliable method for picking up early signs of fetal distress in mothers with high blood pressure.

INTRODUCTION

High blood pressure during pregnancy, also called hypertensive disorders of pregnancy (HDP), is one of the more frequent medical problems seen in expecting mothers. It's unfortunately still a major reason for both maternal and baby-related complications around the world. HDPs are believed to affect around 5 to 10% of pregnancies globally, and they can lead to problems like poor fetal growth, premature birth, placental separation, and sometimes even stillbirth. The situation is even more critical in places where proper prenatal care isn't always available or consistent.

There are different types of HDP — like chronic hypertension, gestational hypertension, preeclampsia, and eclampsia — but what's common in all of them is some kind of issue with how the placenta develops. This poor placental development makes it hard for the baby to get enough blood, oxygen, and nutrients, which obviously affects growth and development.

One reason this happens is because the spiral arteries in the placenta don't go through proper remodeling, which is needed to maintain strong and steady blood flow. When that remodeling doesn't happen as it should, resistance in the vessels goes up, and the baby ends up in a low-oxygen state (called hypoxia). Over time, this affects the baby's circulatory system — particularly parts like the ductus venosus (DV), which is important for getting oxygen-rich blood to the brain and heart.

The DV is a tiny but very important vessel. It carries blood directly from the umbilical vein to the inferior vena cava, allowing the most oxygenated blood to go straight to the areas that need it most. When the baby is in any sort of stress inside the womb, this shunt becomes even more critical. That's why changes in DV blood flow are considered early warnings that something might be going wrong.

Doppler ultrasound is a great, non-invasive tool that lets doctors see how the blood is moving through vessels like the DV. By measuring certain things like the pulsatility index (PI), resistive index (RI), and S/D ratio, we can actually get early clues about whether the baby is under cardiovascular stress or not getting enough oxygen. Some DV waveforms — for example, a reversed 'a' wave or raised PI — have been linked to serious outcomes like fetal acidosis or even stillbirth.

Even though Doppler tests for umbilical and uterine arteries are commonly used, not enough attention is paid to DV Doppler. Research is now showing that DV Doppler might actually pick up signs of fetal trouble earlier than the other methods, especially in mothers with hypertension. However, in many clinics — especially in developing regions — DV Doppler isn't widely used yet. This might be due to lack of training, limited equipment, or just not enough awareness.

So, this study aims to explore this gap. By comparing DV Doppler readings in women with and without hypertension, we're hoping to show how valuable it can be in spotting fetal compromise early — and maybe encourage more doctors to include it in their routine pregnancy monitoring for high-risk cases.

Objectives

The primary objective of this study was to compare ductus venosus Doppler waveform patterns between hypertensive and non-hypertensive pregnancies.

Another key objective was to identify early signs of fetal compromise specifically in hypertensive pregnancies.

Methodology

This was a cross-sectional comparative study conducted at Gillani Ultrasound Clinic, Lahore, over a duration of six months. A total of 110 pregnant women were enrolled using a non-probability consecutive sampling technique. The participants were divided into two equal groups. Group A consisted of 55 pregnant women who were diagnosed with hypertension, while Group B included 55 pregnant women without hypertension.

The inclusion criteria for the study were as follows: pregnant women aged between 20 and 40 years, gestational age ranging from 14 weeks to full term, singleton pregnancies, and willingness to participate in the study. The exclusion criteria eliminated women with pre-existing conditions such as diabetes, thyroid disease, renal failure, cardiac anomalies, or fetal malformations. Smokers, substance users, and women with multiple pregnancies were also excluded from the study.

All ultrasound examinations were carried out using the Toshiba Xario 45 ultrasound system, equipped with a 3.5 MHz convex transducer. Doppler assessments were conducted under specific technical conditions: the sample gate was set between 0.5 to 1.0 mm, the insonation angle was maintained at less than 30 degrees, and the sweep speed was adjusted to 2–3 cm/s. Filters were minimized to allow the detection of low-velocity blood flow.

