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ZAUFISHAN AHMAD

SU91-MSAHW-F23-020

FAHS

EVALUATION OF UTERINE AND UMBILICAL ARTERY DOPPLER INDICES IN NORMOTENSIVE VERSUS HYPERTENSIVE PREGNANT FEMALES OF SECOND AND THIRD TRIMESTER

SUPERIOR UNIVERSITY

Thesis Submitted to

The Superior University Lahore

In Partial Fulfillment of the

Requirement for the Degree of

Master of Science in Allied Health Sciences

By

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AUTHOR'S DECLARATION

I hereby state that my MS thesis titled **"Evaluation of Uterine and Umbilical Artery Doppler Indices in Normotensive Versus Hypertensive Pregnant Females of Second and Third Trimester"** is my work and has not been submitted previously by me for taking any degree from this University, **The Superior University, Lahore,** or anywhere else in the country/world.

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This is to certify that the thesis entitled **"Evaluation of Uterine and Umbilical Artery Doppler Indices in Normotensive Versus Hypertensive Pregnant Females of Second and Third Trimester"** submitted by **"Zaufishan Ahmad "**has been accepted towards the partial fulfillment of the requirement for **"MS Allied Health Sciences"**. The quality of the work contained in this thesis is adequate for the award of degree.

Signature: _____

Supervisor Name: Dr Fehmida Ansari
Designation: Assistant Professor

CERTIFICATE OF APPROVAL

This is to certify that the research work presented in this thesis, titled **"Evaluation of Uterine and Umbilical Artery Doppler Indices in Normotensive Versus Hypertensive Pregnant Females of Second and Third Trimester"** was conducted by **"ZAUFISHAN AHMAD"** under the supervision of **"Dr Fehmida Ansari".**

No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Faculty of Allied Health Sciences, The Superior University, Lahore in partial fulfillment of the requirements for the degree of Master of Science in the field of "**Allied Health Sciences"** in Faculty of Allied Health Sciences at The Superior University, Lahore.

Zaufishan Ahmad: Signature: _____

Examination Committee:

Dr. Muhammad Naveed Babur: Signature: _____

a) External Examiner: Signature: _____

b) Internal Examiner: Signature: _____

c) Dr Fehmida Ansari: Signature: _____

d) PL/HOD: Dr. Hafiz Shehzad Signature: _____

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f) Controller of Examination: Dr. M. Haris Signature: _____

DEDICATION

Dedicated to

SARDAR- E- KAINAT صلى الله عليه آله وسلم ***& KHATOON -E- JANNAT*** **فاطمۃ الزہراء**

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LIST OF ABBREVIATIONS

RI	Resistivity Index
PI	Pulsatility Index
PIH	Pregnancy Induced Hypertension
LBW	Low Birth Weight
IUGR	Intra Uterine Growth Restriction

ABSTRACT

Introduction: Hypertensive disorders of pregnancy such as preeclampsia and gestational hypertension preeclampsia are leading causes of mortality, fetal morbidity around the world. Uterine and umbilical artery Doppler indices by Doppler ultrasonography have emerged as important parameters in the assessment of placental perfusion and fetal well-being in hypertensive disorders. However, the clinical value of the indices in discriminating normotensive from hypertensive pregnancies remains under investigation.

Objective: To evaluate the uterine and umbilical artery Doppler indices in normotensive and hypertensive women during second and third trimesters to find early predictors for early detection and interventions of hypertensive diseases in pregnancy.

Methods: This is a cross-sectional, case control study conducted at a single center involving 80 pregnant women: 40 normotensives and 40 hypertensives. I, RI, and SD ratio of the uterine and umbilical arteries were obtained by doppler ultrasonography in the second and third trimesters. Independent t-test and logistic regression analyses were used to compare the Doppler indices between the groups and to determine the potential predictive values for hypertensive disorders.

Results: These results were showing the significant differences in uterine artery PI and normotensive and hypertensive pregnancies ($p = 0.0016$) with hypertensive pregnancies having higher values. These results showing no significant difference in uterine artery RI ($p = 0.1002$), indicating its lower sensitivity in hypertension. However, they indicate that no statistical differences in the umbilical artery resistance index and pulsatility index in the two groups, suggesting that these indices are not good indicators in the hypertensive pregnancies. The SD ratio was increased in hypertensive pregnancies, though insignificantly ($p = 0.0733$). The logistic model to predict hypertensive pregnancies presented moderate accuracy (54.17%), and low sensitivity (38.46%) and specificity (38.46%).

Conclusion: Uterine artery Doppler indices, mainly PI are useful in differentiating normotensive and hypertensive pregnancies, probably serving as early predictors of hypertensive pathologies. But the fact that no Doppler umbilical artery indices were significantly different indicates that they would not be so useful as early warning markers for hypertension. By supporting the role of Doppler ultrasonography in hypertensive pregnancies, however, larger studies in different populations are

required to determine the specificity of the Doppler variables used in this study before the applied cut-offs become more generally applicable for the prediction of hypertensive disorder.

CHAPTER 1

INTRODUCTION

Maternal and fetal health are important aspects of obstetric medicine underlying pregnancy outcomes and the persistent health of mother and offspring. Since they influence the outcome of pregnancy and the lifelong well-being of the mother or her fetal, aspects of maternal or fetal health are fundamental to obstetric care. During pregnancy some of the mother's circulatory and cardiovascular systems go through significant changes so that the growing fetus receives adequate nutrients. This also speeds the evacuation of waste, as well as altering the pH; (and parent' inserting the finger- air supply for the developing egg. But block those processes, and the effects can be grim for both the mother and the fetus, particularly if those blockages come as a result of the mother's countless health problems, such as high blood pressure [1,2].

Pregnancy-induced hypertension (PH) is an urgent global issue that affects 5%–8% of all pregnancies and 22%–29% of adults in the world. It results in bad pregnancy outcome including low birth weight (LBW), preterm delivery and plays a key role in the morbidity and maternal, neonatal and fetal mortality. Hypertensive disorders (preeclampsia and eclampsia) are a major cause of maternal deaths (46%) in Pakistan. Early detection and management of hypertension are essential for improved maternal and fetal outcomes [3,4].

For each woman it's all different the gestation period is a time of amazing and miraculous bodily changes: It is accepted that there are higher risks of maternal morbidity and death when there is complication on the way of pregnancy. Hypertension and anemia as complications of pregnancy are the most common health problems and failure to treat these issues leads to pathology. Pregnancy induced high blood pressure is known to be the most prevalent of all the disorders in women. If not treated, or not treated in time, it can result in dangerous labour and delivery complications and adverse effects for the baby [5,6].

Pregnancy induced hypertension Pregnancy induced hypertension (PIH) is a multifactorial disorder that includes preeclampsia and gestational hypertension. Though the mechanism of PIH development is not completely clear, a few potential new related factors in its etiology have been reported recently [7].

Endothelial dysfunction, immuno-pathological maladaptation and placental ischemia are the hallmarks of gestational hypertension and preeclampsia, which are part of PIH.

Increased formation of vasoconstrictors including endothelin-1 (ET-1) plus decreased formation of vasodilators including nitric oxide (NO) results from endothelial dysfunction, which elicits hypertension. Immune maladaptation contributes to defective spiral artery remodeling and limited trophoblast invasion that results in placental ischemia releasing anti-angiogenic factors such as soluble fms-like tyrosine kinase-1 (sFlt-1) and soluble endoglin (sEng) [8,9]. 'Endothelial dysfunction, immunological mis adaptation, hypoxia due to placental ischemia imply the development of pregnancy-induced hypertension (PIH), comprising gestational HT and preeclampsia. This leads to higher blood pressure via endothelial dysfunction, which stimulates production of vasoconstrictor factors including endothelin-1 (ET-1) and reduction of vasodilatory factors such nitric oxide (NO). This immune maladaptation results in inadequate spiral artery remodeling and trophoblast invasion and is associated with placental ischemia and release of anti-angiogenic factors, including soluble fms-like tyrosine kinase-1 (sFlt-1) and soluble endoglin (sEng) [10]. The uterine arteries, which branch off to form arcuate arteries, mainly supply blood to the uterus. The arcuate arteries run in horizontal circles around the uterus. The arcuate arteries then divide into radial, basal, and spiral arteries through the uterine walls. Maternal vessels bring blood to the placenta, which fills up the placenta tissue in the intervillous region [11].

The uterine artery Doppler indices pulsatility index and resistance index are important prenatal examinations to evaluate uteroplacental blood flow and to predict pregnancy complications such as preeclampsia (PE) and intrauterine growth restriction (IUGR). These indexes can reveal a lot about how well blood is flowing to the placenta and the uterus, which are critical for proper fetal development. The reference ranges of UtA-PI are suggested in clinical application in the pregnancy to interpret blood flow impedance. Thus, pulsatility index (PI) was advocated in various reports as the best Doppler index. Ultrasound examination for weeks 11-14, transvaginal and for weeks 15-41, transabdominal ultrasound was used [12,13].

The uterine artery (UA) is assessed using two principal Doppler indices: the resistance pulsatility index and resistance index. The PI, compares the peak systolic and the end diastolic velocities to mean velocity and the RI, compares the peak systolic velocity with the end diastolic. Lower values indicate better perfusion. The two indices are employed in evaluating the resistance of uterine artery to blood flow. With progression of the pregnancy, the uterine artery doppler causes shift [14]. With improvement of

uteroplacental circulation in the second trimester, the PI and RI are often decreased. The mean RI in the second trimester ranged between 0.65 and 0.75 and that of the PI between 1.45 and 1.75.

As gestational age (GA) increases, the mean PI in the second trimester decreases, ranging from 1.14 to 0.95. The mean PI is roughly 1.14 at 20 weeks and drops to about 0.95 at 24 weeks. As gestation progresses, the RI likewise exhibits a declining tendency. According to a study, the average RI throughout the second trimester was approximately 0.59. The PI keeps declining by the third trimester. According to reference ranges, by the conclusion of pregnancy, the PI should be at least 0.65. In a similar vein, in the end of third trimester, the resistance index usually drops to about 0.35 [15].

In pregnant women with uterine artery Doppler indices and hypertension, such as high pulsatility index and resistance index, are suggestive of impaired uteroplacental blood flow. Augment the vascular resistance in uterine arteries is frequently linked to elevated RI and PI readings. This is indicative of inadequate placentation and predicts negative consequences like intrauterine growth restriction (IUGR) and preeclampsia. Notching is a rather common finding in the first trimester, seen in 45–67% of normal pregnancies. At 20 weeks of gestation, a diastolic notch is present when the maximum diastolic flow is diminished its 50 cm/s." However, most reports employ arbitrary diagnostic criteria. Like the "notch" continues to decrease and remains stable after 24 weeks of gestation [16]. Atypical uterine vascular trauma may present in the form of a persistent early diastolic notch, and suboptimum placentation can result in increased uterine artery impedance. UtA-PI is preferable as index of vascular impedance, since the reproducibility of uterine artery notch was low. Both the RI and PI are noticeably elevated in hypertensive pregnancies. In hypertension pregnancies, the mean uterine artery RI was 0.64, while in normotensive pregnancies, it was 0.50. Likewise, during the antepartum phase, the mean PI in hypertension pregnancies was 1.14, while in normotensive pregnancies it was 0.68. For gas and food exchange, the fetus's deoxygenated blood must be transported from the umbilical artery to the placenta. On either side of the internal iliac artery's anterior division in the fetal pelvis is where the two navel arteries originate. These two umbilical arteries wind around the umbilical vein inside the umbilical cord and reach the placenta, where they help move the fetus's deoxygenated blood to the mother's circulation for oxygenation and waste [17].

Normal umbilical artery doppler waveforms exhibit low resistance, which facilitates

adequate placental perfusion. An umbilical artery in normal condition Doppler indices is essential for determining the health of the fetus and making sure the placenta is adequately perfused. As gestation advances in a typical pregnancy, the PI and RI values fall, indicating better placental blood flow and decreased resistance. This pattern is linked to positive pregnancy outcomes and is suggestive of a healthy fetoplacental circulation. Increased PI or no/reverse flow in end-diastole are examples of abnormal Doppler indices that suggest dysfunction in the placenta and the potential for complications such as preeclampsia and IUGR. Close surveillance by umbilical artery Doppler measurement is essential to obtain the best outcome in health for the mother and baby by allowing for timely detection and subsequent disease control [18,19].

The RI ratio, systolic-to-diastolic ratio, and the PI, are some of the umbilical artery Doppler indices that normally decrease with gestation in normotensive pregnancy. These changes are secondary to relaxation of tone and enlarge in placental blood flow, that is important to optimal fetal development and growth. Mean systolic-to-diastolic ratio in second trimester is 2.55 ± 0.56. This number reduces as pregnancy continues, denoting improved placental perfusion. The mean Pulse Doppler PI in the mid-gestation period is approximately 1.07 ± 0.47. This ratio decreases with advance of pregnancy. Second trimester's average PI is about 0.59 ± 0.14. With the advance of gestation, RI, like the S/D ratio, and as PI may decrease. The mean systolic-to-diastolic ratio decreases to 3.30±0.54, at 3rd trimester. The normal pulsatility index (PI) at third trimester is approximately 0.86 ± 0.27. This reduction in PI indicates an increase in placental blood flow. By the third trimester, the average value of RI is around 0.54 ± 0.11. Since there is less friction against blood flow, this number is lower than it was in the second trimester [19,20].

Preeclampsia and Eclampsia (Hypertensive disorders in Pregnancy-HDP) are the major cause of mortality globally, maternal and perinatal morbidity. These conditions range from gestational hypertension, preeclampsia, chronic hypertension to eclampsia. Hypertensive disorders of pregnancy are caused by new hypertension that occurred 20 weeks of incubation and presents without albuminuria or other systemic symptoms that organ damage (6). Preeclampsia, on the other hand, is distinguished by hypertension with proteinuria or systemic involvement (renal, hepatic, neurologic) [21]. The term "chronic hypertension" refers to hypertension that is identified prior to pregnancy or before 20 weeks of pregnancy. While eclampsia is the severe end of the

spectrum with seizures that are not attributable to other neurological conditions. These diseases have high influence on the fetus's and mother's outcomes. For instance, preeclampsia is associated with increased risks of fetal growth restriction, preterm birth stillbirth, and placental abruption. It also leads to women being more susceptible to long-term health issues including increased likelihood of kidney and heart diseases later in life. Later in life implications are a long-term increased risk of metabolic and cardiovascular diseases as an adult [22].

