

## THE UTERINE ARTERY STUDY BY DOPPLER ULTRASOUND IN PREDICTION OF PREECLAMPSIA

Rafah Jamouz<sup>1</sup>, Amer Jarkas<sup>2</sup>, Hasan Saleh<sup>3</sup>

1. Resident, Department of Radiology, Medical College, Tishreen University, Lattakia, Syria.
2. Lecturer, Department of Radiology, Medical College, Tishreen University, Lattakia, Syria.
3. Assistant Professor, Department of Obstetrics and Gynecology, Medical College, Tishreen University, Lattakia, Syria

### ABSTRACT:

**Objective :** To study the role of uterine artery Doppler ultrasound at 24-26 weeks of gestation in prediction of preeclampsia in high risk pregnant women.

**Materials and Methods :** 76 women with high risk pregnancies were studied for evaluation of resistive index (RI) and presence or absence of uterine artery notch by Doppler ultrasound at 24-26 weeks of gestation.

Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of Doppler ultrasonography of the uterine artery, for the prediction of preeclampsia were assessed .

**Results :** Preeclampsia has developed in 61.8% of pregnancies in our study. Sensitivity , specificity , PPV and NPV of abnormal uterine artery Doppler study for prediction of preeclampsia were 85.1% , 72.4% , 83.3% , and 75%, respectively.

Uterine artery notching and RI had a significant role in predicting preeclampsia in high risk pregnant women , sensitivity and specificity had increased when they were used in combination .

**Conclusion :** Doppler of uterine artery at 24-26 weeks of gestation can be used as a reliable screening test for prediction of preeclampsia and helps to identify women at high risk and helps to modify follow up and management.

**Keywords:** Uterine artery notch , resistive index (RI) , Doppler ultrasonography , preeclampsia .



### INTRODUCTION:

Hypertension during pregnancy disorders complicates about 10% of pregnancies.<sup>[1]</sup> Preeclampsia is the most common type of hypertension during pregnancy. Preeclampsia is a multi-system disorder unique to human pregnancy characterized by hypertension and involvement of one or more other organ systems and/or the fetus.<sup>[2]</sup> Preeclampsia is best described as a pregnancy – specific syndrome that can affect virtually every organ system.

Preeclampsia is defined as the development of hypertension (>140/90 mmHg) after 20 weeks in a woman previously normal blood pressure ,with proteinuria ( $\geq 300$  mg/24 h) or with signs of multiorgan involvement which may include thrombocytopenia, renal dysfunction, liver dysfunction, central nervous system perturbations or pulmonary edema.<sup>[3]</sup>

Risk factor for preeclampsia include; nulliparity, twin pregnancy (increased

risk with multiples), previous history of preeclampsia, family history of preeclampsia, maternal age <20 or > 35-40 years, Chronic hypertension, chronic autoimmune disease, antiphospholipid antibodies, pre-existing diabetes, renal disease, inter-pregnancy interval greater than 10 years.<sup>[4]</sup> The incidence of preeclampsia is increasing in the United States and may be related to the higher prevalence of predisposing disorders such as hypertension, diabetes, obesity, delay in child-bearing, and the use of artificial reproductive technologies with associated increase in multi-fetal gestation.<sup>[5]</sup>

In normal pregnancy, placental trophoblast cells invade the inner third of the myometrium and migrate the entire length of the maternal spiral arteries what optimizes delivery of oxygen and nutrients to the fetus. In women who develop preeclampsia there is failure of trophoblast invasion of the uterine muscular wall with the result that the spiral arteries retain the muscle elastic coating and impedance to blood flow persists. Theoretically, a pathological increase in placental vascular resistance should be detectable by abnormal Doppler flow studies of the maternal uterine vessels, and this could offers the potential to detect women at risk for diseases like preeclampsia. <sup>[6]</sup>

Early detection of preeclampsia plays an important role in management and treatment plan, uterine artery Doppler studies have been utilized as a screening tool to predict pregnancy complications

associated with uteroplacental insufficiency before the onset of clinical features, since in preeclampsia the failure of trophoblasts invasion lead to resistance to blood flow within the uteroplacental circulation and it is transmitted upstream to the uterine arteries.<sup>[7]</sup>