The ductus venosus was identified at its inlet near the inferior vena cava. Doppler parameters measured during the assessment included the Pulsatility Index (PI), Resistive Index (RI), Systolic/Diastolic Ratio (S/D ratio), Peak Systolic Velocity (PSV), End-Diastolic Velocity (EDV), and Mean Volume Flow (MV-Flow). Each measurement was taken during fetal rest and recorded when the heart rate was normal. After informed consent, all selected participants underwent a detailed ultrasound and Doppler scan. Relevant data were recorded on structured forms. The results were grouped into hypertensive and non-hypertensive categories for analysis. Data were entered and analyzed using SPSS version 29.0. Descriptive statistics were applied to summarize demographics and Doppler indices. Mean ± standard deviation was calculated for all continuous variables. The independent samples t-test was used for comparison between groups, and p-values < 0.05 were considered statistically significant.

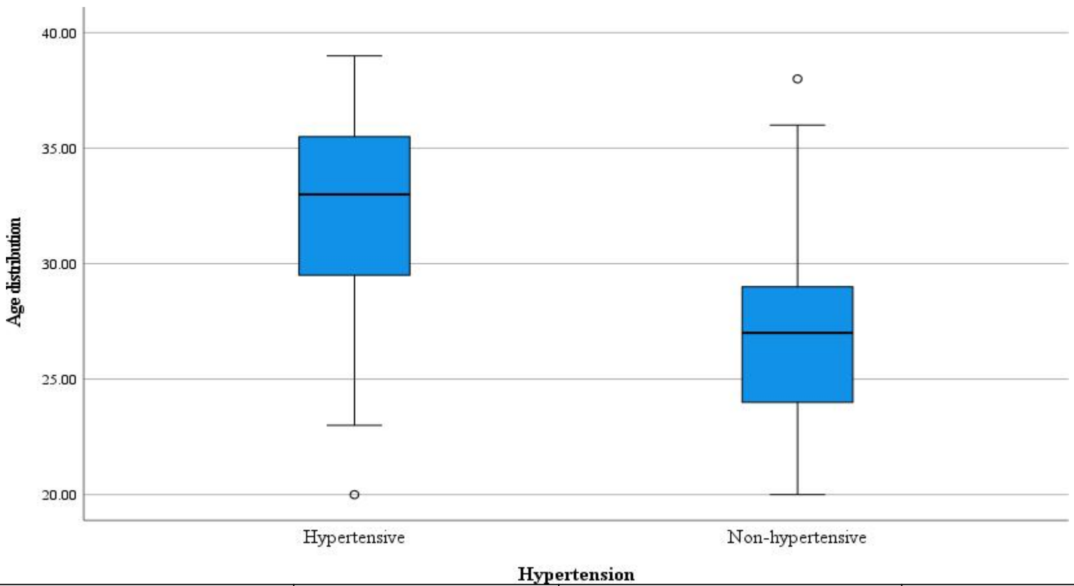
Results

The study included 110 pregnant women, evenly divided between hypertensive (n=55) and non-hypertensive (n=55) groups. The overall mean age was 29.61 ± 4.87 years, with hypertensive women being significantly older (32.07 ± 4.02 years) than non-hypertensive women (27.15 ± 4.40 years; p < 0.001). Socioeconomic status distribution was similar across groups: 20% lower class, 70% middle class, and 10% upper class in both cohorts, showing no association with hypertension status (p=0.949).

The analysis Within-group comparisons revealed no significant associations between hypertension and either socioeconomic status or parity. Parity distribution was comparable: 17.3% primiparous (1 child), 40.9% with 2 children, 24.5% with 3 children, and 17.3% with 4 children across both groups (p=0.444). However, amniotic fluid index (AFI) differed significantly: hypertensive women had higher rates of excessive AFI (49.1% vs. 29.1%) and lower adequate AFI (50.9% vs. 70.9%) compared to non-hypertensive women (p=0.032).