Appropriate management of disease states depends on the ability to differentiate normotensive from hypertensive pregnancies. Physiological changes occur in the vasculature during normotensive pregnancies to establish adequate uteroplacental perfusion to ensure optimal fetal growth and development. These compensations could become altered in hypertensive pregnancies and potentially lead to hypoxia, endothelial dysfunction, and reduced blood flow to the placenta. These short comings can be detected by umbilical arteries doppler art ultrasonography of the uterine, and predetermined for the pregnancies at risk and the closely monitoring– and a plan of precocious interventions. Fetal health in complicated by hypertensive disorders or from other high-risk diseases can be monitored by Doppler ultrasonography and it is important to monitor the wellness of the fetus and mother. Blood flow between placenta and uterus is to cut down, as its gradual becomes imperceptible decline with the failure of trophoblast early vascular invasion obvious uterine artery have aberrant Doppler wave forms and keep a pulse there in diastolic index [23].

In the same way, fetal compromise, including fetal hypoxia, can also be detected by Doppler studies of the fetal circulation. It is father of the weakly pulsatile memory syndrome and leads to many missed diagnoses. Such findings help the doctor to expect such problems as premature birth and preeclampsia in ante-natal care. Cases where infants are stillborn have also been found during this process. In this context a chart can be created that allows one to look forward with confidence regarding which patients may need special attention, while giving others more standard care [24].

This represented hope and inspiration for all patients facing high-risk pregnancy, because use of the technique actually had saved their babies' lives time and again. By making an instant appraisal of whether the fetus was still getting enough blood with great ease whenever one pleases now at any time combined with other signs in ultrasonography and tests such as biophysical profile or maternal serum marker findings, the haunt change family found its overall predictive accuracy improved and

its risk stratification comprehensively done. Despite the widespread use of ultrasonography doppler in obstetrics, there remain notable gaps in the understanding of Doppler indices in normotensive versus hypertensive pregnancies, especially during the both trimesters such as 3rd and 2nd. Although several studies have demonstrated the doppler indices in predicting adverse outcomes, the data on how these indices differ between normotensive and hypertensive pregnancies are often limited or conflicting. Some studies suggest a clear association between abnormal Doppler findings and poor pregnancy outcomes in hypertensive disorders, while others report variability in the predictive accuracy of these indices [25].

The physiological changes in vascular resistance and compliance in the umbilical arteries and uterine during pregnancy are well-documented in normotensive women. However, the extent to which these changes are disrupted in hypertensive pregnancies, particularly across different trimesters, remains inadequately explored. In the second trimester, placental development enters a critical phase and by the third trimester we are witnessing the ultimate reversal of all life-sentiment in matter from geared maternally and fatally arranged to one where both are acting together. `Variations in Doppler indices during these phases might give some clues about the pathophysiology of this disease and its effects on mother and baby to be born, but as yet have not been well researched a. In purpose, if this is accurate it is identical to our finding; therefore, the only difference we are seeing could be due to methodology and subjects' characteristics on the other hand, this contradiction necessitates further large sample size prospective trials with well-defined objective data in order to evaluate quantitatively the role of Doppler ultrasonography in caring for women whose pregnancies are complicated by hypertensive disorders of pregnancy. Inter-population differences require additional characterization so that antenatal care schedules can be optimized for the respective populations, enhancing maternal and perinatal outcomes [26,27].

Current published data on Doppler indices in the 2nd and 3rd trimester are contradictory and differ, particularly cut-off values that would define normal and pathological vascular findings. These inconsistencies are a barrier to the potential to integrated Doppler ultrasonography as such to the diagnosis and prognosis in the care of hypertensive pregnancies. In addition, most of the previous research focused on advanced stages of the chronic hypertensive disorders of pregnancy, and therefore, did not clarify the vascular changes throughout the first to third trimesters. Doing this

Doppler indices in normo-or h hypertense vet pregnancy may improve antenatal care. This is particularly applicable to high-risk regions with heavy maternal medical burdens and early high-risk pregnancy management can reduce the complications with which they are associated. In these scenarios, further analysis of these Doppler indices may not only help guide clinical decision-making, but also the allocation of scarce resources and intervention strategies in places where resources are limited [28].

The aim of this study is to assess and compare uterine and umbilical artery Doppler findings, namely resistance index (RI) and pulsatility index (PI), in normotensive and hypertensive pregnant women in the second and third trimesters of pregnancy. Furthermore, the study aims at searching for patterns or cut-off levels in the Doppler data which may represent predictors of adverse pregnancy outcomes, thus improving the surveillance of high-risk pregnancies [29].

AIM AND OBJECTIVES

To compare uterine and umbilical artery Doppler indices in normotensive and hypertensive pregnant women during the second and third trimesters, aiming to enhance early detection, risk assessment, and management of high-risk pregnancies**.**

CHAPTER 2

LITERATURE REVIEW

Yingying Tian (2022), carried out research on the infiltration of trophoblasts into uterine decidua and decidual vasculature is necessary for development of placenta. Placental disorders are associated with the etiologies for preeclampsia (PE), fetal growth restriction (FGR) and small-for-gestational age infants. Uterine artery Doppler (UAD) is used to predict significant vascular events in pregnancy. Assessment of changes in uterine and placental vasculature from implantation to end of pregnancy can be a useful diagnostic approach for pregnancy disorders. The aim of this review is to comprise some work related to the role of UAD in pregnancy diseases. Anticipation of problematic pregnancies in advance allows medical professionals to take action in order to prevent or minimize harm to mothers and infants. Regular daily dose of aspirin prior to 16 weeks of pregnancy can reduce threat of pregnancy complications, study finds. UAD can be integrated with other maternal factors, biochemical markers, and fetal measurement data into a Combine test from early to late pregnancy to screen high risk patients. The detection of high-risk groups may permit a decrease in maternal mortality. Also, with the classification for moderate risk, strict surveillance to pregnant women at high risk may be applied, and the occurrence of events is reduced [30].

In 2020, Diyar. O Hassan was gathered to identify and describe the echocardiographic and demographic features of pre-eclampsia. High blood pressure and proteinuria are the symptoms of pre-eclampsia. Fetal-maternal blood flow was analyzed by color Doppler indices on both normal and pre-eclamptic mother. A Cross Sectional Study was carried out and 103 high risk pregnant women (51 controls and 52 cases) from Maternity Teaching Hospital in Erbil City were participated in the study. During pregnancy (24-39 weeks) maternal, uterine, umbilical and middle cerebral artery blood velocity waveforms were obtained by transabdominal examination. Doppler index parameters were evaluated with color Doppler, in cases as well as in controls. Data was processed by the social science statistics' software. The PI, RI and S/D ratios of the umbilical and uterine arteries were significantly higher (p= 0.001, 0.002, 0.003, respectively) for cases than for controls. Controls not with pre-eclampsia showed higher PI, RI and systolic/diastolic ratio of MCA than those of pre-eclampsia cases (P= 0.001 and 0.002, respectively). Approximately 10% of all cases were associated with absent umbilical artery end-diastolic flow and a positive uterine artery notch with

significantly (P= 0.01) higher systolic and diastolic blood pressure than those without a uterine artery notch. Differences in UA and MCA findings obtained from the cases and controls can be useful predictive tools for preeclampsia. These markers could also be used for the monitoring of cases of pe-eclampsia to assist [31].

Veeranki Leela Madhuri studied in 2024, on the efficacy of second-trimester uterine artery Doppler screening in the prediction of preeclampsia (PE) risk, risk for FGR, and its impact on pregnancy outcome. A pared prospective cohort study of 100 antenatal women at 2nd trimesters of pregnancy. Potential algorithms to screen patients at high risk for PE and FGR. The pulsatility and resistance index (PI, RI) of that were determined by Doppler examination. The primary outcomes included PE and FGR, and the secondary outcomes included the therapeutic effect and neonatal outcomes. Sensitivity, specificity, positive predictive value, negative predictive value, likelihood ratios, and ROC curve analysis were performed using statistical tests [32]. Sensitivity was 85% and specificity was 48% for the prediction of PE, with a positive predictive value of 40% and a negative predictive value of 91%. FGR had a sensitivity of 71%, NPV of 90%, specificity of 45%, PPV of 23%, and NPV of 90%. The overall predictive sensitivity was 83%; specificity, 47%; PPV%. Statistical analysis showed a significant correlation of Doppler screening with fetal outcome for maternal risk factor. Preventive aspirin was received but, 36 cases of Doppler abnormality developed with pregnancy-induced hypertension complications. Conclusion: second-trimester uterine artery. Doppler surveillance has excellent predictive values for PE and FGR. The early detection allows intervention in pregnancies at high risk and may improve maternal and fetal outcomes [33].

The current research was performed by Atiporn Chaiwong in 2023 and intended to evaluate umbilical artery pulsatile index, resistance index, and systolic/diastolic ratio among pregnant women with AMA and normal maternal age. Participants were pregnant women who attended antenatal care at the maternal-fetal medicine unit at Bhumibol Adulyadej. Hospital, Royal Thai Air Force, Bangkok, Thailand. The present study was conducted from February to December 2022. The study population included patients older than 35 years (study group); the control group was represented by patients younger than 35 years. All subjects underwent ultrasonography study of the umbilical artery (UA) Doppler velocimetry, including umbilical artery -PI, umbilical artery -RI and umbilical artery -S/D. Demographic details of the study and control cases were used in statistical analysis. The sample consisted of 500 pregnant women

with a gestational age of eighteen to twenty-four weeks. The mean age in the study was 37.9 years versus 26.0 years in the control group. The BMI of the NGT trial groups is higher than the control. There was no significant difference in the diastolic and systolic blood pressures between the study and control groups. Mean (SD of UA-PI, UA-RI, and S/D ratio of the study/control group were, respectively, in a statistically significant manner. LGA,) gestational diabetes mellitus, and Pregnancy-induced hypertension (PIH), were all significantly more common in the study group than in the control group. In contrast to those under 35 years old, AMA pregnant women had higher, incidence of gestational diabetes mellitus, LGA, Pregnancy-induced hypertension [34].

In 2022, Mishal Asif conducted a study to investigate the one prevalent condition that can affect the wellness of both the offspring and the mother during pregnancy is hypertension. It is a large contributor to neonatal mortality, fetal, and maternal and raises the possibility of an unfavorable pregnancy outcome. to compare the dynamics of the uterine arteries on Doppler ultrasonography between normotensive and gestational hypertension pregnancies. Within the radiology department of (DHQ) hospital in Faisalabad, a cross-sectional case control research was conducted. All patients gave their written consent prior to examination of ultrasound [35]. The sample size that was determined was 98. Patients' eligibility was evaluated based on the inclusion criteria. Regular obstetric ultrasonography was used to confirm the gestational age and intrauterine live pregnancy. Both normal and hypertensive pregnant individuals who were enrolled were evaluated for uterine artery Doppler ultrasonography examination. The study involved 98 women, 49 of whom had hypertension and the remaining 49 of whom were healthy. Data comparison revealed that the hypertension group's mean blood pressure and prenatal weight were considerably higher than those of the normotensive group. Additionally, ultrasound doppler revealed that the hypertensive group had considerably higher values of uterine artery parameters, including RI, S/D Ratio, and PI, than the normotensive group. Compared to patients with normotension, hypertension patients have noticeably increased uterine artery Doppler values. Based on our study's results, diagnostic measures for assessing the complications before they worsen include bilateral, right, or left notching, as well as the Pulsatility and Resistivity indices [36].

In 2021, Fehmida gul conducted a study to investigate the Pregnancy-induced hypertension is the most prevalent pregnancy-related complication that can impact

both the mother and the fetus. This study was conducted in Department of Radiology in conjunction with the Department of Gynae and Obs at the tertiary care hospital of Nawab shah for a duration of six months. A total of 106 participants were chosen for the study, and all of the females were pregnant with a first or second trimester gestational record. All participants' medical histories were obtained, co-morbidities were assessed, and blood pressure was measured for each patient [37]. Twenty-six participants were between the ages of 18 and 21, thirty-four were between the ages of 22 and 25, twenty-one were between the ages of 26 and 29, and just seven were between the ages of 34 and 37. There were 26 participants in the first trimester, 34 in the second, and 21 in the third. Additionally, PI was recorded with three distinct readings. The uterine artery is number 37, the middle cerebral artery is number 21, and the umbilical artery is number 32. Additionally, RI was observed in the umbilical, middle cerebral, and uterine arteries (41, 36, and 39, respectively). Additionally, S/D was observed in the uterine arteries 30, middle cerebral artery 49, and umbilical artery 33. Hemodynamic changes in the uteroplacental vasculature brought on by pregnancy-induced hypertension may occasionally be the cause of decreased fetal growth [38].

In 2024, Dr uzma Banu Munawar conducted a study to investigate one serious obstetric issue that puts the mother and the fetus at serious risk is pregnancy-induced hypertension (PIH). PIH is a major cause of maternal and neonatal morbidity and mortality, affecting 5–10% of pregnancies globally. Color During pregnancy, Doppler ultrasonography has become a useful non-invasive method for evaluating blood flow in different maternal and fetal arteries. A thorough evaluation of the fetal state in PIH is provided by combining the results of Doppler ultrasonography from the uterine artery, umbilical artery, and MCA. By examining blood flow in the uterine, umbilical, and middle cerebral arteries, Doppler ultrasound can be used to assess how well it manages pregnancy-induced hypertension (PIH). This two-year, cross-sectional study, which ran from September 2022 to August 2024, involved 75 pregnant women with PIH diagnoses. Using GE LOGIQ P9 ultrasound machines equipped with a 5 13MHz linear transducer, a high-resolution Duplex Doppler sonography investigation was conducted. In every instance, the initial scan was carried out as soon as the patient was registered to prevent treatment from affecting the Doppler sonogram. Menstrual history and ultrasound examination were used to confirm the gestational age. Color Doppler imaging was then used to identify the uterine artery, and flow velocity

waveforms from the umbilical artery and MCA were performed. The majority of deliveries among the 75 pregnant women with PIH were induced (42.3%), with elective (17.3%) and emergency (16.0%) cesarean sections coming in second and third, respectively. With a mean systolic-diastolic ratio of 2.51 and a mean resistance index of 0.58, a significant portion of individuals (65.3%) had abnormal uterine artery Doppler results. 49.3% of cases had abnormalities on umbilical artery Doppler, with mean resistance and pulsatility indices of 0.68 and 1.32, respectively. 54.7% of subjects had middle cerebral artery Doppler anomalies, with mean resistance and pulsatility indices of 0.72 and 1.33 [39].

