

A Case-Control Power Doppler Comparative Study in the Prediction of Pre-Eclampsia in First Trimester Pregnancies

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Abstract

Background: Sonographic examination using power Doppler entity of both umbilical and uterine arteries can detect pregnancies impaired both foetal and maternal sides of the placenta respectively. So it is still the first easible and world-wide available facility for pregnant women.

Aim of Study: To determine the role of fetal and maternal Doppler in predicting pre-eclampsia in the 1st trimester by comparing the normotensive and hypertensive pregnant women.

Patient and Methods: The participants in this prospective study were 160 females, 80 of whom were hypertensive and 80 of whom had normal blood pressure measurements (control). The gestational age of the babies ranged from 12 to 24 weeks.

Results: With *p*-values of (0.001, 0.0001, and 0.0472), Doppler assessment revealed the RI of the right uterine, left uterine, and umbilical arteries were significantly differed between cases and controls, respectively. A significant positive correlation among case group (*p*-value=0.001) was noted between right and left uterine arteries RI as well as both uterine and umbilical arteries RI. Furthermore, it was discovered that 6% of the study patients have a bilateral persistent diastolic notch and 4% have unilateral persistent diastolic notch. There was also a link between having a diastolic notch and having a high RI value.

Conclusion: We can conclude that the Doppler study of both uterine and umbilical arteries in 1st trimester is a simple rapid non-invasive tool. It can be used as a reliable indicator and screening test for patients at high risk to develop pre-eclampsia complicated during or after their pregnancies, and to provide earlier treatment as well a better prognosis for their outcome.

Key Words: *Hypertension in pregnancy – Doppler uterine and umbilical arteries.*

Introduction

HYPERTENSIVE pregnancy is a risk for placental insufficiency and progressive deterioration in placental function that results to decrease in transpla-

cental oxygen and nutrients transfer to the fetus leading to IUGR of the fetus [1].

Hypertension has negative consequences for both mothers and foetuses. It may cause CVS hazardous like persistent chronic hypertension, IHD mounting to stroke in the mother later in life. Stroke, coronary heart disease, and metabolic syndrome are all risks for children who are born small [2].

After 20 weeks in women, this hypertensive pregnancy condition can lead to pre-eclampsia, a systemic disorder characterised by hypertension, proteinuria, or both. The syndrome causes abnormal uteroplacental circulation, which leads to inability of good invasion of the second wave of trophoblast into spiral arterioles, resulting in enhancing the resistance of the vascular flow in maternal uterine arteries as well reducing the placental vascular supply to the fetus [2].

There will be intrauterine growth restriction (IUGR), oligohydraminos, and abruptio placenta in result to impaired utero-placental blood flow. Placental perfusion eventually decreases as a result of IUGR, and foetal Doppler ultrasonography (US) and foetal biometry are affected [3].

Since its inception, ultrasonography has been the preferred noninvasive modality for evaluating a variety of placental parameters. The placental thickness and maturity can have determined by the utility of conventional 2D sonographic technique [4].

Three-dimensional ultrasonography (3DUS) is recently used as one of the most developed technological diagnostic tool. Nowadays, the first and second trimesters 3D power Doppler assessment of the architecture of the placental tree, trophoblast

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development, and uteroplacental perfusion have been well established. Resistance Index (RI) and pulsatility index (PI) Doppler examinations of those vascular indices can detect the impedance of placental, foetal, and maternal blood vessels [5,6].

As a result, the goal of this prospective study was to highlight the first trimester Doppler placental insufficiency assessment in prediction of preeclampsia in pregnancies complicated by hypertension, as well as to compare Doppler parameters to those of a control group.

Patients and Methods

This study is a prospective randomised trial that was approved by our university's review board after being revised by the ethics committees of the Obstetrics and Gynecology and Radiology Departments. All of the participants gave written informed consent for their data for this research study use. This study was conducted during periods between December 2020 till November 2021.

Our study included 160 cases: Patient group (n=80): Pregnant females complicated with hypertension. Control group (n=80): With no medical disorder based on history and clinical examination. Between 12 and 24 weeks of pregnancy, both control and case groups were examined. The Obstetrics and Gynecology Department had referred them. Their age ranged from (20-45), and the average hypertensive patient group' age was (28+3.20) and (27.6+4.15) in the control group.

The case group of hypertensive pregnant women: Had to meet the following:

Any or all clinical history of the these criteria were considered to be high risk for vascular placental impedance and insufficiency during pregnancy: (1) History of pregnancy complicated hypertension (two at least 6 hours apart consecutive readings equal to 140/90mmHg or above recorded and established for more than 3 days in first trimester pregnancy), (2) Preeclampsia as a past history, (3) Past history of recurrent abortions and or fetal death in utero (IUFD) and or placental abruption.

