



Research Article

Diagnostic Evaluation of Uterine Artery Doppler Imaging for the Prediction of Early Abnormal Pregnancy

Thikra N. Abdulla¹, Qays A. Hassan^{2*}, Hawraa K. Abood³

- 1- Department of obstetrics and gynecology, Al-Kindy College of Medicine, University of Baghdad, Baghdad, Iraq.
- 2- Division of Radiology, Department of Surgery, Al-Kindy College of Medicine, University of Baghdad, Baghdad, Iraq.
- 3- Al-Elwiya Maternity Teaching Hospital, Al-Rusafa Health Directorate, Baghdad, Iraq.

*Corresponding to: qtimeme@yahoo.com

ABSTRACT

Article history:

Received 25 December 2020

Accepted 30 May 2021

Available online 30 August 2021

<https://doi.org/10.47723/kcmj.v17i1.286>

Keywords: Uterine artery Doppler, early abnormal pregnancy, hydatidiform mole.



This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license

<http://creativecommons.org/licenses/by/4.0/>

Objective: to assess the predictive value of Doppler imaging of the uterine artery in the identification of early intrauterine abnormal pregnancy as compared to a normal intrauterine pregnancy.

Subjects and methods: one hundred and twenty pregnant ladies, at their 6-12 weeks of gestation, with a singleton pregnancy were included in this population-based case-control study. Thirty women with a missed miscarriage, 30 with hydatidiform mole, 30 with a blighted ovum, and 30 as a control group, without risk factors, underwent Doppler interrogation of the uterine arteries. Resistive index (RI), pulsatility index (PI), and the systolic/diastolic ratio (S/D) were measured for both sides. The t-test, or ANOVA test when appropriate, was used to analyze the relationship between the variables.

Results: there was a significant reduction of RI mean, PI mean, and S/D ratio among women with different types of abnormal pregnancy compared with the control group. RI and PI mean levels were significantly lower in women with hydatidiform mole and significantly higher in women with missed miscarriage. Lower left S/D mean level was significantly associated with hydatidiform mole and upper left S/D level was associated significantly with control women. For prediction of missed miscarriage; right and left uterine artery RI shows a sensitivity of 80%, 73.3%, a specificity of 68%, 71.1%, and the highest AUC was 0.78 for both. For prediction of molar pregnancy, right and left uterine artery RI showed a sensitivity of 63% for both, a specificity of 54.4%, 60%, and the highest AUC was 0.58, 0.61 respectively.

Conclusions: Uterine artery Doppler ultrasonography at 6-12 weeks of gestation is predictive for early pregnancy complications such as missed abortion, hydatidiform mole, and blighted ovum.

Introduction

The direct non-invasive study of the uteroplacental circulation has been allowed since the introduction of pulsed and color Doppler sonography into obstetrics. This circulation is the result of the

invasion of the trophoblastic tissue of the uterine spiral arteries, which occurs between 5th week and 14th week of pregnancy (1,2). Doppler analysis of the uterine vessels has allowed the evaluation of the significant vascular changes which happen at some stage in early

pregnancy. These changes lead to a gradual decrease in the flow resistance of uterine vessels and an increase in blood flow going to the pregnant uterus (3-5).

In complicated early pregnancy, the uteroplacental circulation demonstrates flow characteristics that are strikingly different from those of normal early pregnancy. In abnormal pregnancies, increased flow within the intervillous space is shown by color Doppler imaging (6,7).

Some researchers have projected investigating the uteroplacental circulation in early pregnancy to find out if alterations of the early vascular events could predict a complicated early pregnancy (1,8-10). The present study set out to investigate uterine artery blood flow by transabdominal pulsed and color Doppler to assess the predictive value of Doppler imaging parameters of uterine artery flow in the identification of early intrauterine abnormal pregnancy as compared to normal intrauterine pregnancy.

Subjects and methods

One hundred and twenty women (aged 17-40 years) with a singleton pregnancy, between 6 and 12 weeks of gestational age, who were referred to the Obstetric Outpatient Department in the Al-Elwiya Maternity Teaching Hospital, in Baghdad, Iraq, were selected for this study during July 2016-Jun2017. All chosen women were without any adverse obstetric or past medical history. The women were classified into four groups based on sonographic features and appearances. The 1st group was women with missed miscarriage (n=30). The 2nd group was women having blighted ovum (n=30). The 3rd group was women with molar pregnancy (n=30). The last group was women with normal healthy early intrauterine pregnancy as a control group (n=30).