In 2023, Gupta RS conducted a study to investigate the second trimester of pregnancy, uterine artery Doppler velocimetry (UADV) analysis has been thoroughly investigated as a predictive study for the emergence of unfavorable feta-maternal outcomes in the future. The purpose of this study was to evaluate the relationship between maternal outcome and uterine artery Doppler velocimetry results. From July 2021 to December 2021, pregnant women who visited the inpatient and outpatient obstetrics and gynecology departments of the Bangladesh Institute of Research and Rehabilitation in Diabetes, Metabolic Disorders and Endocrine, Genmaicha, Dhaka, participated in this prospective observational study. In all, 31 singleton pregnant women between the ages of 18 and 24 weeks were included in the study. A semi-structured questionnaire was used to gather information from patients on factors of interest following the acquisition of their informed written consent. The majority of the subjects (51.6%) were above 30 years old. With a range of 21 to 40 years, the mean age was 29.71±4.8 years. Just 32.3% of the individuals had hypertension, while the majority (96.8%) had diabetes mellitus. 32.3% of individuals had adequate diastolic flow, while more than half (54.8%) had diastolic notch. Preeclampsia was present in the majority (64.3%) of respondents who had reduced diastolic flow. The majority of respondents (70.0%) who had diastolic notch also experienced preeclampsia. Every one of these results was statistically significant ($p<0.05$). In conclusion, pregnant women as compared to with normal UADV results in the second trimester are less likely to experience a negative maternal outcome [40].

In 2022, Dr Shilpa kumari conducted a study to investigate the Common pregnancy complications include hypertensive problems, which together with infection and bleeding constitute the lethal trio that significantly increases maternal morbidity and mortality. Worldwide, the prevalence of different pregnancy-related hypertension

disorders ranges greatly, from 5% to 15%. It is responsible with 7–10% of perinatal deaths in wealthy nations and 20% in underdeveloped nations. For mild PIH, the prenatal mortality rate is 5%, but for severe PIH, it ranges from 15% to 25%. The study was carried in 2018 at the Rajendra Institute of Medical Sciences in Ranchi. The study group consisted of fifty pregnant hypertension patients that visited the hospital. All prenatal cases with a clinically determined pregnancy-induced hypertension score greater than 28 weeks met the inclusion criteria. Thirty-six of the fifty instances of pregnancy-induced hypertension in this investigation had positive Doppler indices in one or all three of the examined arteries. None of the three vessels under investigation had any aberrant Doppler indices in the fourteen remaining cases. 21 of the 36 patients had an SD ratio for the uterine arteries of >2.6. In 20 patients, the uterine artery RI was greater than 0.58 [55%]. The uterine artery's diastolic notch was present in 55% of instances. In 69% of instances, the cerebroplacental ratio, or MCA/Umbilical artery PI, was less than 1. Significant fetal morbidity and mortality are linked to pregnancy-induced hypertension. A higher frequency of intrauterine growth restriction and severe forms of hypertension are linked to the persistence of the uterine artery early diastolic notch in the third trimester. The sensitivity of the middle cerebral artery is lower. compared to the umbilical vein. Reverse end diastolic flow (REDF) and absent end diastolic flow (AEDF) are linked to 75% of neonatal deaths and signify significant fetal distress [41].

In 2022, Sameh noted ouda led a study examining whether uterine artery Doppler in the first trimester of the second trimester predicts intrauterine growth restriction. A one hundred pregnant women attending the OB/GYN Outpatient Clinic at Al-Azhar University Hospitals were involved in a cross-sectional observational study. Features of the waveform of uterine artery by flow velocity wave were analyzed with Doppler, using continuous wave type wave. Standard deviations were obtained after the PI and RI results were reported. At cutoff point, uterine PI demonstrated the applicability for predicting IUGR at a with the sensitivity of specificity, PPV and NPV, respectively. Uterine RI was also found to be statistically significant for the prediction of IUGR at a cutoff of with sensitivity, specificity, PPV, NPV. In summary, prediction of IUGR in high-risk women can be achieved on the basis of abnormal UtA Doppler ultrasonography (elevated PI) in the second trimester, which is confirmed by biochemical test [42].

In 2021, Soha Farid Fahim Hassan conducted a study to use Doppler ultrasonography

to predict pre-eclampsia by evaluating placental volume changes using 3-D USS and abnormalities in uterine and umbilical artery Doppler indices. This research was carried out in the Obstetrics and Gynecology Department of Al-Azhar University's Hussein Hospital from May 2016 to April 2017. Two hundred pregnant women were divided into two equal groups for this prospective observational study. 50 primipara and 50 multipara women in Group "A" had a known risk factor for pre-eclampsia, such as a prior medical history or a medical condition like persistent hypertension, while 50 primipara and 50 multipara women in Group "B" had no known risk factor. The two groups' differences were statistically significant in terms of abnormalities, persistent notch, uterine artery PI, and RI (p values = 0.025, 0.037, 0.001, and 0.001 respectively). According to ROC results, the area under the ROC curve was equivalent to 0.672, 0.851, and 0.527, and the cutoff values for placental volume, uterine RI, and umbilical artery RI were greater than 0.67, 0.56, and 43. Placental volume, uterine RI, and umbilical artery RI had respective sensitivity values of 83.0, 86.5, and 79.2, and specificity values of 73.3, 60.0, and 62.5 [43].

In 2021, Daniels Rocha Ramos carried out a study comparing unfavorable perinatal outcomes for pregnant women at 24-28 weeks gestation, regardless of their mean PI for the uterine artery Doppler being made. 3 groups of pregnant women were identified from a retrospective cohort: abnormal uterine artery Doppler between and weeks & positive from weeks (aaUtA), abnormal uterine artery Doppler between & weeks (aaUtA), and normal uterine artery Doppler between & weeks (controls). Chi-square test was used to compare unfavorable perinatal outcomes of the groups. Performances of uterine artery Doppler in the prediction of the combined perinatal outcomes and birthweight < 10th were calculated by binary logistic regression. The aggregate of16aaUtA had a lower birth weight than of a UtA. Birthweight and third trimester mean PI uterine artery Doppler had significant inverse correlation. The frequency of composite perinatal outcomes was significantly more frequent in aaUtA than an UtA. The proto diastolic notch and the association between mean PI uterine artery Doppler and proto diastolic notch did not predict birthweight however, mean PI uterine artery Doppler in the third trimester. The prevalence of composite perinatal outcomes and birthweight was significantly higher in maintaining abnormal UTAD during the third trimester than in late normalization [44].

In 2025, Priyanka Mitra conducted a study to investigate the relationship between the gestational age at which hypertension begins, delivery, and low birth weight, as well

as the utility of the uterine artery diastolic notch in the second trimester for the early prediction of hypertensive diseases of pregnancy. 184 pregnant women participated in this observational prospective case control study. Between weeks 13 and 16 of pregnancy, A diastolic notch in the uterine artery of greater than 50% was evaluated. Additionally, the spiral artery doppler was evaluated. Every prenatal visit's blood pressure was measured, and the gestational age at which hypertension developed and delivery occurred was also noted. Version 20.0 of (SPSS) used to calculate results. 24 women (61%) out of 39 with notch (+) developed hypertension, demonstrating that a diastolic notch in the uterine artery is a predictor of the development of hypertension later on (p-value < 0.0001, statistically significant). Overall, the specificity, sensitivity, positivity and the test's accuracy and negative predictive value were 89.9%, 85.3%, and 61.5%, 91.7%, and 66.7%, respectively [45].

In 2022, Ademola J. Adekanmi performed the following study to evaluate If uterine and umbilical artery Doppler is helpful in prediction of adverse pregnancy outcome in second and third trimesters. The demographic and Doppler ultrasonography (US) findings in 116 women with uterine artery PI, 30-34 weeks gestation and pregnancy outcome, and of 84 consecutive women attending the antenatal clinic at 22-24 weeks were recorded and analyzed, Two pregnant women who subsequently had a poor pregnancy outcome had significantly higher uterine ratio in the second trimester, pulsatility index, umbilical artery, and resistivity index the second-trimester uterine and higher third-trimester uterine S/D and PI. Second-trimester uterine arteries S/D and PI were significantly higher in pregnancies with adverse fetal outcomes but only third-trimester uterine arteries. and umbilical artery PI in relation to pregnant women with normal fetal results. The combination of uterine PI and EDN was an effective predictor of maternal outcomes, correctly predicting 76% of the second positions. The uterine PI by itself was the most effective determinant of outcome by the third trimester. maternal outcomes and 68%. The third trimester uterine PI and the second trimester uterine S/D and early diastolic notch correctly predicted 79% and 78% of the fetal outcomes, respectively. In the population of pregnancies of unselected pregnant women, the prediction of an adverse pregnancy outcome in the mother, based on second-trimester Doppler parameters, is better, while for the fetus, the ability to predict an adverse fetal outcome is similar for the parameters related to uterine and umbilical doppler, in the second and third trimesters [46].

Early detection of the complications preventable in women with high-risk pregnancies

such as preeclampsia, fetal growth restriction or placental insufficiency reference has been given in literature as rationale for routine use of Doppler ultrasonography. Nevertheless, there is little data on the comparison of Doppler indices between normotensive and hypertensive pregnancy, particularly in the second and third trimesters. Additional studies are required to determine proposed cut-off values and predictive accuracy of the Doppler indices in hypertensive disorders of pregnancy. This study was conducted to bridge these gaps and contribute to the decision making in the management of hypertensive pregnancies with the help of Doppler ultrasonography [47].

CHAPTER 3

METHODOLOGY

3.1. Research Design: Case Control Study.

3.2. Clinical Settings: Kishwar Sultana Hospital, Lahore.

3.3. Sample Size: 80

A sample size of 86 cases was calculated with 95% of confidence level and 5% of margin of error.

n=80

3.4. Sampling Technique: Convenient Sampling Technique was utilized.

3.5. Duration of Study: The study was conducted over a period of 6 months, starting from February 1, 2025.

3.6. Selection Criteria

6.1 Inclusion Criteria:

- 2nd and 3rd Trimester Pregnancy
- Hypertensive, Normotensive pregnant females
- Single and Twins Pregnancy
- The patient with Informed Consent

6.2 Exclusion Criteria:

- 1st Trimester pregnancy
- Pre-Existing medical conditions (Diabates Mellitus, Cardiac Disease, Renal Disease, Auto Immune Disease)
- The patients who are not willing to participate

3.7. Ethical Consideration

The rules and regulations set by the ethical committee of Superior University, Lahore was followed while conducting the research and the rights of the research participants will be respected.

- Written informed consent was taken from all the participants.
- All information and data collection were kept confidential.

- Participants were remaining anonymous throughout the study.
- The subjects were informed that there are no disadvantages or risks on the procedure ofthe study.
- They were also be informed that they are free to withdraw at any time during theprocess of the study.
- There were no risks associated with this research.
- We did everything we can to protect your privacy. Your identity will not be revealedin any publication resulting from this study.

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate any time. You will not be penalized inany way should you decide not you participate or to withdraw from this study.

3.8. Data Collection Procedure:

Data for this study was collected using a structured questionnaire.

To evaluate the uterine and umbilical artery Doppler indices in normotensive and hypertensive pregnant females during the second and third trimester.

High-resolution ultrasound machine with Doppler capabilities.

- Ensure the machine is calibrated and ready for use.
- Transabdominal probe (3.5 MHz convex transducer).
- Ultrasound gel to ensure good contact between the probe and the skin.
- **Patient Preparation**:
- Obtain informed consent from the participants.
- Ensure the patient has a partially full bladder to improve visualization of the uterus and surrounding structures.

Procedure

- **Patient Positioning**:
- Asked the patient to lie on their back on the examination table.
- Ensure the patient is comfortable and can remain still during

the examination.

- **Application of Gel**:
- apply a generous amount of ultrasound gel to the lower abdomen, covering the area to be scanned.
- **Transabdominal Ultrasound**:
- Place the transabdominal probe on the gel-covered skin.
- Adjust the probe angle to obtain clear images of the uterus and surrounding structures.
- **Uterine Artery Doppler Assessment**:
- Identify the uterine arteries bilaterally.
- Obtain Doppler waveforms from each uterine artery.
- Measure the following indices:
- **Pulsatility Index (PI)**: PI=TAV/PSV−EDV
- **Resistance Index (RI)**: RI=PSV/PSV−EDV
- **Systolic-Diastolic (S/D) Ratio**: S/D=EDV /PSV
- Ensure the angle of insonation is less than 30 degrees to minimize errors.

Umbilical Artery Doppler Assessment

- Pulsatility Index (PI): PI=TAV/PSV−EDV
- Resistance Index (RI): RI=PSV/PSV−EDV
- Systolic-Diastolic (S/D) Ratio: S/D=EDV/PSV
- Ensure the angle of insonation is less than 30 degrees to minimize errors.

Data Recording:

Record the Doppler waveforms and indices for each artery.

Note any abnormalities or findings during the examination.

Post-Examination:

Wipe off the gel from the patient's skin.

Allow the patient to change back into their clothing

3.9. Data Analysis

Data was analyzed using the Statistical Package for the Social Sciences (IBM® SPSS® Statistics, Version 29). Descriptive variables was presented in frequencies, percentages, mean and standard deviation (SD), median.

CHAPTER 4

RESULTS

Table 4.1: Age Distribution

Age	Frequency	Percentage
20	4	5.00%
21	5	6.25%
22	5	6.25%
23	4	5.00%
25	6	7.50%
26	2	2.50%
27	5	6.25%
28	1	1.25%
29	5	6.25%
30	2	2.50%
31	6	7.50%
32	5	6.25%
33	6	7.50%
34	5	6.25%
35	3	3.75%
36	1	1.25%
37	5	6.25%
38	4	5.00%
39	6	7.50%
Total	**80**	**100**

This table shows the distribution of participants in your study based on their age. It highlights that the majority of participants were between 20 and 40 years old, with the most common age group being 31 years, which had the highest frequency of 6 participants. The age range of 20–35 years encompasses a significant portion of your sample, reflecting the target age range for the study.