Exclusion criteria:

- a- Well established diagnosed cases of preeclampsia (i.e gestational hypertension and confirmed proteinuria beyond first trimester of pregnancy).
- b- Any other medical condition associated with pregnancy.

- c- Abnormalities of the placenta, foetal, and umbilical arteries.

The following were done to all of the participants:

- 1- Obtaining a complete history.
- 2- A general, abdominal, and pelvic examination will be performed.
- 3- Research in the laboratory
- 4- Ultrasound in two dimensions (two-dimensional) on a regular basis (For biometry, foetal weight, AFI)
- 5- Using a three-volume histogram and the VOCAL technique, perform a 3D power Doppler examination for vascularization index (VI), flow index (FI), and vascularization flow index (VFI).

Ultrasound machine:

A machine with a 5.0-7.0 MHz transabdominal probe and both 3D US and power/color Doppler advances were used, (Voluson Pro 700 General Electric, New York City, USA). Radiologist with 10 years of experience and an obstetrician with 15 years of experience, respectively were chosen to use this highly developed ultrasound appliance in this study.

Image analysis and assessment:

A radiologist with 5 years of experience and a candidate for a medical doctorate collected the data.

- 1- Fetal biometry, weight and amniotic fluid index for exclusion of IUGR.
- 2- Transabdominal uterine artery Doppler was done by localizing the patient in semi recumbent position, Transducer was inserted into both iliac fossae and downwards into the pelvis, towards the uterine walls. A colour map of flow over the region of interest was introduced by color flow button on the machine and its image was frozen when three or more consecutive consistent waveforms are seen. The Pulsatility Index (PI), Resistance Index (RI), and S/D Ratio were reproduced automatically. It was determined whether a bilateral early protodiastolic notch existed or not. A notch was identified as a persistent reduce in blood flow velocity below the diastolic peak velocity in early diastole. The absence or reversal of end-diastolic flow in the umbilical and uterine arteries were also investigated.

The following are the statistical methods used to arrive at the results:

When appropriate, the statistical data were based on definitions of mean, standard deviation (SD), median, and range, or frequencies and percentages. The Student *t*-test for independent sam-

ples, chi-square test, Mann-Whitney test, Wilcoxon signed rank test, and kappa agreement were used to compare numerical variables between the study groups. Sensitivity, specificity, and overall accuracy were used to describe accuracy. Statistical significance identified by a p -value less than 0.05. The computer programmes SPSS were used to perform all statistical calculations. (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows.

Results

The average hypertensive patients group' age was (28+3.20) and (27.6+4.15) in the control group. Table (1) shows the obstetric code of both study groups. In the hypertension case group, the placental location was posterior in 75% (n=60/80) and anterior in 25% (n=20/80). As shown in Table (2), 20% of the case group (n=16/80) developed preeclampsia and had preterm labor.

Table (1) shows the distribution of obstetric codes in our research groups.

In our hypertensive group, abnormally high RI was seen in the right or left uterine artery, with or without elevated umbilical artery elevated RI (Table 3). Based on Doppler study, 60 percent of the hypertensive cases had high RI (0.7) of the right uterine artery, 40 percent had a high RI for the left uterine artery, and 45 percent had a high RI for the umbilical artery.

We found that RI of the right uterine, left uterine, and umbilical arteries of cases and controls were significantly different with p (0.001, 0.0001, and 0.0472), respectively (Table 4).

The RI of both uterine arteries had a significant positive correlation (p -value=0.0001). In the study of hypertensive cases, RI of the right and left uterine arteries were also significantly positively correlated with umbilical artery (p -value=0.001, 0.0002), as shown in Table (5).

We also discovered that 6 percent of hypertensive patients (n=5/80) had bilateral diastolic notch in both uterine and umbilical arteries, and 4% (n=4/80) had a unilateral notch. There was no diastolic notch in control cases and 90% (n=71/80) of the case study group of hypertension. As shown in table 6, the relationship between the diastolic notch and the RI value of all scanned uterine and umbilical arteries were found to be positively correlated. Their calculated p -values were significant.

Table (1): Shows the different obstetric codes used by different groups.

	Groups		Total
	Cases	Controls	
<i>Obstetric code:</i>			
G1P0:			
Count	22	30	52
% within groups	27.5%	37.5%	32.5%
G3P0 + 1:			
Count	6	14	20
% within groups	7.5%	17.5%	12.5%
G2P 1:			
Count	0	2	2
% within groups	.0%	2.5%	1.25%
G4P0 + 2:			
Count	2	16	18
% within groups	2.5%	20%	11.25%
G2P1 + 1:			
Count	6	2	8
% within groups	7.5%	2.5%	5.0%
G3P2:			
Count	20	8	28
% within groups	25.0%	10.0%	17.5%
G4P 1 + 2:			
Count	8	2	10
% within groups	10.0%	2.5%	2.5%
G6P2 + 1:			
Count	4	2	6
% within groups	5.0%	2.5%	3.75%
G5P3:			
Count	8	2	10
% within groups	10.0%	2.5%	6.25%
G5P4 + 1:			
Count	4	2	6
% within groups	5.0%	2.5%	3.75%
<i>Total:</i>			
Count	80	80	160
% within groups	100.0%	100.0%	100.0%

Table (2): Preeclampsia as an outcome distribution of the studied group.