“Notching” appears to be a common feature of the uterine artery Doppler waveform in pregnancy, as it is present in 46– 64%of normal gestations in the first trimester. In pregnancies after 20 weeks, a diastolic notch has been defined as a fall of at least 50 cm/s from the maximum diastolic velocity.As the pregnancy evolves normally, a progressive increase in uterine artery compliance is noticed, which continues through 26 weeks’ gestation, during which the «notch» is smoothed and lost. Persistent notching is thought to reflect abnormal maternal vascular tone. <sup>[7,8]</sup>Notching could be unilateral or bilateral. Bilateral notching is more concerning. Unilateral notching of the uterine artery on the ipsilateral side of the placenta, if the placenta is along one lateral wall (right or left) carries the same significance as bilateral notching. So that the presence of notching after 22 weeks is associated with several other conditions including adverse pregnancy outcomes like preeclampsia.<sup>[8]</sup>

Resistive index (RI), this is calculated by the following equation

$$RI = (PSV-EDV) / PSV = (\text{peak systolic velocity} - \text{end diastolic velocity}) / \text{peak}$$

systolic velocity . Normal value of RI < 0.55. similarly to notching, resistance to blood flow gradually drops during gestation as a greater trophoblastic invasion of the myometrium takes place. An abnormally high resistance can persist in preeclampsia and it reflects placental defect.

Abnormal patterns of doppler uterine artery waveform include:

- persistence of a high resistance flows throughout pregnancy.
- persistence of notching throughout pregnancy.
- reversal of diastolic flow throughout pregnancy: severe state.<sup>[10]</sup>

If one of the uterine arteries is abnormal, patients are followed with more frequent clinic visits and ultrasounds for growth because the positive predictive value in populations at risk ranges from 50% to 75%.<sup>[11]</sup>

The purpose of this prospective study is to evaluate the predictive value of uterine artery notch and RI on color Doppler ultrasound at 24-26 weeks of gestation in a high risk women for prediction of preeclampsia, and examine the use of uterine artery Doppler at 24-26 weeks gestation in a high risk women as a screening test for the prediction of preeclampsia.

## **MATERIALS AND METHODS:**

This is study conducted in Radiology Department at Tishreen and Al-Assad

University Hospitals , Lattakia , Syria , during the period between June 2016 and June 2017.

76 women with high risk pregnancies including nulliparity, women with family history of PIH, previous history of PIH, abortion , previous intrauterine death, maternal age <20 or > 35years , Assisted reproductive, were studied.

Multiple pregnancies or pregnancies with recognized fetal abnormalities were excluded. Ultrasonography was done in each of them with Siemens<sup>®</sup> machine( 3.5-5 MHz curvilinear probe) to confirm the gestational age by using measurements of biparietal diameter(BPD) and femur length(FL) and to exclude any fetal anomaly.

Then a Doppler ultrasound of uterine artery velocity waveform was performed ,the woman was examined in a semi recumbent position, the ultrasound transducer was placed in either the left or right iliac fossae of the abdomen, directed towards the lateral uterine walls and downwards into the pelvis, to obtain the sagittal section of the uterus and cervical canal. This is followed by the introduction of the colour flow imaging to produce a colour map of flow over the region. The probe is tilted sideways but still maintaining its medial angulation (lower paracervical area), till the uterine artery is visualized as it crosses the external iliac artery, having originated from the internal iliac artery. The sample volume was placed 1cm distal to the point of apparent cross over before any

branching of the uterine arteries . These characters were used as the standard Landmark for investigation of the uterine artery . Pulsed Doppler gate was placed at this location to obtain flow waveforms and when at least 3 consecutive consistent waveforms are produced, the image is frozen.

Persistence of an early diastolic notch, unilateral or bilateral in the main uterine artery, or elevated resistance index or  $RI > 0.60$  ,or both was considered as abnormal flow velocity waveform. A notch was defined as a V-shaped deflection toward the baseline in early diastole. Resistance index (RI) = systolic peak velocity - diastolic peak velocity/systolic peak velocity or  $(S - D)/S$ .

Clinical data and pregnancy outcome information were collected from Obstetrics and Gynecology department , and determine the presence of preeclampsia (hypertension  $>140/90$  mmHg with proteinuria  $\geq 300$  mg/24 h or with signs of multiorgan involvement).

## RESULTS:

76 women were included in the study. Mean maternal age was **29.63** (range 16–44) years. Table 1 shows distribution of high risk women according to risk factors that already mentioned.

### *Analysis of uterine artery Doppler :*

Out of 76 high risk pregnant women, 47 women developed preeclampsia ( incidence 61.8%) .**48** women (**63.1** %)

showed abnormal uterine artery Doppler study, and out of whom 40 developed preeclampsia. In 28 women (36.9%), with normal uterine artery Doppler study, preeclampsia was found in 7 women. Using  $2 \times 2$  table, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of abnormal uterine artery Doppler velocimetry become **%85.1**, **%72.4**, **%83.3**, and 75% , respectively (Table 2).