Table 4.2: Hypertension index

Hypertension	Frequency	Percentage
No	40	50%
Yes	40	50%
Total	**80**	**100**

This table divides participants into two groups based on the presence or absence of hypertension, with 50% of participants in both categories. This distribution is key for understanding the impact of hypertension on the study's findings.

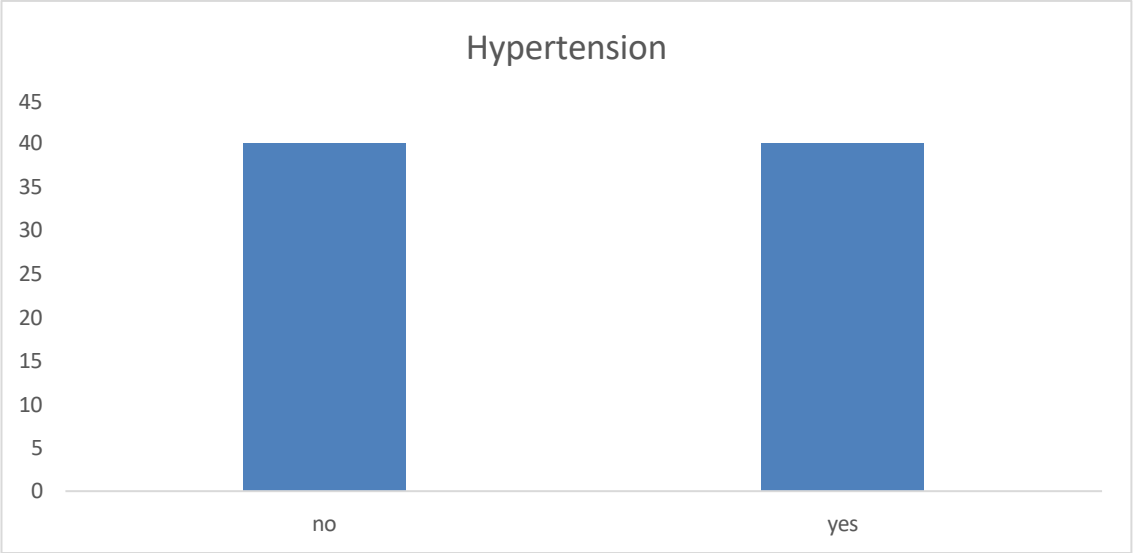


Table 4.3: Trimester Index

Trimester	Frequency	Percentage
2nd	40	50%
3rd	40	50%
Total	**80**	**100**

This table provides the distribution of participants based on their trimester, with an equal distribution of 40 participants in both the 2nd and 3rd trimesters. This ensures that the study includes data from different stages of pregnancy, allowing for a more comprehensive analysis of hypertensive conditions.

Table 1.4: Descriptive Analysis - Uterine Artery Indices

	Uterine Artery RI	Uterine Artery RI	Uterine Artery RI	Uterine Artery RI	Uterine Artery PI	Uterine Artery PI	Uterine Artery PI	Uterine Artery PI
	mean	std	min	max	mean	std	min	max
Hypertension								
no	0.623887	0.080973	0.477733	0.749254	0.831774	0.073914	0.716594	1.00834
yes	0.655732	0.089981	0.437968	0.798831	0.774115	0.083813	0.624294	0.96179

This table presents the descriptive statistics for the uterine artery resistance index (RI) and pulsatility index (PI) for both hypertensive and normotensive participants. The data show that, on average, hypertensive participants have higher uterine artery RI and PI values, suggesting increased vascular resistance, which is consistent with the presence of hypertension. The standard deviations indicate some variability within each group, and the range shows the extremes of the measurements.

Table 4. 2: Descriptive Analysis - Umbilical Artery Indices

	Umb. Artery RI	Umb. Artery RI	Umb. Artery RI	Umbilical Artery RI	Umb. Artery PI	Umb. Artery PI	Umb. Artery PI	Umbilical Artery PI
	mean	std	min	max	mean	std	min	max
Hypertension								
no	0.613065	0.085628	0.402935	0.831884	0.912683	0.105004	0.61816	1.155817
yes	0.607124	0.071485	0.46275	0.760732	0.937786	0.094513	0.770621	1.132828

Similarly to Table 4, this table presents descriptive statistics for the umbilical artery indices (RI and PI) for hypertensive and normotensive groups. The results suggest that while hypertensive participants have slightly higher values for both umbilical artery RI and PI, the differences are less pronounced compared to uterine artery indices.

Table 4.3: Descriptive Analysis - SD Ratio

Hypertension	Mean	Std
no	2.897031	0.574338
yes	3.122168	0.533976

The SD ratio (systolic to diastolic ratio) is presented here for both hypertensive and normotensive groups. It shows that the hypertensive group has a higher mean SD ratio (3.12) compared to the normotensive group (2.90), suggesting that hypertensive pregnancies may experience impaired placental blood flow, although the result is not statistically significant.

Table 4. 4: Comparative Analysis Table (Normotensive vs Hypertensive)

Variable	T-Statistic	P-Value
Uterine Artery RI	-1.6638	0.1002
Uterine Artery PI	3.2632	0.0016
Umbilical Artery RI	0.3369	0.7371
Umbilical Artery PI	-1.1238	0.2645
SD Ratio	-1.8157	0.0733

This table compares the uterine and umbilical artery indices and SD ratio between normotensive and hypertensive groups using t-tests. The most notable finding is the significant difference in uterine artery PI (p-value = 0.0016), indicating that uterine artery PI is a potential marker for differentiating between hypertensive and normotensive pregnancies. Other variables, such as uterine artery RI, umbilical artery indices, and SD ratio, do not show statistically significant differences (p-values > 0.05).

Table 4.5: Correlation Analysis

Variable Pair	Correlation Coefficient
Uterine Artery RI vs Umbilical Artery RI	0.399993
Uterine Artery PI vs Umbilical Artery PI	-0.05931
Uterine Artery RI vs SD Ratio	0.684211
Uterine Artery PI vs SD Ratio	-0.40815

This table shows the correlation coefficients between various pairs of variables. Notably, the correlation between uterine artery RI and SD ratio (0.684) suggests a strong positive relationship, indicating that as uterine artery resistance increases, the SD ratio tends to increase as well. The correlation between uterine artery PI and umbilical artery PI is negative (-0.059), showing a very weak relationship between these two variables.

Table 4.6: ***Logistic Regression Model Performance:***

Metric	Value
Accuracy	0.541667
Precision	0.625
Sensitivity (Recall)	0.384615
Specificity	0.384615

This table evaluates the performance of a logistic regression model in predicting hypertensive pregnancies. The model's accuracy is 54.17%, with a precision of 62.5%, sensitivity (recall) of 38.46%, and specificity of 38.46%. These results suggest that while the model has a decent ability to identify hypertensive pregnancies, its sensitivity and specificity could be improved for better performance.