Development of preeclampsia	Hypertensive group	Control
Yes	16 (20%)	0
No	64 (80%)	80 (100%)
Total	80 (100%)	80 (100%)

Table (3): Distribution of RI indices among studied groups.

Groups	Age	RT uterine artery RI	Left uterine artery RI	Umbilical artery RI
Cases: N=80	N=80	N=80		
Elevated RI (≥ 0.7)		48/80 (60%)	32/80 (40%)	36/80 (45%)
Normal RI		32/80 (40%)	48/80 (60%)	44/80 (55%)
Mean	28	0.62	0.62	0.67
Standard deviation	± 3.20	0.08	0.07	0.08
Minimum	23	0.46	0.42	0.49
Maximum	40	0.9	0.82	0.98
Control: N=80		N=80		
Mean	27.6	0.58	0.54	0.65
Standard deviation	± 4.15	0.07	0.05	0.04
Minimum	19	0.45	0.39	0.61
Maximum	38	0.67	0.65	0.69

Table (4): Comparison between studied groups according to mean of RT & LT uterine and umbilical arteries.

Group	Mean RT uterine artery	Mean left uterine artery RI	Mean umbilical artery RI
Case n=80	0.62	0.62	0.67
Control n=80	0.58	0.54	0.65
<i>t</i> -test for Equality of means	<i>t</i> =3.63 <i>p</i> -value 0.0010	<i>t</i> =8.3 <i>p</i> -value <0.0001	<i>t</i> =2.00 <i>p</i> -value e0.0472

Table (5): Pearson correlation coefficient among RI indices of the scanned arteries in hypertensive group.

Hypertensive individuals	RT uterine artery RI	LT uterine artery RI	Umbilical artery RI
<i>Pearson correlation:</i>			
RT uterine artery RI	1	0.56	0.41
	80	<.00001	.0001
<i>Sig (2-tailed):</i>			
LT uterine artery RI	0.56	1	0.40
	<.00001	80	.0002
<i>N:</i>			
Umbilical artery RI	0.41	0.40	1
	.0001	.0002	80
	80	80	80

Table (6): Pearson correlation coefficient between RI indices of the scanned arteries and presence of diastolic notch.

Hypertensive group	Presence of diastolic notch
<i>Pearson correlation:</i>	
RT uterine artery RI	0.51 <.00001
<i>Sig (2-tailed):</i>	
LT uterine artery RI	80 0.40 .0002
<i>N:</i>	
Umbilical artery RI	80 0.42 .0001 80

Fig. (1): A 33-year-old female patient. The patient is pregnant on aldomet and has a history of preeclampsia in her third pregnancy. G5P4+1 was her obstetric code. She gave birth by caesarean section at 22 weeks and 1 day into her pregnancy, with a baby of average birth weight. Both right and left uterine arteries have normal RI of 0.7 and 0.48 respectively on Doppler examination.