The analyses Between-group showed hypertensive women had significantly higher systolic-diastolic ratios (5.39 ± 5.28 vs. 2.34 ± 1.98; p=0.003) and abnormal Doppler indices, including elevated pulsatility index (PI: 1.07 ± 0.54 vs. 0.74 ± 0.32; p=0.001) and resistive index (RI: 0.66 ± 0.32 vs. 0.53 ± 0.19; p=0.037). They also exhibited reduced blood flow velocities: lower end-diastolic velocity (EDV: 6.62 ± 20.02 vs. 15.21 ± 14.03; p=0.012), peak systolic velocity (PSV: 12.65 ± 35.00 vs. 34.98 ± 24.34; p<0.001), and MV-flow (3.57 ± 18.50 vs. 15.84 ± 12.24; p<0.001). Gestational age did not differ significantly between groups (29.24 ± 5.51 vs. 29.22 ± 6.28 weeks; p=0.9

Figure 4.1: Box plot showing distribution of patients according to age Table 4.1: Comparison of Socioeconomic Status According to Hypertension



Socioeconomic status	Hypertension		Total
	Hypertensive	Non-hypertensive	
Lower	11(20.00%)	11(20.00%)	22(20.00%)
Middle	39(70.90%)	38(69.10%)	77(70.00%)
Upper	5(9.10%)	6(10.90%)	11(10.00%)
Total	55	55	110

This table presents the distribution of socioeconomic status among hypertensive and non-hypertensive pregnant women. Most of the participants in both groups belonged to the middle socioeconomic class (70.90% of hypertensive and 69.10% of non-hypertensive), followed by the lower class (20.00% in both groups), and the upper class (9.10% hypertensive and 10.90% non-hypertensive). The Pearson Chi- Square test indicated no significant association between socioeconomic status and hypertension during pregnancy (p-value = 0.949), suggesting that socioeconomic factors did not influence the occurrence of hypertension in the study population.