In 76 pregnant women a notch was absent in 30 (39.47%) patients and unilateral in 16 (21.05%) and bilateral in 30 ( 39.47%). $RI < 0.60$  ( normal) was in 32 (42.1%) patients and  $RI > 0.60$  (abnormal) in 44 (57.9%) patients. Table 3 shows the relation between the uterine artery Doppler findings( notch and RI) and the development of preeclampsia in our patients. Table 4 shows the role of uterine artery Doppler ( notch and RI) in predicting of preeclampsia. sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

## DISCUSSION:

This study evaluated clinical usefulness of uterine artery Doppler ultrasound at 24-26 weeks of gestation as a predictor of preeclampsia in high risk pregnant women.

Out of 76 pregnant women , 47 women developed preeclampsia. In this study the sensitivity and specificity of abnormal uterine artery Doppler at 24-26 weeks in predicting preeclampsia

were 85.1%,72.4 % , respectively .in a systemic review and bivariable meta analysis by Consen JS , et al <sup>[12]</sup> sensitivity was 86 % and specificity was 78 % in high risk women.

The sensitivity and specificity of bilateral notch were higher than in unilateral notch ( 81 % and 100 % versus 58.85 and 79.3 %) which suggest the valuable role of bilateral notch in predicting of preeclampsia.

The negative predictive value NPV of presence notch ( unilateral/bilateral) was 76.6% and only 7 cases (23.3%) of pregnant women without notching had preeclampsia. Likewise Asnafi N ,et al <sup>[13]</sup> the NPV of the presence of notching was 88.3% higher than our study and noticed that the absence of uterine artery notching could lead to pregnancy without preeclampsia and recommended to use the uterine artery Doppler at 24-26 weeks as a screening test to predict preeclampsia in high risk women.

In our study the sensitivity of elevated  $RI > 0.60$  in uterine artery Doppler in predicting preeclampsia was 76.6%. Parreti E , et al <sup>[14]</sup> which considered elevated  $RI > 0.58$  the sensitivity in predicting preeclampsia in high risk women was 77.8%. Also in Sahoo K , et al <sup>[15]</sup> which studied the role of elevated  $RI > 0.7$  to predicting preeclampsia in high risk women and the sensitivity was 77.8%.

When we studied the combination of both uterine artery notching and elevated  $RI > 0.60$  between 24-26 weeks

of gestation in predicting of preeclampsia in high risk women , the presence of unilateral notch and elevated RI had sensitivity and specificity 58.8% and 77.7 % , respectively .while the presence of bilateral notch and elevated RI had sensitivity and specificity 78.7% and 100%,respectively. This mean that there is a significance role of the combined bilateral notch and elevated  $RI > 0.60$  together in uterine artery Doppler between 24-26 weeks of gestation in the predicting of preeclampsia in high risk pregnant women , and this is similar to a systemic review and bivariable meta analysis by J.S,consen , et al <sup>[12]</sup>

## CONCLUSION:

After analysis of the results, it has been established that uterine artery notching shows a high sensitivity and specificity for predicting preeclampsia than elevated RI . Combined together both the tests also show sensitivity and specificity as high as uterine artery notching alone or elevated RI alone. PPV of uterine artery notching is found to be 87%, which is higher than the PPV of both tests combined together (83.3%).

From results of this study it can be concluded that uterine artery Doppler between 24-26 weeks of gestation can be used as a reliable screening test for prediction of preeclampsia in high risk women , and we can recommend to use the uterine artery Doppler between 24-26 weeks as a routine screening test in pregnant women and to combine both of

uterine artery notching and RI to increase the sensitivity and specificity of the test.

The rate of incidence preeclampsia in our study was 61.8% don't exactly

correspond (higher) with any of the international studies conducted preciously. This can be attributed to the difference between risk factors included in our study and other studies.