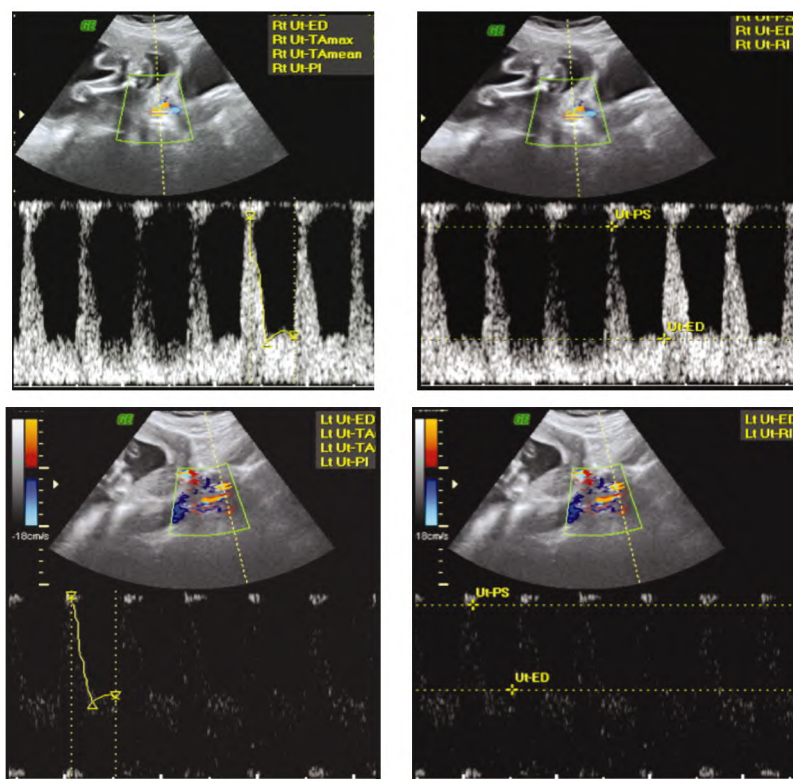
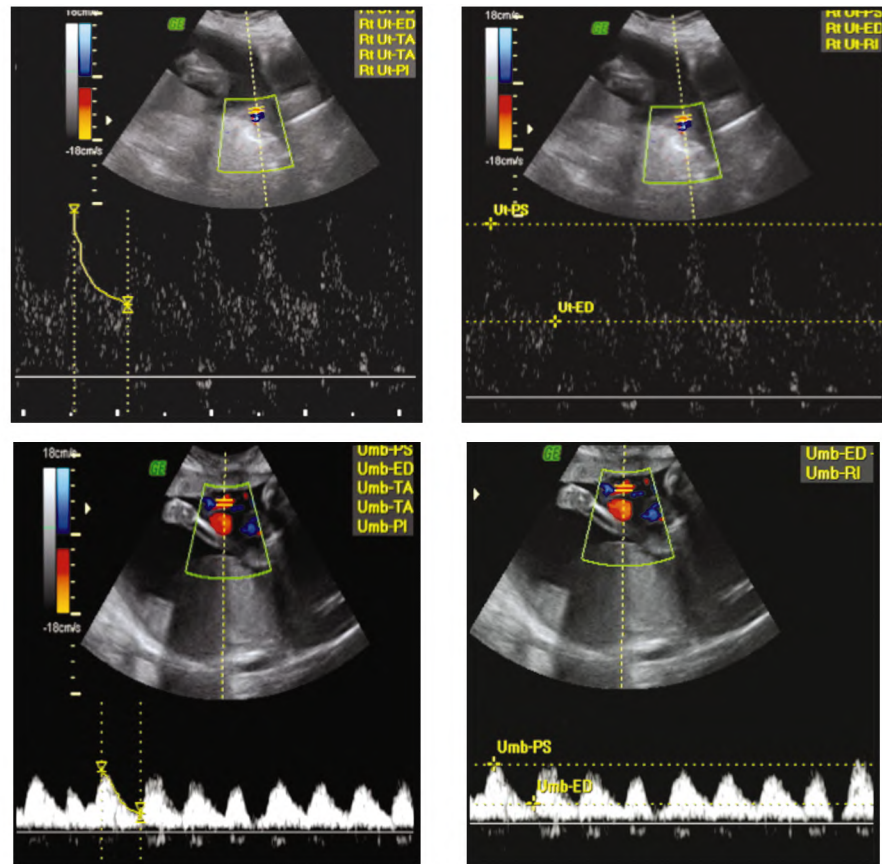
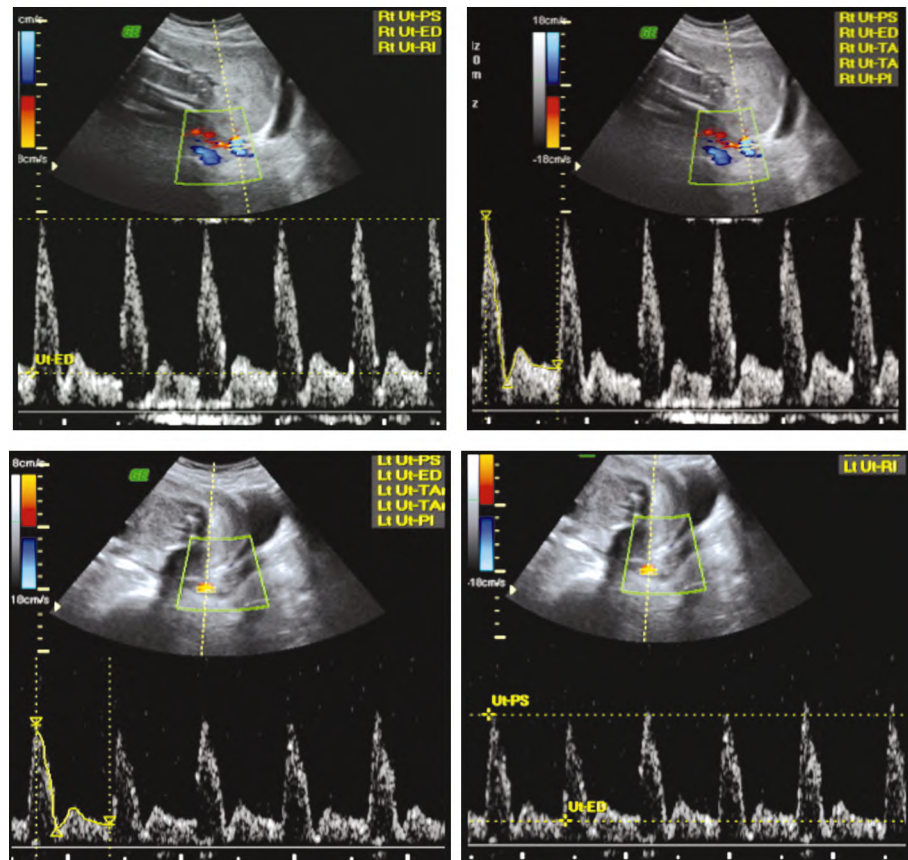