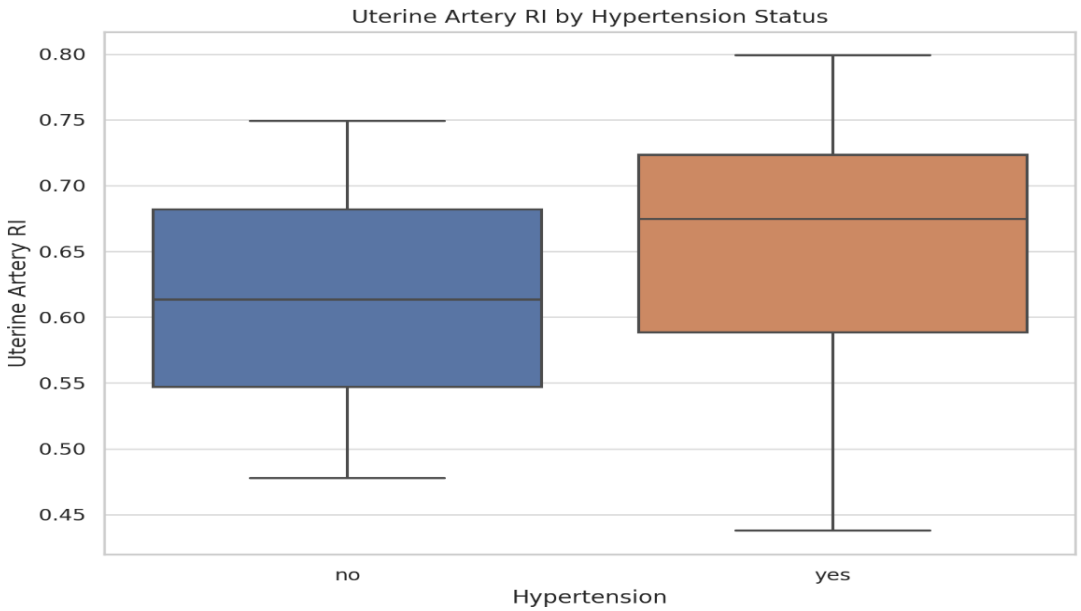


Figure 4.1: Uterine Artery RI by Hypertension Status

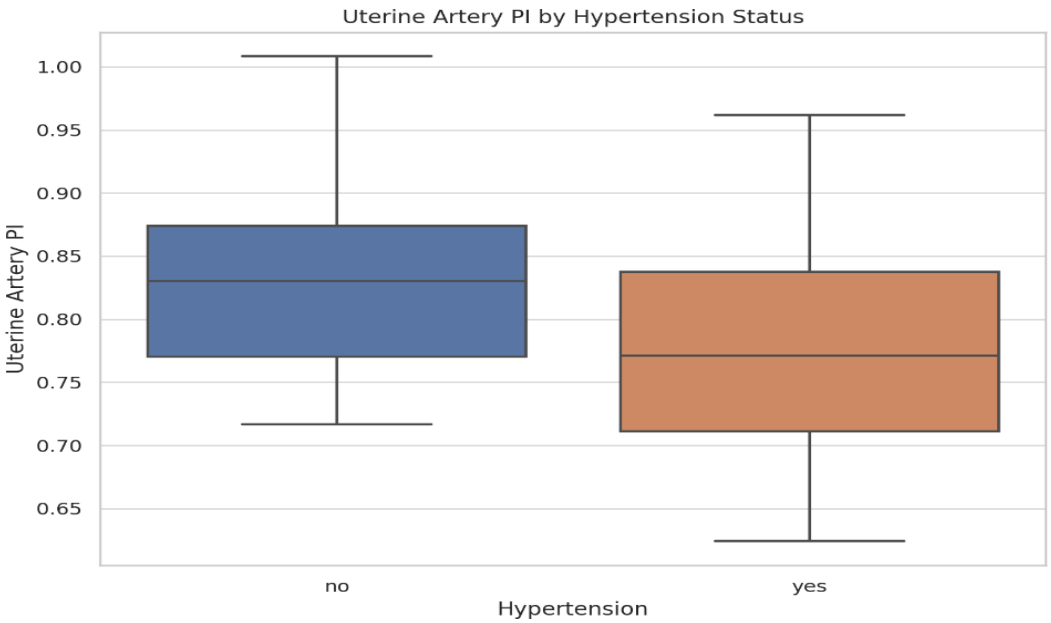


Figure 4.2: Uterine Artery RI by Hypertension Status

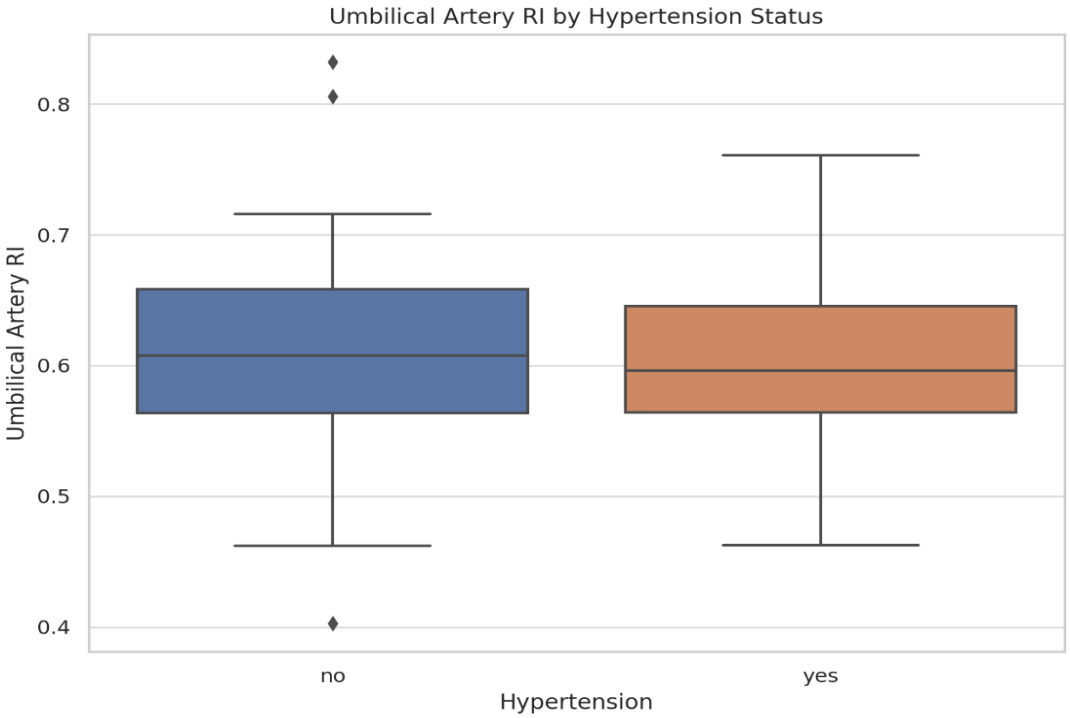


Figure 4.3: Umbilical Artery RI by Hypertension Status

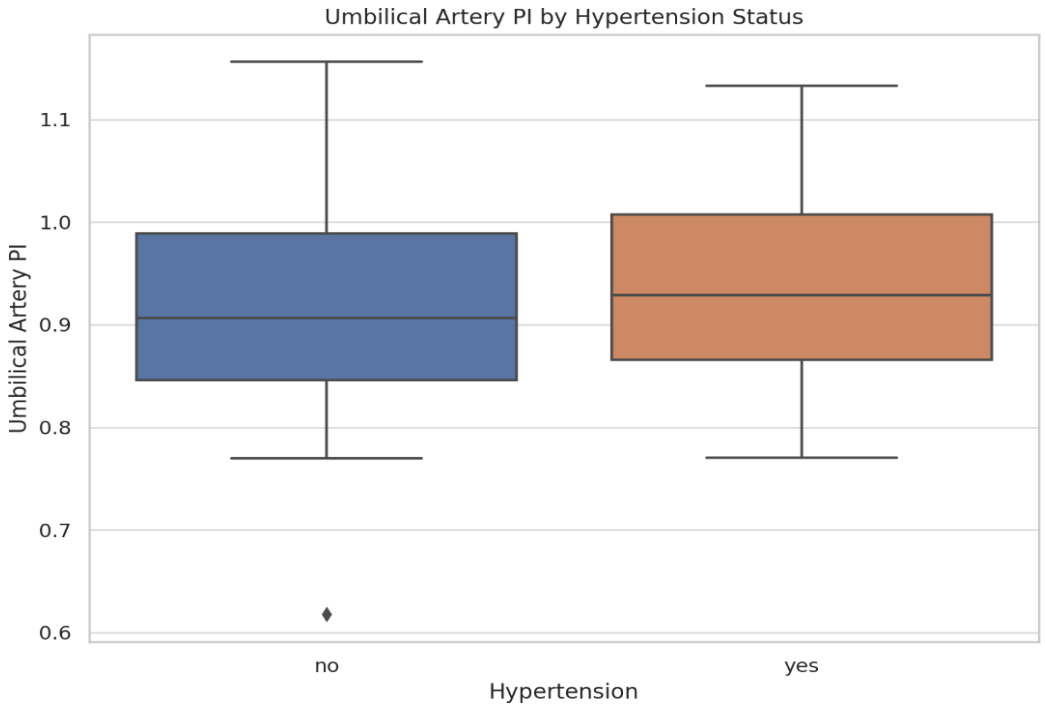


Figure 4.4: Umbilical Artery PI by Hypertension Status

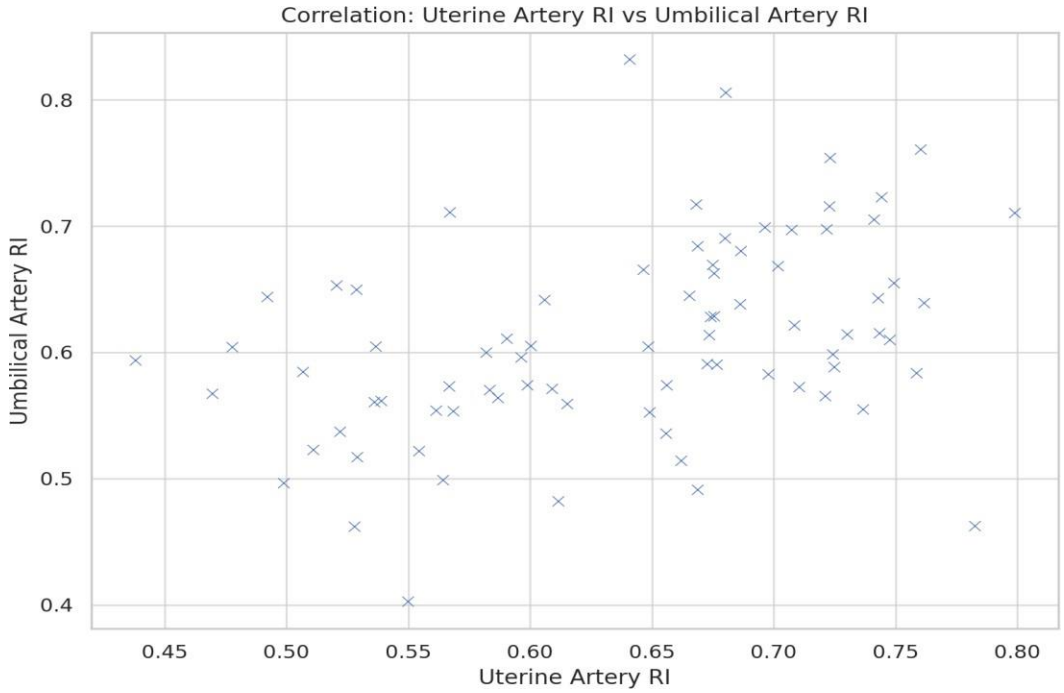


Figure 4.5: Correlation: Uterine Artery RI vs Umbilical Artery RI

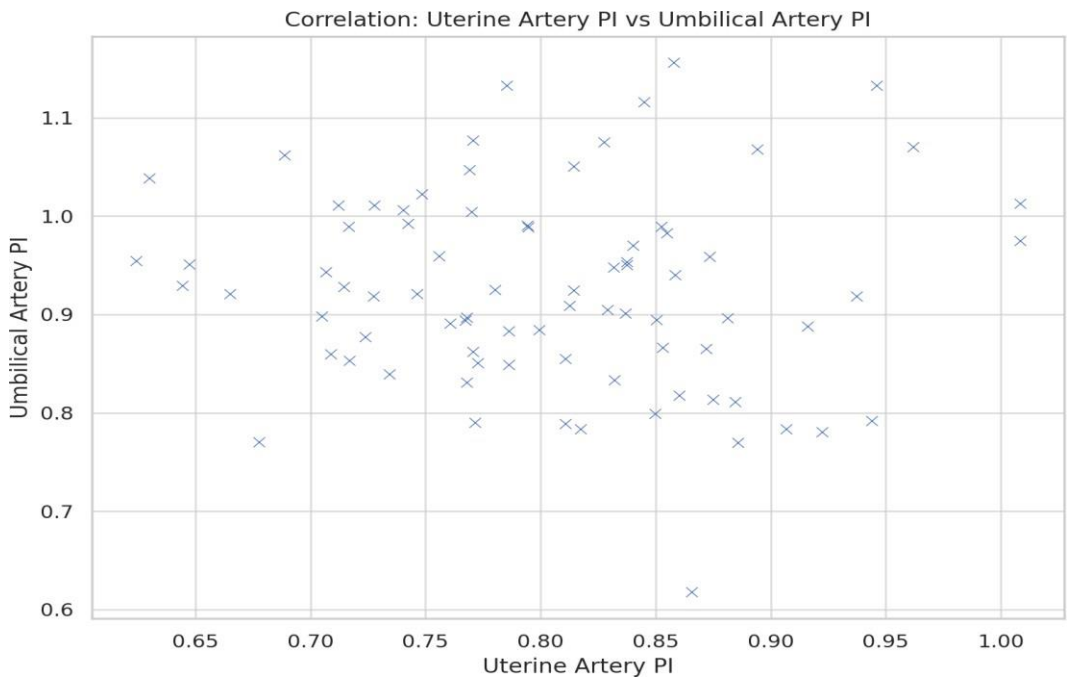


Figure 4.6: Correlation: Uterine Artery PI vs Umbilical Arte

CHAPTER 5

DISCUSSION

The aim of this study was to compare uterine with umbilical arterial Doppler indices between normal pregnancy and hypertension in latter trimesters Results/consequences of this study's findings This study's results show the potential for Doppler indices to serve as a predictor in GHDs, especially gestational hypertension (GH) or pre-eclampsia The results highlighted that the uterine artery pulsatility index (PI) and the systolic/diastolic (SD) ratio, which were verified early for discriminating between a normal pregnancy and the hypertensive ones (33).Hypertensive pregnancies were found to have significantly higher RI and PI of the uterine arteries compared to normotensive pregnancies. the uterine artery resistance index showed no significant difference (p=0.1002) whereas the pulsatility index did show a significant difference (p=0.0016), suggesting that uterine artery PI might be a better predictor marking own for hypertension. These results are in line with those of previous studies wherein increased PI and RI have been observed in patients with hypertensive pregnancies, implying poor placental perfusion and increased vascular resistance (18).

The higher values of uterine artery PI among pregnancies affected by HTN may demonstrate the higher resistance in flow of the blood to the placenta that is a characteristic of HTN conditions as preeclampsia. This result is consistent with previous literature documenting the predictive value of Doppler ultrasonography, especially for the uterine artery PI, in the screening of adverse pregnancy outcomes such as preeclampsia and IUGR. This study by [Fehmida Gul (2022)] found similar results that higher uterine artery Doppler resistance indices like PI were possibly associated with PIH, which supported the results of our study (25).

Fortunately, the disparity of the umbilical artery indices (RI and PI) of hypertensive and normotensive pregnancies was relatively low. Neither RI and PI of the umbilical artery were significantly different between them, as shown also in the literature, which underlines that umbilical artery may not be a hypertensive sensitive predictive parameter in pregnancy. This may be of particular relevance in relation to the diagnostic value of Doppler indices, as it indirectly indicates that whereas umbilical artery indices can reflect fetal well-being, their value in the early identification of hypertensive disorders is less consistent [36,37].

Consistent with these results, some additional analysis (see [Vasilenko et al. (2014) and [Mishal Asif (2022)], have reported that in the presence of umbilical artery Doppler

abnormalities in the form of absence or reversal of end-diastolic flow are associated with adverse pregnancy outcomes, changes in UA indices are related with fetal decompensation rather than maternal hypertensive disorders. The data in the present study imply that (though somewhat variable) the umbilical artery Doppler indices do not correlate as well with hypertensions as do the uterine artery Doppler indices [40].

Another important Doppler index, the SD ratio, also presented remarkable findings in hypertensive pregnancies. Although there was no significant difference between groups, the mean SD ratio was higher in the hypertensive group, suggesting that hypertensive disorders might impair the blood supply of the placenta and increase vascular resistance. These results are consistent with those reported in [Mishal Asif (2022)] where higher SD ratio values were measured for hypertensive pregnancy. While the SD ratio did not clear statistical significance in this cohort ($p = 0.0733$), the higher values in hypertensive cases provide evidence for the SD ratio as an adjuvant measure in the analysis of placental perfusion and prediction of hypertensive disease [20].

The logistic regression model for estimation of hypertensive pregnancies had a moderate predictive accuracy (54.17%; precision = 62.5%). Nevertheless, the model had moderate sensitivity and specificity (38.46% each), suggesting that although Doppler indices are useful for diagnosing hypertensive pregnancies, the performance of the model could be further enhanced. Such findings emphasize the importance of other studies in which it is reported that the Doppler indices combined with other clinical or biochemical markers are required for accurate prediction. The poor sensitivity and specificity of the present model indicate that the Doppler indices alone may be inadequate for reliable prediction, and that their combination with other clinical information may lead to detrimental effects [38].

The sample size was also relatively small, which might also reduce the generalizability of study findings. Furthermore, although the study concentrated on

Doppler indices for the identification of hypertensive conditions, the contribution of additional potential markers and clinical factors would yield more insights on the pathophysiology of hypertensive syndromes of pregnancy. Whether this relation also applies for other hypertensive disorders (gestational hypertension, pre-eclampsia, and chronic hypertension) remains to be elucidated in further study with a larger sample size [45].

Moreover, future longitudinal studies of Doppler indices across the entire pregnancy, especially in early cross-sections, will provide enlightenment regarding hypertensive disorders' Natural History twisted time course and better thresholds for abnormal Doppler findings. To learn more about the connection between uterine and umbilical artery indices may further guide clinical management in this population with high risks. In summary, uterine artery Doppler indices (particularly the plasticity index) were found to be effective indices in distinguishing the normotensive and hypertensive pregnancy. And although the umbilical artery indices were slightly less sensitive than they, data is ripe for utilization. These results indicate a possible clinical application of Doppler ultrasonography in the high-risk pregnancies. It is also possible that the combination of Doppler indices with other diagnostic modalities may further supplement early screening and management for hypertensive disorders of pregnancy. Further study is needed to refine the above data and increase the predictive power of Doppler in obstetric practice [47].

CONCLUSIONS

The **Uterine Artery PI** is a robust and effective Doppler index for differentiating between normotensive and hypertensive pregnancies in the second and third trimesters. However, to translate this diagnostic utility into a powerful predictive tool for clinical practice, it is **imperative that these Doppler parameters be combined with other diagnostic modalities** (e.g., clinical risk factors or biochemical markers) to achieve the high sensitivity and specificity required for effective early intervention and individualized management of high-risk pregnancies.

LIMITATIONS

1. **Sample Size:** The sample size in the current study was small, which may not allow the findings to be generalized. More powerful results could be obtained in addition to simply larger data by a sample size larger.
2. **Unicenter Study:** The research was conducted at one center, so generalization of the sample may be restricted. Geographic or health setting differences may exist between pregnancies, which might limit the generalizability of the findings.
3. **Cross-Sectional Study Design:** The design used researchers to gather data at one point in time. Longitudinal cohorts as opposed to only cross-sectional cohorts with participants that are followed from early pregnancy and the dynamics of Doppler indices and their response to hypertensive disorders would be of interest.
4. **Degree of Hypertension:** Level of BP among the cases varied from a mild form of hypertension to moderate and severe ones like preeclampsia. This difference in the severity of hypertension may have affected the results, especially for the umbilical artery indices which might be more sensitive in severe grades of hypertension.
5. **Exclusion Criteria:** Subjects with any preexisting conditions such as diabetes, renal disease, etc., were excluded from the trial. While this offers protection against confounding, it also limits the generalizability of the findings to a generalizable sample of pregnant women, including those with comorbidity.
6. **Measurement Variability:** While Doppler ultrasonography is a reliable diagnostic tool, operator dependence is present and therefore measurement variability may exist. Doppler indices would probably be both more consistent and accurate if the procedure was standardized and only a small group of trained persons performed the measurements.