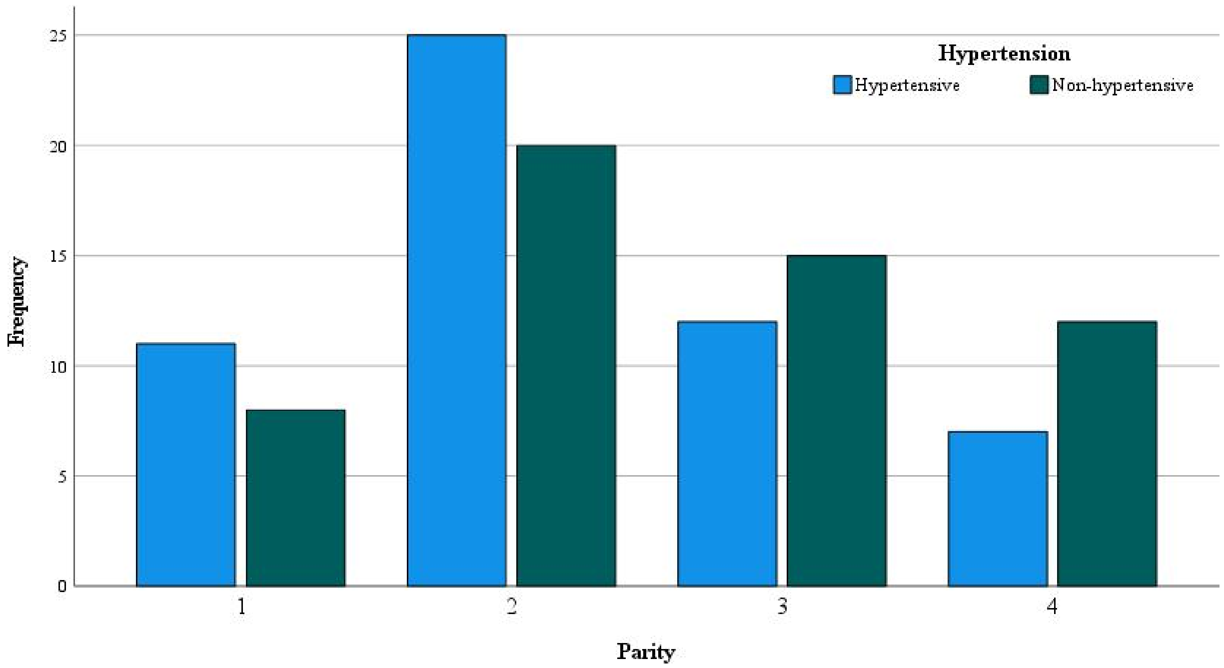


Figure 4.3: Bar chart showing parity distribution by hypertension status

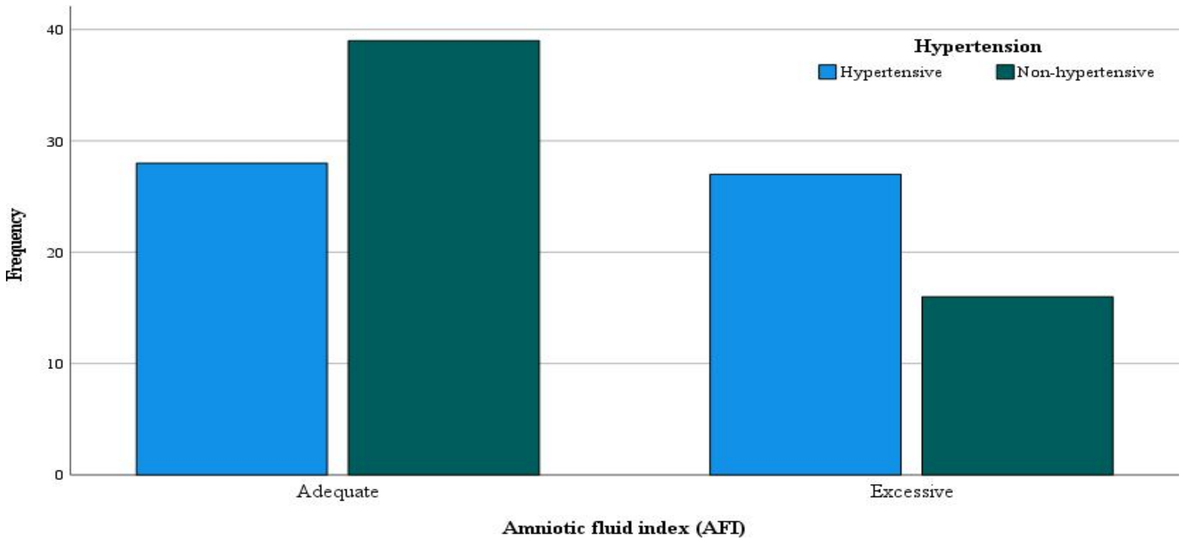


Figure 4.4: Bar chart showing amniotic fluid index distribution by hypertension status

Table 4.4: Comparison of Gestational Age and Systolic Diastolic Ratio

Findings	Hypertension		p-value
	Hypertensive	**Non-hypertensive**	
Systolic diastolic ratio (SD)	5.39±5.28	2.34±1.98	0.003
Gestational Age	29.24±5.51	29.22±6.28	0.938

This table compares the systolic/diastolic (SD) ratio and gestational age between hypertensive and non-hypertensive pregnancies. While the gestational age was nearly identical in both groups, the SD ratio was significantly higher in hypertensive patients (p-value = 0.003), reflecting increased vascular resistance, a common feature of pregnancy-induced hypertension. This suggests that Doppler findings may be useful in identifying vascular changes associated with hypertensive pregnancies.