Fig. (2): A 28-year-old female patient. With history of hypertension and on aldomet therapy during her pregnancy. She has no history of preeclampsia. She was G2P1. She gave birth by caesarean section with an average-weight baby at 25 weeks and 2 days' gestation. Assessment by Doppler of the right uterine and umbilical arteries revealed normal RIs of 0.56 and 0.67, respectively, with normal uterine artery wave and no notch.



Ultrasound Imaging:

Fig. (3): A 28-year-old female patient. The patient is pregnant and taking aldomet and aspid for hypertension. G3P0+1 was her obstetric code. She developed preeclampsia and had preterm labour when she was 23 weeks pregnant. The right uterine artery has an abnormally high RI of 0.8 and the left uterine artery has an abnormally high RI of 0.82 on Doppler examination of both uterine arteries.



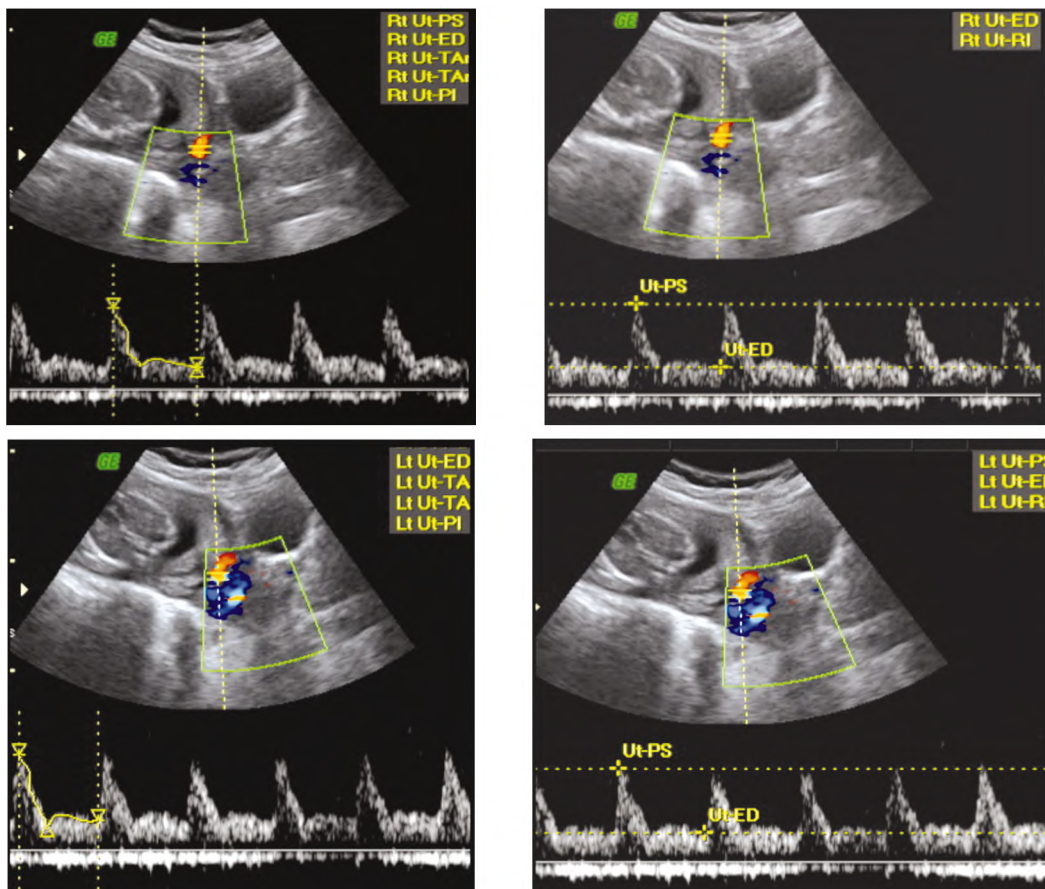


Fig. (4A): 19-year-old female patient. During pregnancy, the patient developed hypertension. G1P0 was her obstetric code. By US, the patient's gestational age was 22w+1 ds and she had no recollection of her first day of LMP. The patient developed preeclampsia and went into labour prematurely. The right and left uterine arteries have normal RI of 0.81 and 0.80 respectively on a Doppler examination of both uterinearteries.