RECOMMENDATIONS

1. **Multi-center, larger studies:** Future studies should have larger sample size and be multi-center to have a more diverse sample. It could confirm the results and to increase generalizability of the findings to other populations.
2. **Longitudinal Studies:** In order to understand the dynamics of changes in Doppler indices through gestation; and their correlation with hypertensive diseases, a greater number of longitudinal studies are warranted. Monitoring Doppler indices during the late second and third trimester, will enable us with early diagnosis and evolution of hypertension to be studied.
3. **Stratification of Hypertensive Disease:** Underlying hypertensive cases of increasing severity (e.g., gestational hypertension, preeclampsia, and chronic hypertension) should be further investigated to determine how the Doppler indices diverge along the spectrum of hypertensive disease. This work will aid in determining more precise markers for each stage of hypertension.
4. **Combination of Doppler with Nother Markers:** To increase the predictive accuracy, Doppler should be associated with other clinical and biochemical markers. Such as, using Doppler ultrasonography and maternal serum sFlt-1 and PlGF in combination might be able to estimate and predict early detection better.
5. **A Better Standard Method of Measurement:** We suggest a need to have standard protocols and training for Doppler US technique to minimize the operator-dependent differences in future research. This would possibly support a more consistent and reliable measurements across diverse research scenes.
6. **Investigating Early Screening Tools for preeclampsia:** As HDP can be detrimental for the mother and for the fetus and can lead to the development of such condition even if there is no antecedent of hypertension is important its exploration given the question of early identification. Further study to investigate the new diagnostic techniques, potentially combining the use of Doppler indices to other diagnostic imaging or genetic screening may improve early detection and provide earlier intervention for high risk pregnant.

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DIAGRAMS:



Fig 1:Umblical Artery RI &PI



Fig 2:Umblical Artery RI &PI

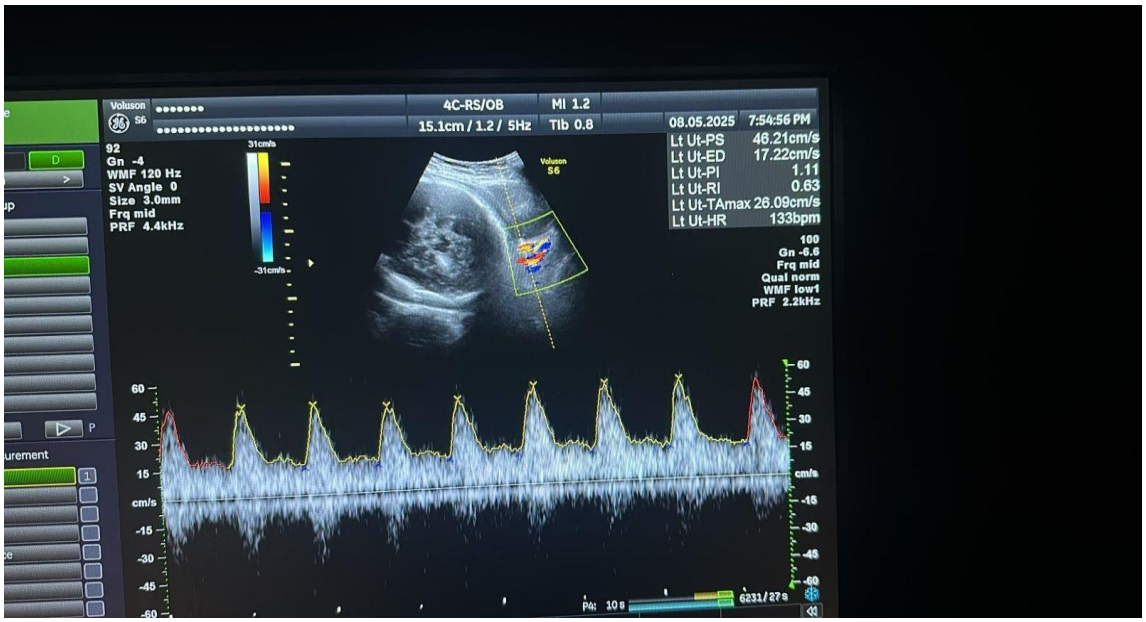


Fig 3:Left Uterine Artery PI &RI

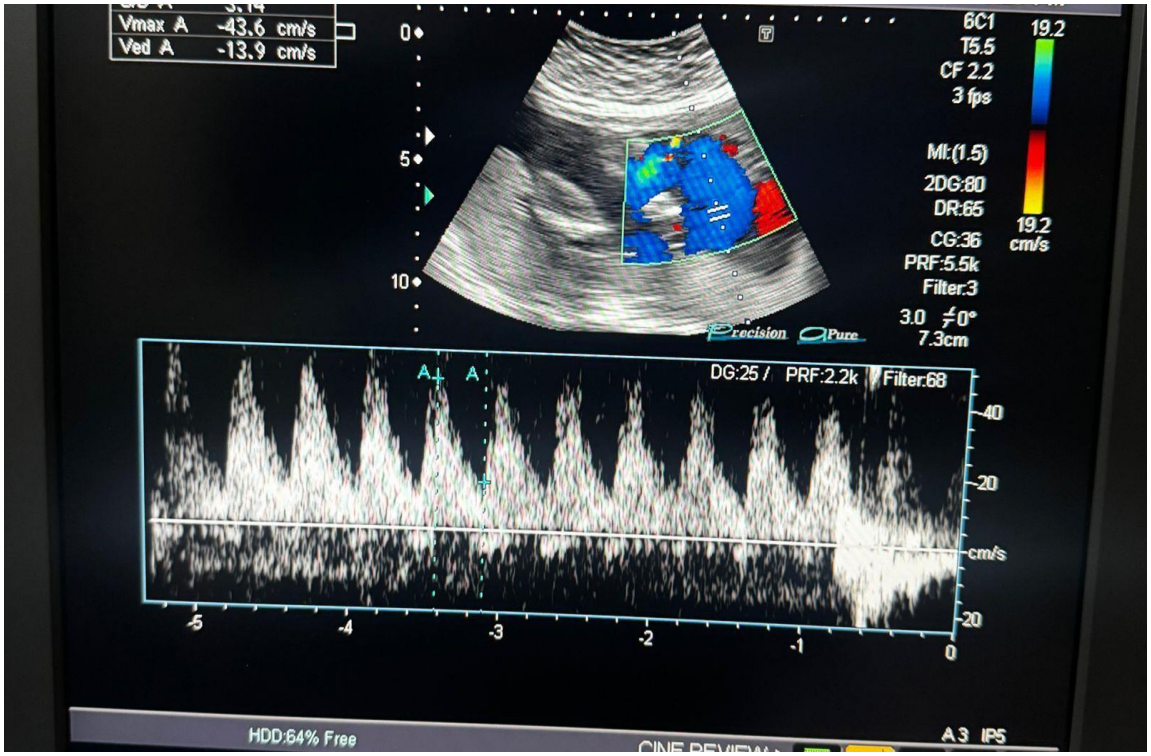


Fig 4: Umblical Artery Doppler in Hypertensive Female

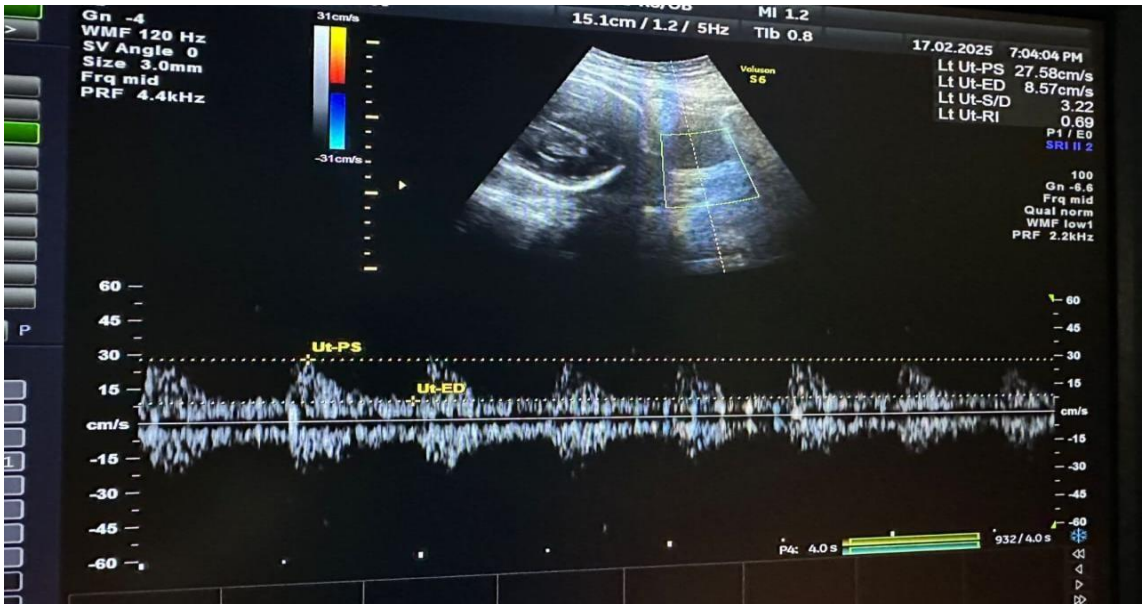


Fig 5:Left Uterine Artery RI

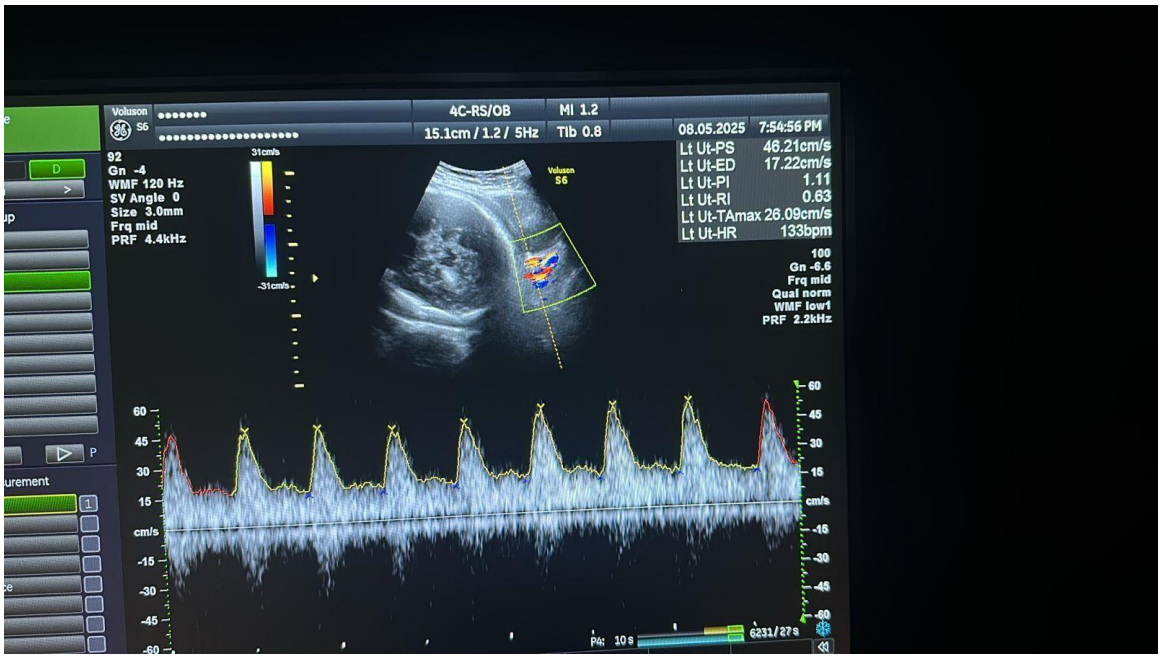


Fig 6:Left Uterine Artery Doppler Indices

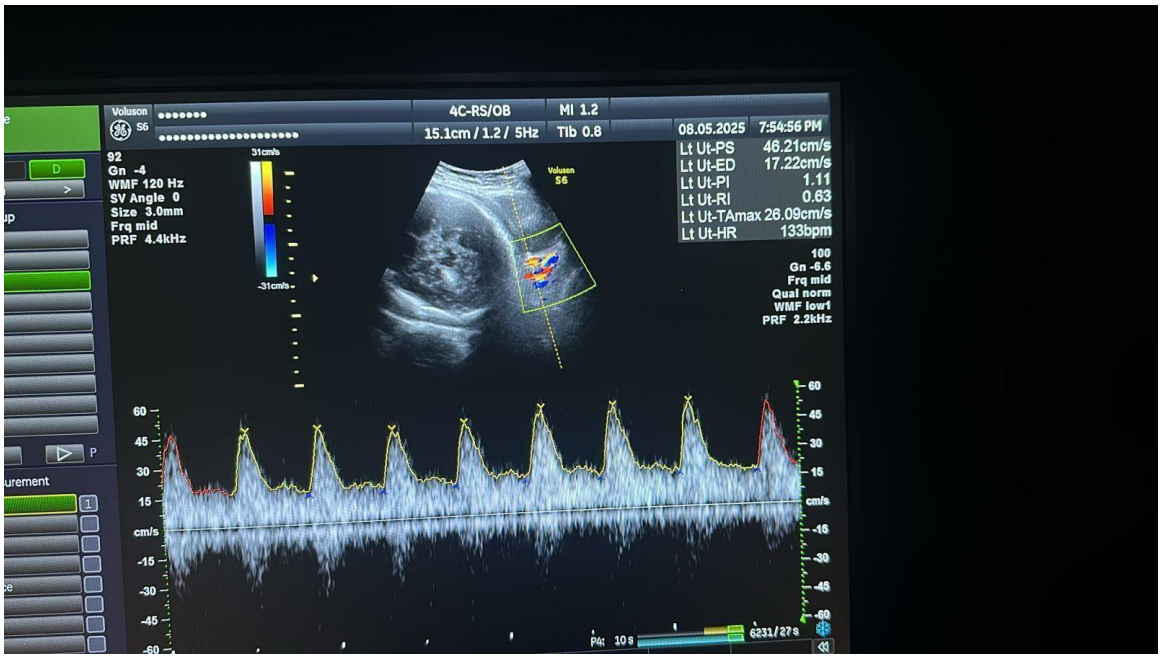


Fig 7:Uterine Artery RI& PI

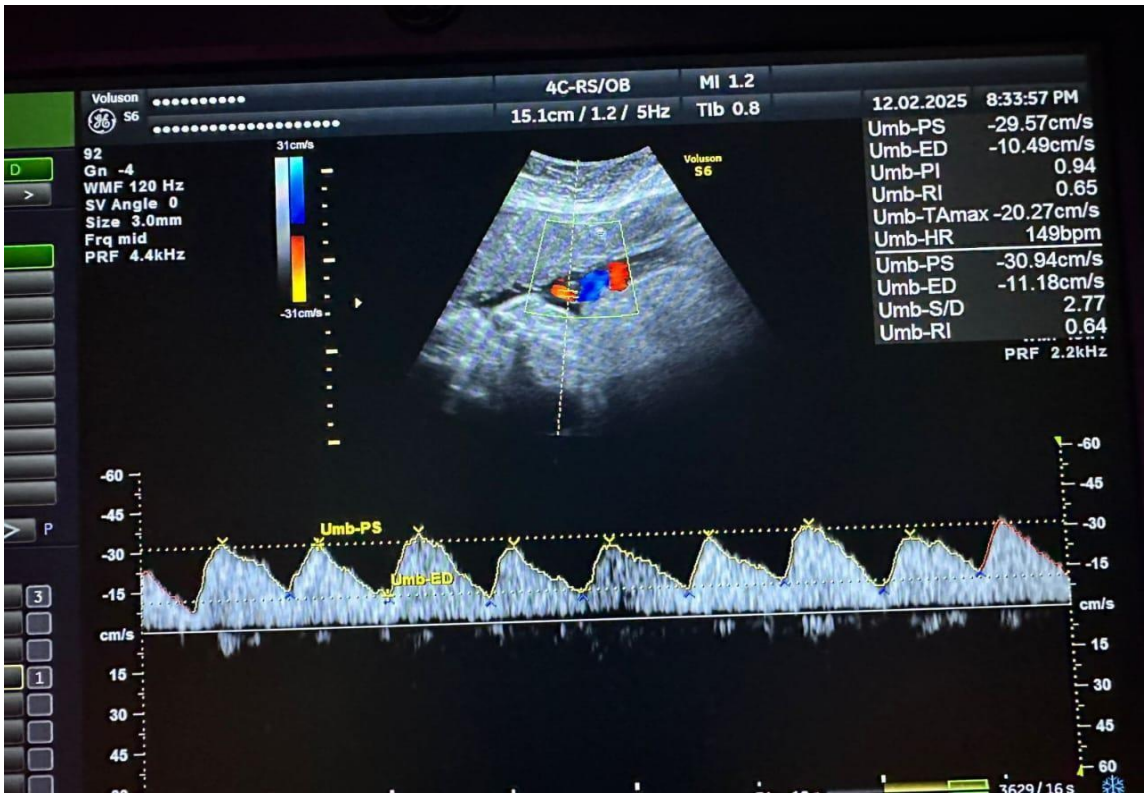


Fig 8:Umblical Artery Doppler Indices RI,PI,SD Ratio

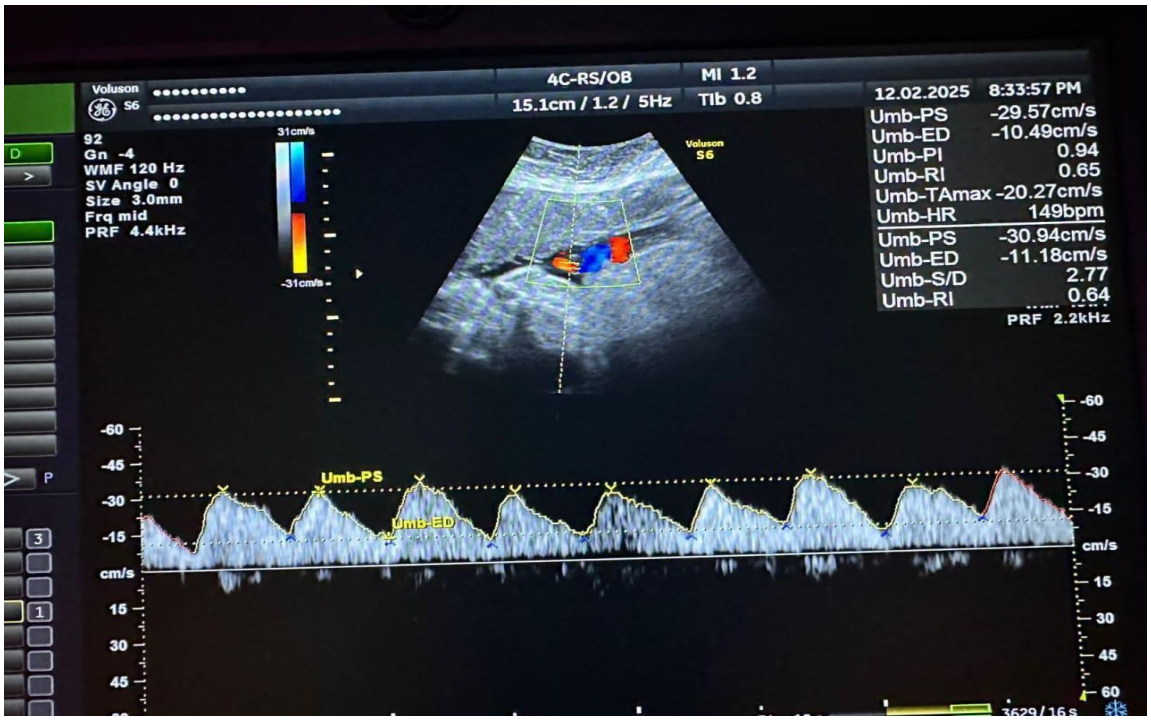


Fig 9:Umblical Artery Doppler Indices RI,PI,SD Ratio

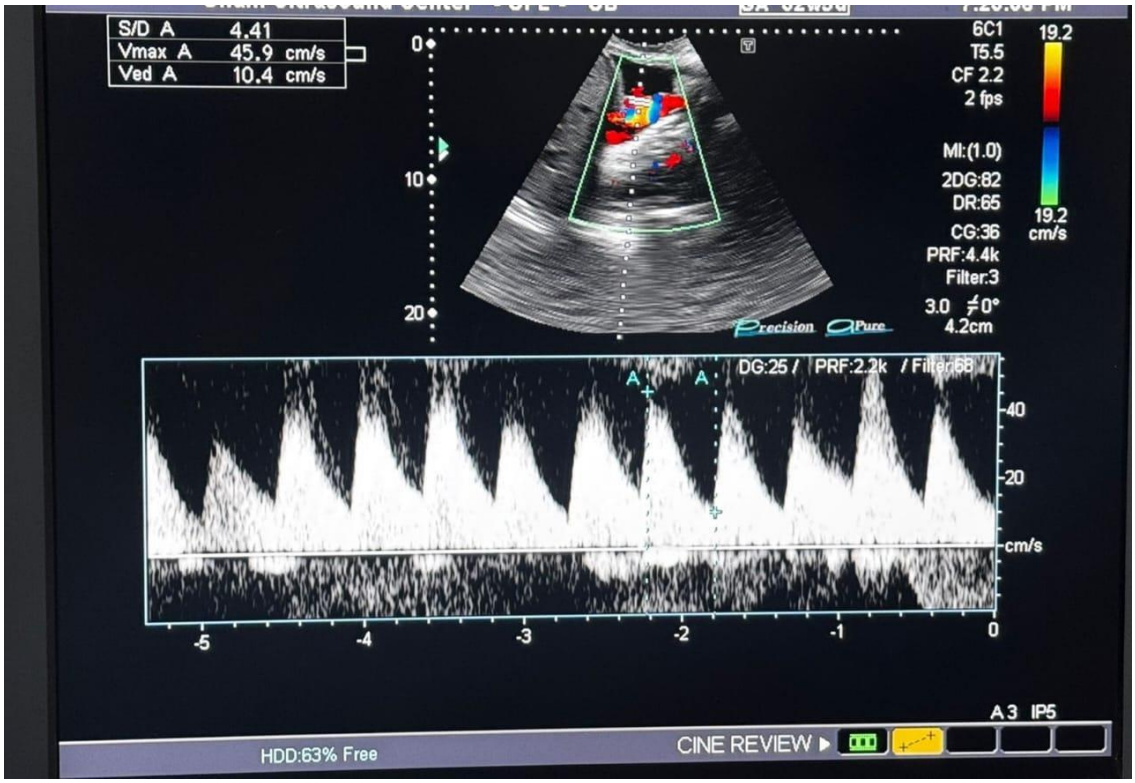


Fig 10: Umblical Artery In Hypertension

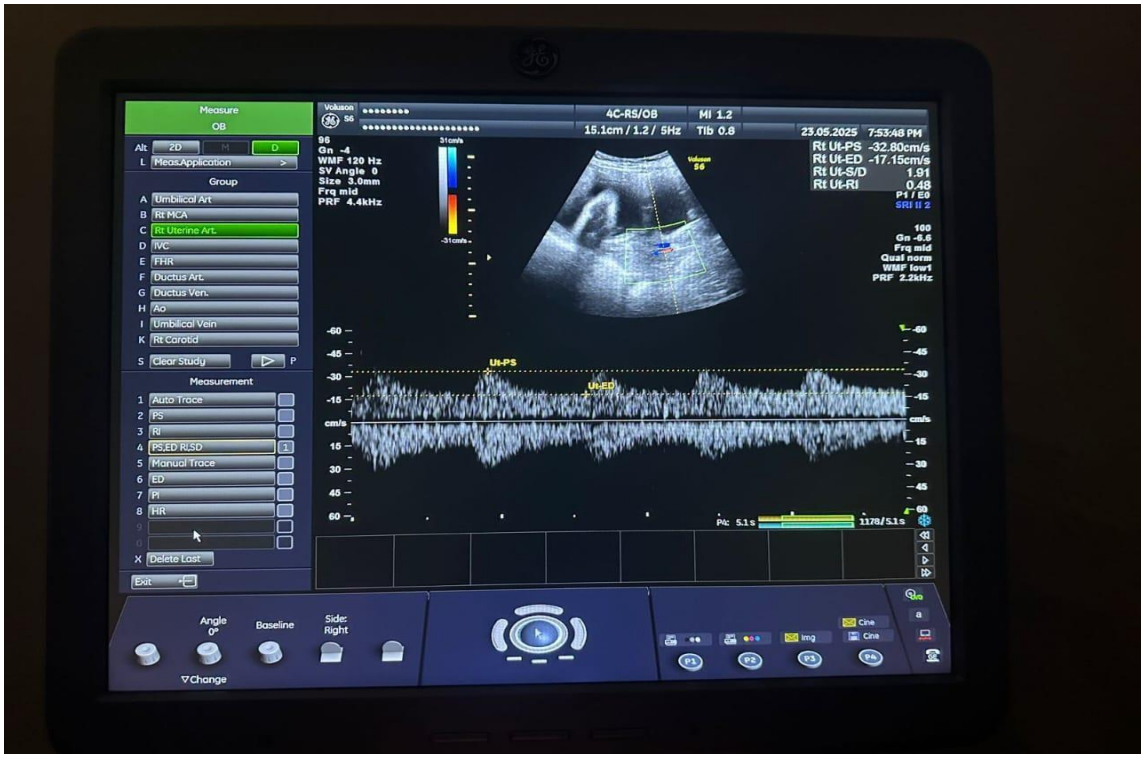


Fig 11:Right Uterine Artery Doppler Indices



Fig 12:Uterine Artery RI



Fig 13:Umblical Artery Doppler Indices RI,PI,SD Ratio

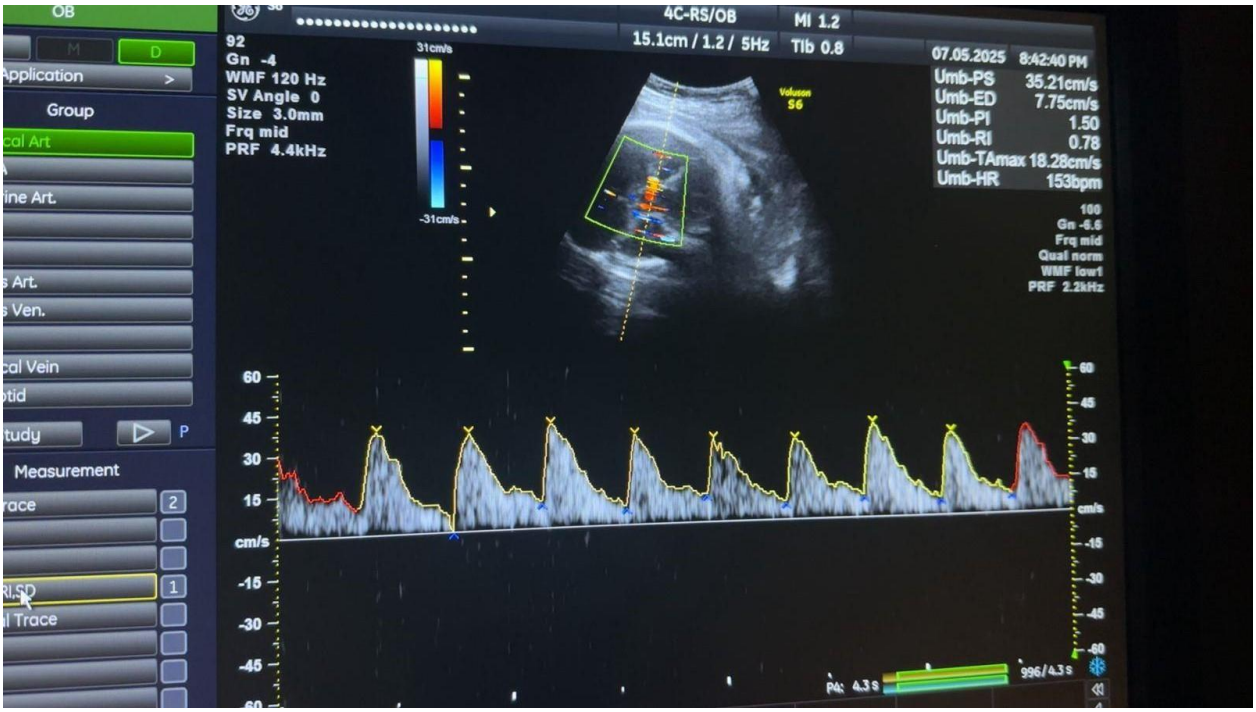


Fig 14:Umblical Artery Doppler RI&PI

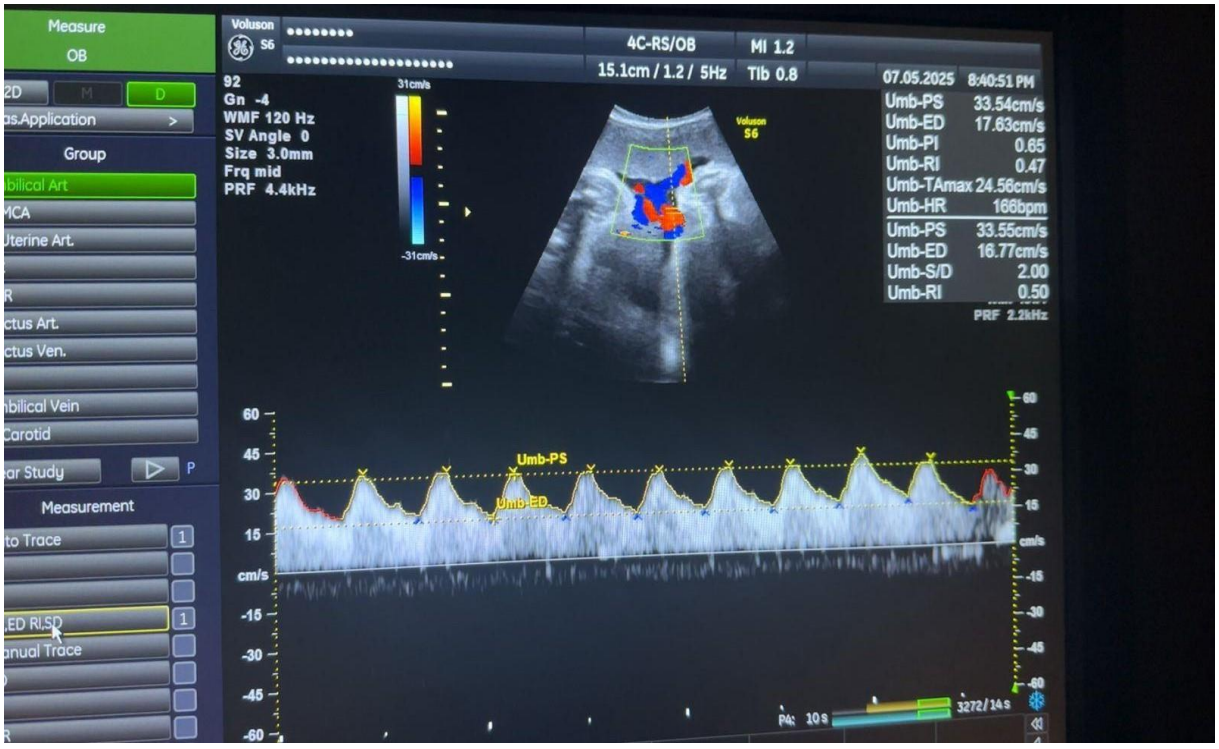


Fig 15:Umblical Artery Doppler RI,PI,SD Ratio

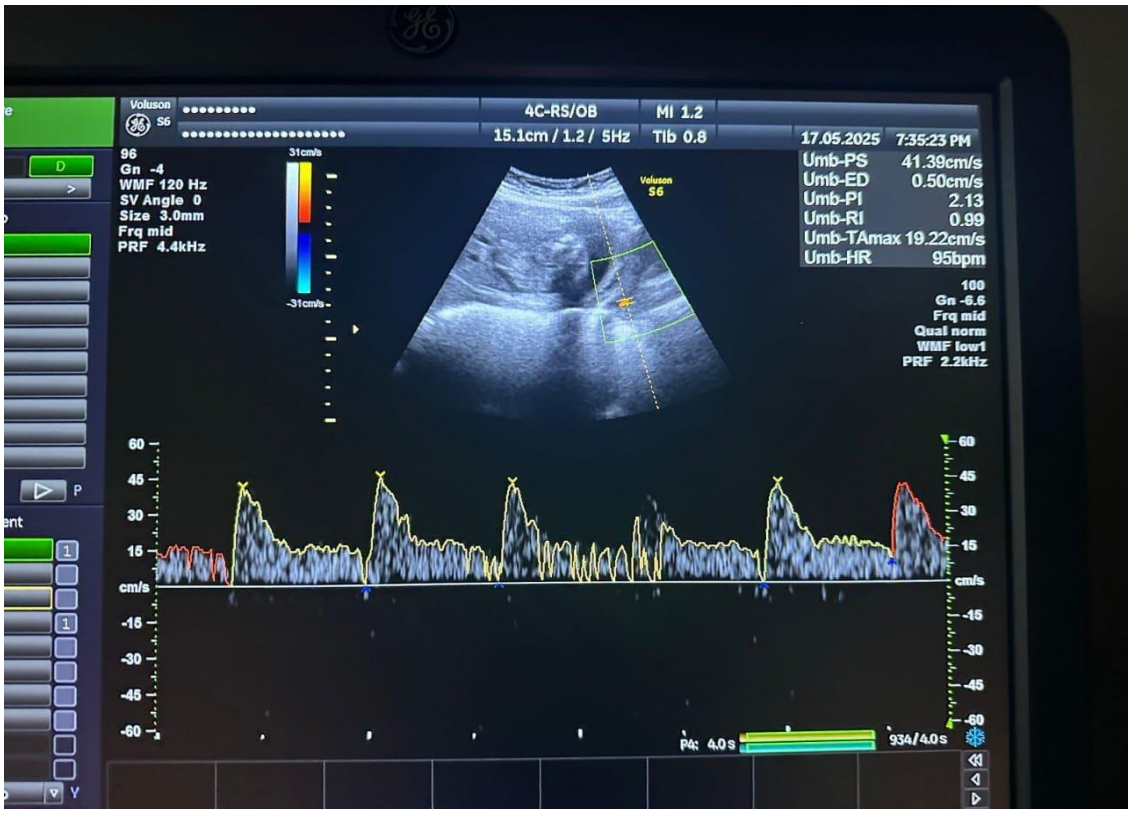


Fig 16:Umblical Artery Doppler RI,PI

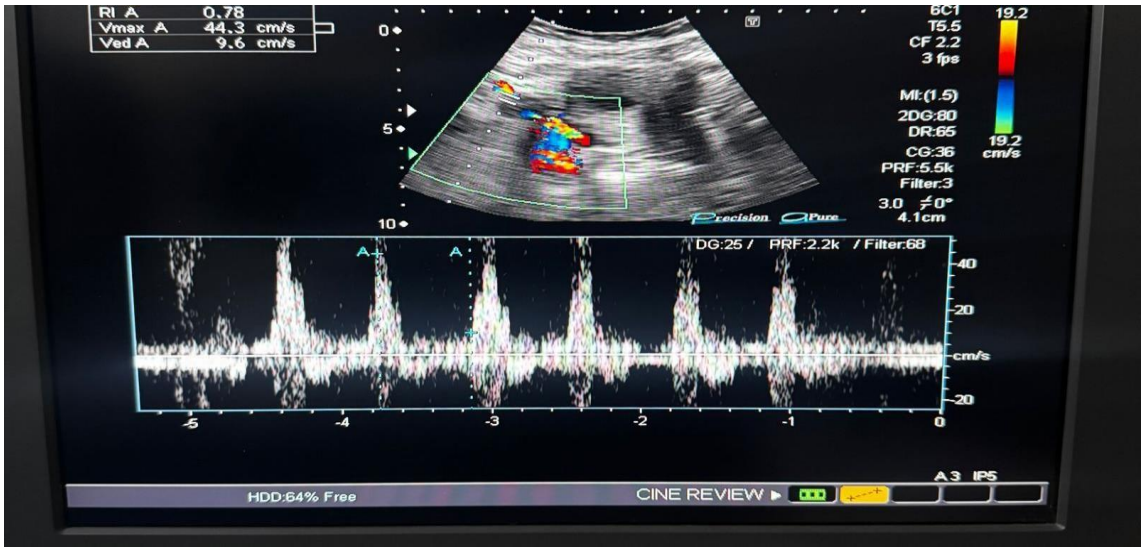


Fig 17:Umblical Artery In Hypertension

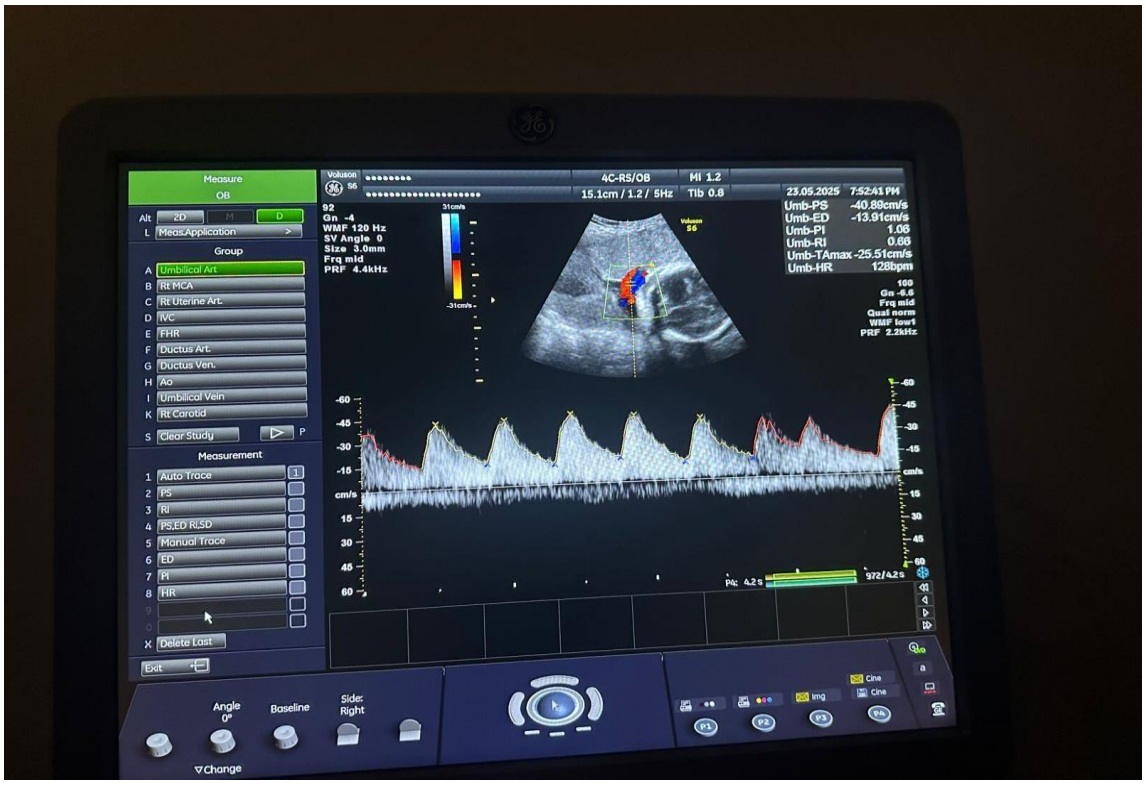


Fig 18.Normal Doppler Indices of Umblical Artery

APPENDICES

ENGLISH CONSENT FORM

The study you are about to participate is a randomized control trial survey titled as;

"EVALUATION OF UTERINE AND UMBLICAL
ARTERY DOPPLER INDICES IN
NORMOTENSIVE AND HYPERTENSIVE
FEMALES OF SECOND AND THIRD
TRIMESTER"

The study has no potential harm to participants. All data collected from you will be coded in order to protect your identity, and should not be disclosed to anyone. Following the study there will be no way to connect your name with your data. Your answers to the questions will not affect the quality of education given to you. Any additional information about the study results will be provided to you at its conclusion, upon your request.