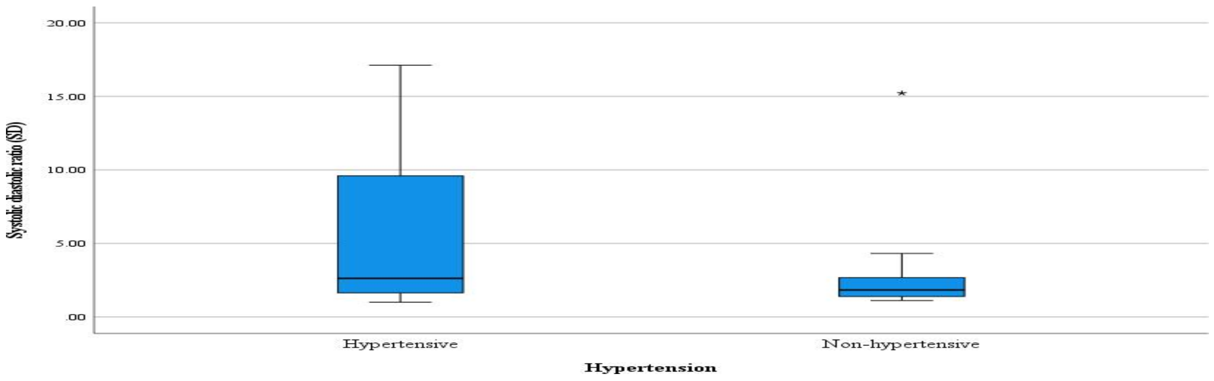


Figure 4.5: Bar chart comparing systolic-diastolic ratio by hypertension status

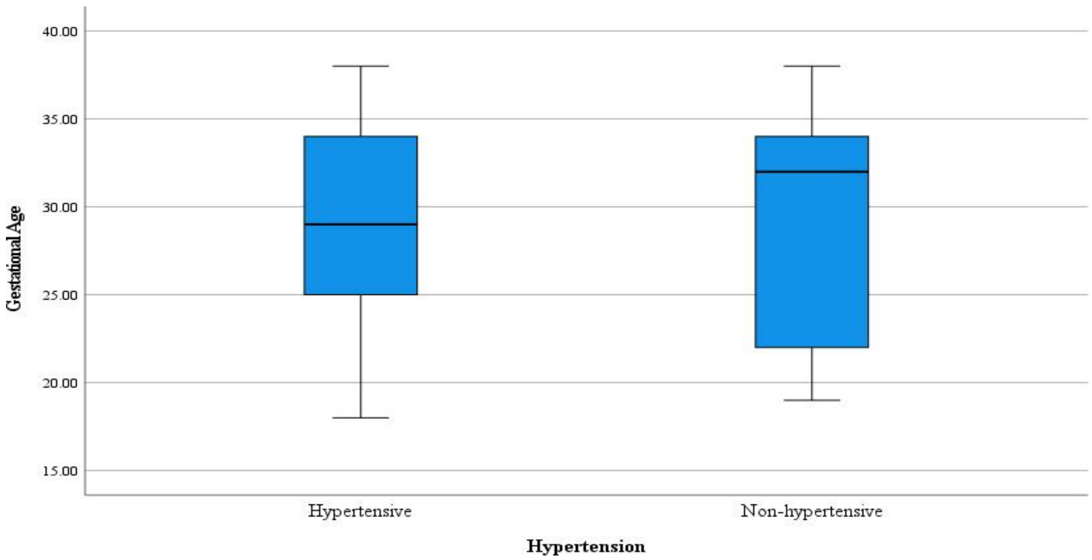


Figure 4.6: Gestational age comparison between hypertensive and non- hypertensive groups

Table 4.5: Comparison of Ultrasound Findings by Hypertension Status

Ultrasound finding	Hypertension		p-value
	Hypertensive	**Non-hypertensive**	
Pulsatility index (PI)	1.07±0.54	0.74±0.32	0.001
Resistive index (RI)	0.66±0.32	0.53±0.19	0.037

This table highlights the Doppler ultrasound indices (PI and RI) in hypertensive and non-hypertensive pregnancies. Both pulsatility index and resistive index were significantly elevated in hypertensive women. These findings are indicative of increased resistance to blood flow in the uteroplacental circulation among hypertensive patients, underscoring the role of Doppler studies in assessing vascular changes in pregnancy