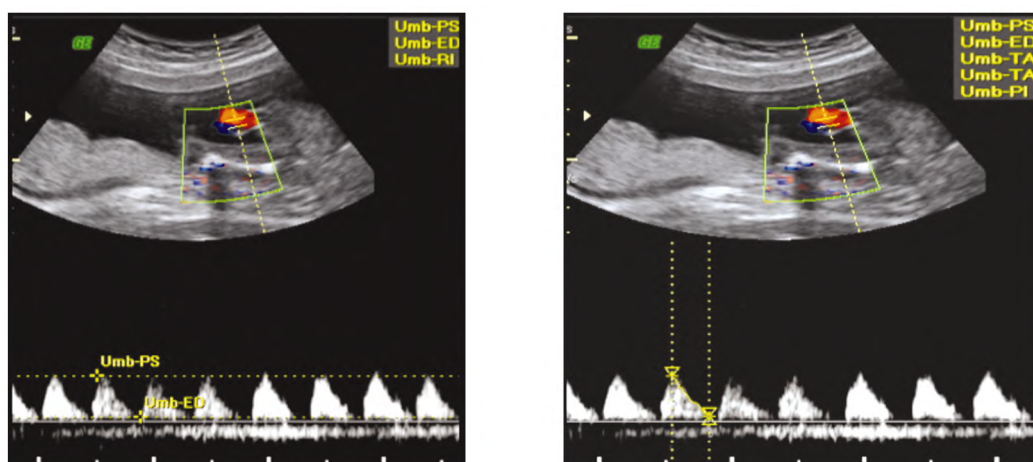


Fig. (4B): Doppler of the Umbilical artery with RI 0.91.

Discussion

Accurate early evaluation of hypertensive pregnant women could not only cut antenatal care costs in half, but also improve long-term management of hypertensive disorders. Prenatal evaluation of the placenta and vascular abnormalities, primarily

performed by ultrasound with Doppler evaluation of the placental maternal uterine arteries and the foetal umbilical arteries, has been extensively performed because preeclampsia syndrome is a hazardous situation happened during pregnancy [2].

Our study enclosed 160 pregnant women, 80 of cases diagnosed as gestational hypertension but not yet preeclampsia and 80 cases were control who were medically free by history and clinical examination. The mean age among the case group was 28 ± 3.20 , and was 27.6 ± 4.15 in control group. All participants were in between 12 and 24 weeks of gestation and assessed by 3D USS.

In this study, we evaluated placental sufficiency in the first trimester of pregnancy using Doppler ultrasound to evaluate the uterine and umbilical arteries.

The timing matches study [7], as hemodynamic changes in uterine artery were significantly found, and this stage of pregnancy was correlated in timing between the intervillous circulation and both umbilical and foetal circulations.

The diastolic notch of uterine arteries was positively related to vascular resistance, IUGR, and hypertension, according to data on uteroplacental circulation presented using Doppler velocimetry. As a result, it is more effective than high resistance index (RI) or systolic/diastolic ratio in predicting pre-eclampsia. However, the importance of presence of diastolic notching at 12-24 weeks in pregnancy with high risk is unknown [8].

Doppler examination of the uterine artery in our study concluded that 6% of the case group patients with hypertension had bilateral diastolic notch and 4% had a unilateral notch in the left uterine artery, for a total of 10%. These findings were nearly identical to those [6], who found a statistically significant difference between high-risk preeclampsia cases and normotensive groups in terms of uterine artery persistent notch, which was found to be 14 percent on both uterine arteries of the high-risk patients.

Both stated that uterine artery RI and PI are significantly higher in the study group in a prospective case-control study. This was discovered during our investigation (Figs. 3,4), as we discovered a significant relationship between the RI of the right uterine, left uterine, and umbilical arteries in cases and controls, with p (0.001, 0.0001, and 0.0472, respectively). As a result, the uterine artery RI proved to be an effective diagnostic tool for detecting vascular abnormalities in hypertensive pregnancies. This was also noted in the study, which found a statistically significant difference in uterine artery PI and RI between groups [9,10].