## REFERENCES:

1. World Health Organization .WHO recommendations for Prevention and treatment of pre-eclampsia and eclampsia . 2011.
2. Royal College of physician of Ireland and the clinical strategy and programmes division , Health Service Executive .Clinical practice guideline :The diagnosis and management of preeclampsia and eclampsia.version:2.0,guidelin No:3, June 2016 .
3. Cunningham FG , Leveno KJ ,Bloom SL, Spong CY, Dash JS, Hoffman BL,Casey BM, Sheffield JS. Williams Obstetrics , 24<sup>th</sup> ed ; McGraw-Hill Education ,2014 ; pp.728-732.
4. Health professionals in Queensland public and private maternity services .Queensland clinical guidelines:Hypertensive disorders of pregnancy , MN 15.13-V7-R20 ,August 2016.
5. Jeyabalan A. Epidemiology of preeclampsia: Impact of obesity , National Institute of health NIH public access 2013 October ; 71(0 1): . doi:10.1111/nure.12055.
6. Giordano R ,et al . Uterine artery Doppler flow studies in obstetric Practice. Journal of Prenatal Medicine 2010; 4 (4): 59-62.
7. Khong SL, et al.First-Trimester Uterine Artery Doppler Analysis in the Prediction of Later Pregnancy Complications. Article in disease markers May 2015; Impact Factor: 1.56 · DOI: 10.1155/2015/679730.
8. LG ,et al. Internal iliac and uterine arteries Doppler ultrasound in the assessment of normotensive and chronic hypertensive pregnant women.Scintifitic reports January 2014; 4 : 3785 | DOI: 10.1038/srep03785.
9. Radiopaedia: Uterine artery flow notching <https://radiopaedia.org/articles/uterine-artery-flow-notching>
10. Radiopaedia :Uteroplacental blood flow assessment. <https://radiopaedia.org/articles/uteroplacental-blood-flow-assessment>.
11. Rumack CM, ,Wilson SR, Charboneau JW, Levine D. DIAGNOSTIC ULTRASOUND, 4<sup>TH</sup> ed ; Mosby, Inc., an affiliate of Elsevier Inc, 2011; pp.1747-1475.
12. Cnossen JS, et al . Use of uterine artery Doppler ultrasonography to predict pre-eclampsia and intrauterine growth restriction: a systematic review and bivariable

- meta-analysis . CMAJ • March 2008 ;178(6) .
13. Asnafi N, Hajian K. Mid-trimester uterine artery Doppler ultrasound as a predictor of adverse obstetric outcome in high-risk pregnancy . Taiwanese Journal of Obstetrics & Gynecology 50 (2011); 29e32 .
14. Parretti E,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 2003; 22: 160–165.
15. Sahoo K, et al . The Role of Uterine Artery Doppler Sonography in Predicting Pre Eclampsia at 14-20 Weeks of Gestation . International Journal of Science and Research (IJSR) February 2016 ;Impact Factor : 5.611.

**TABLES:**

**Table 1** Distribution of high risk women according to risk factors

Risk factors	No. of women (n)	Percentage (%)
Age (>35 or <20 )years	14	18.4%
Previous abortion	30	39.4%
Previous preeclampsia	2	2.6%
Assisted reproductive	2	2.6%
Previous intrauterine death	6	7.8%
Nulliparity	22	28.9%

**Table 2** Performance of uterine artery Doppler velocimetry in predicting preeclampsia

	Preeclampsia	Sensitivity %	Specificity %	PPV %	NPV %
Women (n=76)	47	85.1	72.4	83.3	75
Abnormal UAD (48)	40				
Normal UAD(28)	7				

UAD uterine artery Doppler

**Table 3** the relation between notch and RI and the development of preeclampsia

Notch	No preeclampsia (n) %	Preeclampsia (n) %	No preeclampsia		Preeclampsia	
			RI<0.60 (n) %	RI>0.60 (n) %	RI<0.60 (n) %	RI>0.60 (n) %
Notch absent (n=30)	(23) 76.67%	(7) 23.33%	(21) 70%	(2) 6.67%	(7) 23.33%	(0) 0%
Unilateral notch(n=16)	(6) 37.5%	(10) 62.5%	(0) 0%	(6) 37.5%	(0) 0%	(10) 62.5%
Bilateral notch(n=30)	0% (0)	(30) 100%	(0) 0%	(0) 0%	(4) 13.3%	(26) 86.7%

**Table 4** the role of uterine artery Doppler(notch and RI) in predicting of preeclampsia sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV)

<b>Uterine artery Doppler</b>	<b>Sensitivity %</b>	<b>Specificity %</b>	<b>PPV %</b>	<b>NPV %</b>
Any notch	85.1	79.3	87	76.6
Unilateral notch	58.8	79.3	62.5	76.6
Bilateral notch	81	100	100	76.6
RI>0.60	76.6	72.4	81.8	65.6
Unilateral notch + RI>0.60	58.8	77.7	62.5	75
Bilateral notch + RI>0.60	78.7	100	100	75