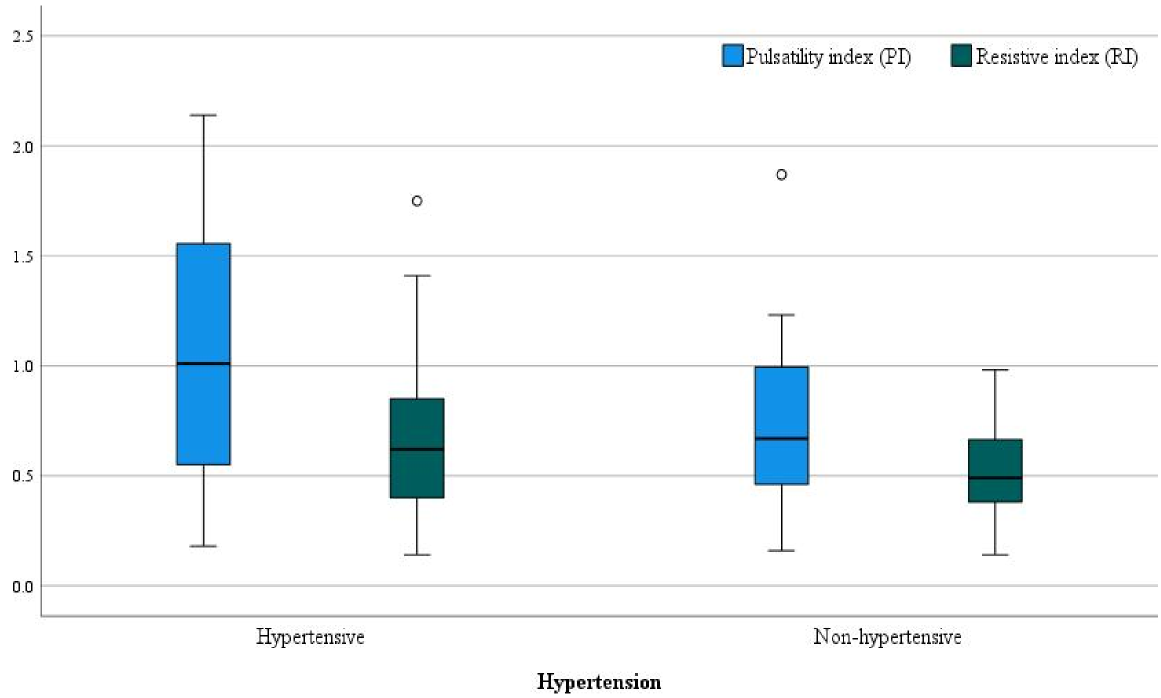


Figure 4.7: Comparison of PI and RI between hypertensive and non-hypertensive pregnancies

Table 4.6: Comparison of Doppler Ultrasound Parameters

Doppler ultrasound	Hypertension		p-value
	Hypertensive	**Non-hypertensive**	
End-diastolic velocity (EDV)	6.62±20.02	15.21±14.03	0.012
Peak systolic velocity (PSV)	12.65±35.00	34.98±24.34	<0.001
MV-Flow	3.57±18.50	15.84±12.24	<0.001

This table compares advanced Doppler ultrasound parameters between hypertensive and non-hypertensive pregnant women. All three measured parameters — EDV, PSV, and MV-Flow — were significantly lower in the hypertensive group, indicating impaired blood flow and reduced vascular compliance. These reductions may reflect compromised placental perfusion and serve as early indicators of fetal compromise in hypertensive pregnancies.