Our findings matched with other studies [11,12,13], which used a higher RI cut-off value

(0.7) as a main index to determine adverse pregnancy outcomes in their studies. When RI, PI, and bilateral notch values were found together as combined factors, the value of specificity to early diagnosis of placental insufficiency was found to be higher. This was also discovered in our study, with a significant positive correlation between the presence of diastolic notch and RI values of the scanned arteries. This enhance the early evaluation of hypertensive patients with high risk to develop placental insufficiency and hence preeclampsia.

Preeclampsia and preterm labour were also discovered in 9% ($n=7/80$) of hypertensive patients with high vascular uterine and umbilical indices. This finding supports the findings of previous meta-analysis prospective studies [14,15], which found that those with higher mean RI indices have a higher risk of serious pregnancy complications such as preeclampsia.

According to the findings [16], pregnant women with no preeclampsia (PE) had a lower mean umbilical RI than those who did. This is consistent with our findings (Figs. 1,2), as we found a significant difference in the RI of the umbilical artery in both groups. Furthermore, we discovered a positive correlation between the RI of the right and left uterine arteries, as well as the RI of both the uterine and umbilical arteries, among the cases group, indicating that they are a useful indicator of placental vascular abnormalities in hypertensive females, with p -values of (.00001, .0001, and .0002).

The study's strength was its early detection of both maternal and foetal adverse outcomes such as PE and IUGR in pregnant hypertensive patients.

Conclusion:

Three-dimensional Doppler US result, RI from umbilical and uterine arteries abnormality, and persistent notch may be considered as combined tools to determine hemodynamic changes in hypertensive pregnant women and to early detect its adverse consequences for both fetus and mother. Both maternal and fetal sides will benefit from early prophylaxis and enhanced surveillance.

References

- 1- ABDELHAMID SHAHEEN, MOHAMD EMARH, HEBA MAGD, et al.: Three-dimensional sonographic assessment of placental volume and vascularization in pregnancies complicated by hypertensive disorders: Case-control study. Evidence-Based Women's Health Journal, Aug., 8 (3): 207-214, 2018. [Google Scholar].
- 2- MAYSAA A. CHYAD, ENAS A. AZAB, MENNATAL-LAH H. SHALABY, et al.: The Role of Uterine Artery Doppler Sonography in Predicting Pre-eclampsia at 14-

- 20 Weeks of Gestation. *The Egyptian Journal of Hospital Medicine*. Oct., 73 (11): 7850-7859, 2018. [Google Scholar].
- 3- GÖRKEM SB, COSKUN A , ESLIK M, KÜTÜK M.S. and Öztürk A.: Diffusion-weighted imaging of placenta in intrauterine growth restriction with worsening Doppler US findings. *Diagn Interv Radiol*. Jul., 25 (4): 280-284, 2019. [PMC free article] [PubMed].
 - 4- NAGPAL K., MITTAL P. and GROVER S.B.: Role of Ultrasonographic Placental Thickness in Prediction of Fetal Outcome: A Prospective Indian Study. *Journal of Obstetrics and Gynaecology of India*, 68: 349-354, 2018. [Google Scholar].
 - 5- SCANDIUZZI R.M., PRADO CA DE C., ARAUJO JÚNIOR E., et al.: Maternal uterine artery Doppler in the first and second trimesters as screening method for hypertensive disorders and adverse perinatal outcomes in low-risk pregnancies. *Obstetrics & Gynecology Science*. Sep., 59 (5): 347-56, 2016. [ORCID] [Google Scholar].
 - 6- SOHA FARID FAHIM HASSAN, ABD EL-MONEIM ZAKARIA and SAMEH SAEED FARAJ: Value of 3D USS of placental volume, uterine and umbilical artery doppler in prediction of pre-eclampsia. *Al-azhar med. J*. Jul., 50 (3): 1945-58, 2021. [Google Scholar].
 - 7- POLAT I., GEDIKBASI A., KIYAK H., GULAC B., ATIS A., et al.: Double notches: Association of uterine artery notch forms with pregnancy outcome and severity of preeclampsia. *Hypertension in Pregnancy*. Feb., 34 (1): 90-101, 2015. [Google Scholar].
 - 8- KANE S., DENNIS P. and ALICIA T.: Doppler assessment of uterine blood flow in pre-eclampsia: A review. *Hypertension in Pregnancy*, 34 (4): 400-421, 2015. [Crossref].
 - 9- DE ALMEIDA E., DE PAULA C., CAMPOS J., et al.: Three-Dimensional Sonographic Assessment of Placental Volume and Vascularization in Pregnancies Complicated by Hypertensive Disorders. *J. Ultrasound Med*. Mar., 33 (3): 483-91, 2014. [Crossref].
 - 10- HASHISH N., HASSAN A. and EL-SEMARY A.: Could 3D placental volume and perfusion indices measured at 11-14 weeks predict occurrence of preeclampsia in high-risk pregnant women?. *The journal of maternal-fetal & neonatal medicine*. Jun., 28 (9): 1094-98, 2015. [Crossref].
 - 11- MELCHIORRE K., WORMALD B., LESLIE K., BHITE A., et al.: First trimester uterine artery Doppler indices in term and preterm pre-eclampsia. *Ultrasound Obstet-Gynecol*. Aug., 32 (2): 133-37, 2008. [isuog].
 - 12- PARRETTI E., MEALLI F., MAGRINI A., CIONI R., et al.: Cross sectional and longitudinal evaluation of uterine artery Doppler velocimetry for the prediction of pre-eclampsia in normotensive women with specific risk factors *Ultrasound Obstet Gynecol*. Aug., 22 (2): 160-65, 2003. [isuog].
 - 13- DEGHANI-FIROUZABADI R., SAEDEH A. and REZA N.M.: Uterine artery Doppler sonography in predicting preeclampsia and IUGR at 14-16 week gestation. *World Applied Sciences Journal*, 22 (2): 197-201, 2013. [PubMed].
 - 14- PAPAGEORGHIU A.T. and LESLIE K.: Uterine artery Doppler in the prediction of adverse pregnancy outcome. *Current Opinion in Obstetrics and Gynecology*, April 19 (2): 103-09, 2007. [Google Scholar].
 - 15- DHAKAR V. and NAZ S.: Role of uterine and umbilical artery doppler assessment of the uteroplacental circulation in predicting pre-eclampsia: Comparison between different doppler parameters. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, Oct., 6 (10): 4314-18, 2017. [Google Scholar].
 - 16- ADEKANMI A.J., ROBERTS A., AKINMOLADUN J.A. and ADEYINKA A.O.: Uterine and umbilical artery doppler in women with pre-eclampsia and their pregnancy outcomes. *Niger Postgrad Med J*. Apr-Jun., 26 (2): 106-12, 2019. [Google Scholar] [PubMed].