The study was approved by the ethical committee of the hospital. The principle and procedures were illustrated to all women, and they were given the right to participate or not, consents were taken with the reassurance that interprets gained will be kept confidentially. After receiving their approval, those pregnant women who were cooperative and interested in joining this study were subjected to Doppler study of the uterine arteries. Resistive index (RI), pulsatility index (PI), and the systolic/diastolic ratio (S/D) were measured for both sides. All measurements were performed by an expert radiologist, with a minimum of 5 years of experience on performing Doppler study of the uterine artery. The machine used was (GE healthcare, Voluson 730 pro V, Austria) equipped with a 3.5-5 MHz convex probe. The uterine arteries were identified using color Doppler at the level of the internal cervical os. Tilting the transabdominal probe from side to side ensuring us to recognize the right and left uterine artery. Pulsed wave Doppler was used when the sampling gate set at 2mm to cover the whole vessel. The insonation angle was less than 30 degree. After three consecutive similar waveforms were obtained, the RI, PI, and S/D were automatically calculated by the scanner software. The following formulas defined the RI, PI, and S/D: $RI = X - Y / X$, $PI = X - Y / \text{Mean}$, $SD = X / Y$ where: X= peak systolic velocity, Y= end diastolic velocity, and Mean= mean velocity.

Statistical analysis

All patients' data entered using the Statistical Package for Social Sciences software (IBM SPSS Statistics for Windows, version 21.0 Armonk, NY, USA). Descriptive statistics presented as (mean \pm standard deviation) and frequencies as percentages. Kolmogorov Smirnov analysis verified the normality of the data set. The t-test was applied to compare between two means. One-way ANOVA analysis was used to compare more than two means. Receiver operating characteristic (ROC) analysis, including calculation of the areas under the curves, was used to clarify the cutoff values for predicting the abnormal pregnancies. In all statistical analysis, the level of significance (p-value) was set at ≤ 0.05 .

Results

All studied groups show a comparable median patient age which was 24 years (17-40 years) and median gestational age which was nine weeks (6-12 weeks).

Table 1 shows a significant reduction of all studied Doppler parameters of both uterine arteries among women with abnormal pregnancy as compared to the control group.

Table 1: Mean levels of uterine artery parameters between women with abnormal pregnancy and controls.

Variable	Abnormal	Control	t-test	P
Right RI	0.66 \pm 0.18	0.75 \pm 0.11	2.4	0.01
Right PI	1.73 \pm 0.94	2.28 \pm 0.5	3.03	0.003
Right S/D	4.56 \pm 2.52	6.35 \pm 1.7	3.6	<0.001
Left RI	0.67 \pm 0.18	0.74 \pm 0.1	2.07	0.04
Left PI	1.79 \pm 0.91	2.18 \pm 0.51	2.2	0.02
Left S/D	4.6 \pm 2	6.27 \pm 1.53	4.1	<0.001

Abbreviations: RI, Resistive index; PI, pulsatility index; S/D, systolic/diastolic ratio. Continuous variables expressed as Mean \pm standard deviation or SE as appropriate

Table 2 shows that the lower right and left RI mean level, lower right and left PI index, and lower right and left S/D mean level was significantly associated with hydatidiform mole (p<0.001). Higher right and left RI mean level, higher right and left PI index, upper right and left S/D level was significantly associated with missed miscarriage (p<0.001).

Table 2 also shows that for pregnant women with a blighted ovum, the means of Doppler S/D were significantly lower than S/D means of normal pregnant women (p<0.001).

The acceptable cut off points of Doppler parameters in predicting missed miscarriage was distributed as followings (right RI 0.77, right PI 1.9, right S/D 5.1, left RI 0.78, left PI 1.96, left S/D 4.8). The coordinates of the ROC Curve of Doppler parameters for prediction of missed miscarriage in early pregnancy was shown in Table 3.

Table 2: Uterine artery Doppler parameters means between study groups.