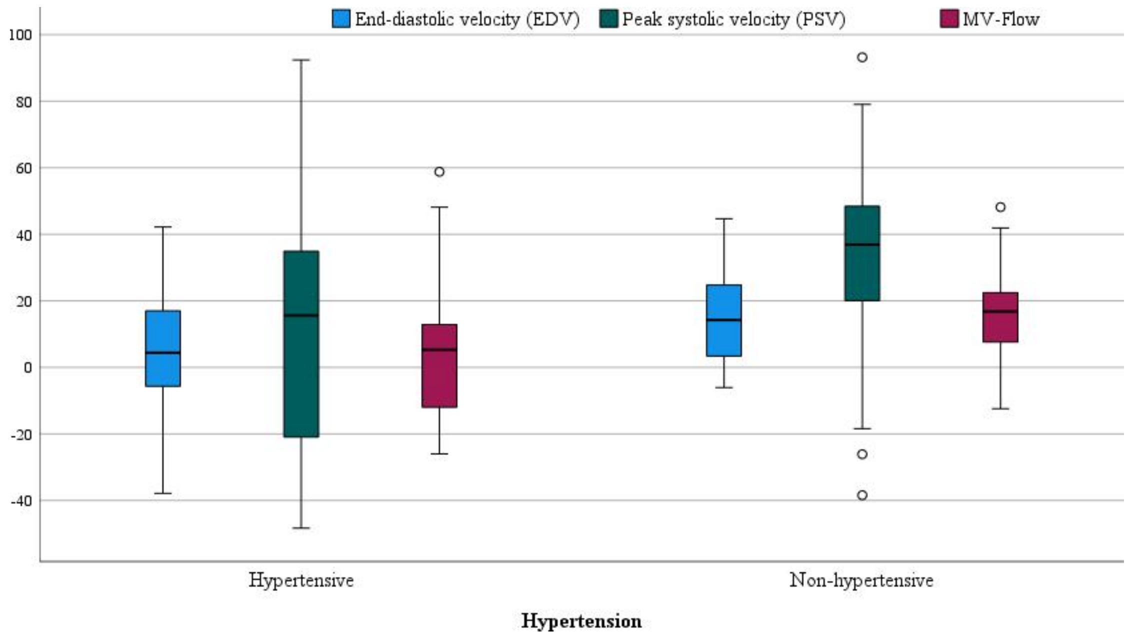


Figure 4.8: Doppler ultrasound comparison by hypertension status

Discussion

In this study, it was seen that pregnancy-related hypertension seems to change the ductus venosus Doppler patterns quite a lot. The resistance indexes, like PI and RI, came out higher in women with hypertension, which probably means blood isn't flowing properly — and that can cause low oxygen levels for the baby. The readings for PSV and EDV were also lower, which supports that the placenta might not be delivering blood effectively in these pregnancies.

These results are quite similar to what earlier researchers like El-Demiry et al. (2020) and Salman et al. (2021) found, especially in cases of preeclampsia. But one thing different in our data was that some hypertensive women had too much amniotic fluid, which is the opposite of what most previous studies reported — they usually found less fluid (oligohydramnios) in such cases.

Doppler studies of the ductus venosus (DV) are especially helpful because they can catch early signs of how the baby's heart and blood flow are adapting — even before any obvious problems show up. In particular, markers like the S/D ratio and pulsatility index (PI) seem to be quite sensitive when it comes to picking up signs that the baby might be under stress.

If these abnormal DV patterns are picked up early enough, especially in pregnancies where the mother has high blood pressure, it gives doctors a chance to step in before things get worse. Acting early can really make a difference, both for the mother's health and the baby's outcome.

Doppler ultrasound is usually a good and cost-effective choice for monitoring the baby during pregnancy. Because it's accessible in most hospitals and does not need expensive machines, it is effective even in facilities that have limited resources.

Also, the Doppler readings will assist physicians in determining which mothers can require additional monitoring. For example, if the measurements indicate a high PI or RI, or if the blood flow appears slower than usual, that can signal the baby should be monitored more closely. In certain instances, such information assists in determining whether it would be advisable to give birth to the baby somewhat prematurely in order to prevent potential complications.

Conclusion

In this study, it became quite clear that the Doppler waveforms of the ductus venosus (DV) were noticeably different in pregnancies where hypertension was present. The group with high blood pressure consistently showed increased values for resistance measurements — like the pulsatility index (PI), resistive index (RI), and the systolic-diastolic (S/D) ratio. These results suggest that the blood was facing more resistance in the vessels, which isn't ideal. At the same time, this group also had much lower readings for end-diastolic velocity (EDV), peak systolic velocity (PSV), and mean volume flow (MV-Flow). When these values are down, it usually means the blood flow isn't as strong or effective, and that could put the baby at risk.

All of these Doppler changes seem to point toward problems with the placenta not working as well as it should, and also suggest the baby's heart might be under more pressure than usual. These are both pretty common in pregnancies where the mother has hypertension. What's important here is that these changes were showing up in the scans even when there weren't any clear clinical signs of the baby being in distress. That really shows how helpful DV Doppler can be for catching potential problems early, before anything serious develops.

Noticing these changes in the DV waveform early on gives doctors a better chance to act in time. It allows for more focused monitoring, smarter planning around delivery, and care that's more tailored to each patient's situation. Because of this, using ductus venosus Doppler ultrasound in high-risk pregnancies isn't just helpful — it's becoming something that should really be considered necessary. Making it a standard part of antenatal check-ups for women with high blood pressure could make a big difference in preventing complications and improving outcomes for both mother and baby.

To sum it up, DV Doppler is safe, practical, and dependable. Given how much it can reveal about the baby's condition, especially in pregnancies affected by hypertension, it's something that deserves more attention in everyday obstetric care.

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