You are free to withdraw from the study at any time. You agree to participate, indicating that you have read and understood the nature of the study, and that all your inquiries concerning the activities have been answered to your satisfaction.

NAME :_____

SIGNATURE:_____

DATE:_____

URDU CONSENT FORM

میں_____ تصدیق کرتا/ کرتی ہوں کہ **محترمہ ضوفشاں احمد** نے اپنی اس تحقیق

"دوسری اور تیسری سہ ماہی میں نارموتینسو اور ہائپرٹینسو حاملہ خواتین میں یوٹیرن اور امبلیکل آرٹری ڈوپلر انڈیکس کی تشخیص"

.زیرنگرانی **ڈاکٹر فہمیدہ انصاری** کے متعلق بتا دیا ہے۔ مجھے اس تحقیق کی نوعیت، مقاصد، احداف، توقعات، فوائد اور خطرات کے متعلق ، ساری معلومات فراہم کر دی گئی ہیں

اس تحقیق کے دوران ساری معلومات صیغۃ راز میں رہیں گی اور مریض کا نام اور دیگر معلومات صرف تحقیق کے لیے استعمال ہوں گی۔مجھے یہ بھی بتا دیا گیا ہے کہ میں اس تحقیق سے متعلقہ ہر قسم کے سوال پوچھنے کا مجاز ہوں اور یہ تحقیق صرف ایک شخص ک مفاد میں نہیں ہے بلکہ بحشیت مجموعی انسانیت کا مفاد اس سے وابسطہ ہے۔ تمام تفصیلات جاننے کے بعد یس تحقیق میں شامل ہونے یا نہ ہونے پر کسی کا قائل نہیں ہوں۔ اس تحقیق سے کسی بھی وقت علیحدہ ہونے پر مجھ پر کوئی پابندی نہیں ہو گی۔ میں بذاتِ خود بقائمی حوش و حواس

.اور رضا مندی سے اس تحقیقاتی عمل میں شامل ہوتی/ ہوتا ہوں

.---------- دستخط محقق

.---------- دستخط شرکت کار

.---------- تاریخ

DEMOGRAPHICS FORM & QUESTIONNAIRES
PERMISSION LETTER

Patient ID: _____
Age: _____
Gestational Age: _____
Trimester: _____
Hypertension: Present/Absent

Uterine Artery		**Umbilical Artery**		
RI	**PI**	**RI**	**PI**	**S/D ratio**

Sr No	**Hypertension**	**Gestational Age**	**Trimester**	**Uterine Artery**		**Umbilical Artery**		
	Yes or No		**2^{nd} / 3^{rd}**	**RI**	**PI**	**RI**	**PI**	**S/D ratio**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Report:Evaluation Of Uterine and Umbilical Artery Doppler Indices in Normotensive Versus Hypertensive Pregnant Females of Second and Third Trimester (ZAUFISHAN AHMAD)

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