Groups	Right RI	Right PI	Right S/D	Left RI	Left PI	Left S/D
Missed miscarriage (n=30)	0.8±0.12	2.39±0.93	6.74±2.95	0.8±0.08	2.41±0.86	6.15±2.1
Blighted ovum (n=30)	0.75±0.08	2.03±0.57	4.09±1.12	0.77±0.05	2.11±0.48	4.75±0.92
Hydatidiform mole (n=30)	0.43±0.07	0.78±0.25	2.85±1.15	0.43±0.09	0.84±0.4	2.9±1.23
Control (n=30)	0.75±0.11	2.28±0.5	6.35±1.73	0.74±0.1	2.18±0.51	6.27±1.53
P*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Abbreviations: RI, Resistive index; PI, pulsatility index; S/D, systolic/diastolic ratio. Continuous variables expressed as Mean± standard deviation or SE as appropriate. *ANOVA

Table 3: Coordinates of the ROC Curve of Doppler parameters for prediction of missed miscarriage in early pregnancy.

Parameter	Cutoff	A	Se%	S%
Right RI	0.77	0.78	80	68
Right PI	1.90	0.69	73	58.9
Right S/D	5.10	0.73	70	73.3
Left RI	0.78	0.78	73.3	71.1
Left PI	1.96	0.71	70	56.7
Left S/D	4.80	0.69	70	61.1

A=Area under the ROC curve; Se = Sensitivity; S = Specificity; RI= Resistive index; PI= pulsatility index; S/D= systolic/diastolic ratio.

The acceptable cut off points for of Doppler parameters in predicting hydatidiform mole was distributed as followings (right RI 0.50, right PI 1.0, right S/D 4.0, left RI 0.52, left PI 1.24, left S/D 4.13). The coordinates of the ROC Curve of Doppler parameters for prediction of hydatidiform mole in early pregnancy was shown in Table 4. There was high concern of the parents about the patient's future marriage (69%), conception (62%) and career (52%).

Table 4: Coordinates of the ROC Curve of Doppler parameters for prediction of hydatidiform mole in early pregnancy.

Parameter	Cutoff	A	Se%	S%
Right RI	0.75	0.58	63	54.4
Right PI	1.40	0.57	63.3	53.3
Right S/D	4.90	0.38	44	42
Left RI	0.76	0.61	63	60
Left PI	1.38	0.49	55	43
Left S/D	4.80	0.32	38	40

A=Area under the ROC curve; Se = Sensitivity; S = Specificity; RI= Resistive index; PI= pulsatility index; S/D= systolic/diastolic ratio.

Discussion

It is documented that there is a decline in vascular resistance of uteroplacental bed with advance gestation in healthy pregnancy but in abnormal pregnancy, there is a defect in early trophoblast invasion and failure to convert spiral artery into low resistance. Studying maternal and fetal arterial flow by colored Doppler ultrasonography is represented as auseful diagnostic choice for assessment of maternal-fetal unit physiology (1). Doppler velocimetry testing detected the adverse pregnancy outcome like pre-eclampsia, intrauterine growth restriction and Hydatidiform mole (11).

Difficulties in vascular remodeling of maternal-fetal circulation are strongly related to bad gestational outcomes (12). Previous literature revealed that this early intensive vascular remodeling is responsible for many adverse pregnancy outcomes. There were anatomical studies showed a defect in initial trophoblast invasion and a failure to convert the spiral artery into low-resistance channels which in turn lead to complications of the pregnancy stem (13).

This study found lower means of Doppler parameters (RI, PI and S/D) in early pregnancy among women with Hydatidiform mole (p<0.001). This finding was in accord with the results of Lin et al. (14) and Wiafe et al. (15) studies. Similarly, Amin et al. (16) and Al-Waeely (17) studies documented that colored Doppler imaging is used for prediction of molar pregnancy in conjunction with β-HCG. The gestational trophoblastic disease showed hyperdynamic flow in the uterine circulation due to the destructive effect of trophoblasts on uterine vessels (18). Uterine artery is presented with high velocity and low impedance caused by low resistance downstream circulation which is predictive of trophoblastic activity.