دراسة مقارنة بالدوبلر الملون فى التنبؤ بتسمم الحمل فى الشهور الأولى للحمل

أن الإناث الحوامل اللاتى يعانون من الارتفاع فى ضغط الدم من المرشحين لقصور المشيمة وهى العملية التى تؤدى إلى التدهور التدريجى فى وظيفة المشيمة وإنخفاض فى نقل المشيمة من الأوكسجين والمواد المغذية إلى الجنين والذى قد ينتج عنه تسمم الحمل وهو المساهم الرئيسى فى وفيات الأمهات فى جميع أنحاء العالم ويبقى السبب الرئيسى للأمراض والوفيات حول الولادة.

وقد أجريت هذه الدراسة لتقييم وظيفة المشيمة فى هؤلاء الحوامل اللاتى يعانون من ارتفاع ضغط الدم باستخدام كل من الدوبلر لمعرفة كيف يمكن أن يضيف إلى دقة التشخيص فى تقييم المرضى المعرضين لخطر قصور المشيمة.

قد شملت دراستنا (١٦٠) من النساء الحوامل اللاتى يحققن معايير الانتقاء والإقصاء وقد ذكرت من قبل، حيث أن (٨٠) منهن كانوا يعانون من ارتفاع ضغط الدم و (٨٠) آخرين كانوا لا يعانون من أى اضطراب طبي عن طريق الفحص والتاريخ الطبي لهن وقد قمنا بفحص جميعهن باستخدام كل من الموجات فوق الصوتية.

وقد توفر ملاحظتنا أساساً هاماً للدراسات المستقبلية حيث أنه فى النهاية سوف نحتاج إلى فهم أفضل لأسباب أمراض المشيمة والأوعية الدموية المشيمية والذى سوف ينعكس على الحد من قصور المشيمة وبالتالي تخفيض النتائج الناجمة عن ذلك.

وفى الختام، فالنساء الحوامل اللاتى يعانون من ارتفاع فى ضغط الدم ويتم فحصهم باستخدام الموجات فوق الصوتية وفى حالة اشتباه وجود حدوث قصور فى وظيفة المشيمة فقد يكون من الضرورى إعادة فحصهم والذى من الممكن أن يكشف عن علامات ضعف المشيمة فى وقت مبكر، والذى يضيف إلى دقة التشخيص لهؤلاء المرضى والكشف عن المرضى المعرضين لخطر عال من قصور المشيمة والتي يمكن أن تؤثر على كيفية التعامل معهن لتقليل هذا الخطر.

ومما سبق فتوضح دراستنا أن استخدام السونار ثلاثى الأبعاد والدوبلر الملون فى تقييم أمراض الأوعية الدموية للمشيمة قد تكون أداة مفيدة للتنبؤ بالنتائج العكسية على الجنين ولكننا مازلنا بحاجة لدراسات مستقبلية.