The current study showed higher right and left uterine artery parameters (RI, PI and S/D) means in early pregnancy among women with missed abortion (except for left uterine artery S/D). This finding was consistent with results of Özkan et al. (19) and Behery et al. (20) studies in which reported that higher Doppler parameters are predictive for pregnancy loss in early pregnancy. Mean PI of the uterine artery of abnormal pregnancy in our study was significantly lower than PI of healthy women at early pregnancy. This finding was similar to results of Behery et al. (20) study which revealed lower means of uterine artery PI in early pregnancy for women with the abnormal outcome than women with normal pregnancy.

For pregnant women with a blighted ovum in the current study, means of Doppler S/D were significantly lower than S/D means of normal pregnant women. This finding was similar to results of Özkan et al. (19) study which stated that lower S/D ratio is a significant predictor for blighted ovum cases in early pregnancy. In our study, the S/D ratio of the left uterine artery was significantly higher among normal pregnant women while for right uterine artery, S/D was higher among women with missed abortion. This finding was in agreement with results of Anita et al. (21) study which found that divergence in S/D ratio is a physiological event related with abnormal pregnancy outcome.

The limitation in this study included the small sample size, loss of follow up, and variability in Doppler interpretations. However, the results of this study might encourage obstetricians to apply Doppler

ultrasonography in screening and diagnosis of gestational complications in early pregnancy.

Conclusion

Colored Doppler ultrasonography in early pregnancy is predictive for early pregnancy complications as indices of Doppler for uterine artery can aid in the detection of early abnormal pregnancy. RI and PI of the uterine artery Doppler imaging are helpful in the diagnosis of a missed miscarriage and hydatidiform mole in early pregnancy. S/D ratio of Doppler imaging is useful in the diagnosis of the blighted ovum in early pregnancy.

Funding

This research did not receive any specific fund.

Conflict of Interest

No conflict of interest

REFERENCES

- [1] Khong SL, Kane SC, Brennecke SP, da Silva Costa F. First-trimester uterine artery Doppler analysis in the prediction of later pregnancy complications. *Dis markers*. 2015;2015:679730.
- [2] Silver R, Branch D, Goldenberg R, Iams J, Klebanoff M. Nomenclature for Pregnancy Outcomes. *Obstetrics & Gynecology*. 2011;118(6):1402-1408.
- [3] van den Berg M, van Maarle M, van Wely M, Goddijn M. Genetics of early miscarriage. *Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease*. 2012;1822(12):1951-1959.
- [4] Chan Y, Jayaprakasan K, Tan A, Thornton J, Coomarasamy A, Raine-Fenning N. Reproductive outcomes in women with congenital uterine anomalies: a systematic review. *Ultrasound in Obstetrics & Gynecology*. 2011;38(4):371-382.
- [5] Maconochie N, Doyle P, Prior S, Simmons R. Risk factors for first trimester miscarriage-results from a UK-population-based case-control study. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2007;114(2):170-186.
- [6] Jauniaux E, Greenwold N, Hempstock J, Burton G. Comparison of ultrasonographic and Doppler mapping of the intervillous circulation in normal and abnormal early pregnancies. *Fertility and Sterility*. 2003;79(1):100-106.
- [7] Jaffe R. Development of early uteroplacental circulation. *Early pregnancy* 2001;5: 34-5.
- [8] Garrett L, Garner E, Feltmate C, Goldstein D, Berkowitz R. Subsequent Pregnancy Outcomes in Patients With Molar Pregnancy and Persistent Gestational Trophoblastic Neoplasia. *Obstetrical & Gynecological Survey*. 2008;63(11):704-705.
- [9] Jurkovic D, Overton C, Bender-Atik R. Diagnosis and management of first trimester miscarriage. *BMJ*. 2013;346(jun 19 2):f3676-f3676.
- [10] Doubilet P, Benson C, Bourne T, Blaivas M. Diagnostic Criteria for Nonviable Pregnancy Early in the First Trimester. *New England Journal of Medicine*. 2013;369(15):1443-1451.
- [11] Slim R, Mehio A. The genetics of hydatidiform moles: new lights on an ancient disease. *Clinical Genetics*. 2006;71(1):25-34.
- [12] Al-Hussaini T, Abd El Aal D, Van den Veyver I. Recurrent pregnancy loss due to familial and non-familial habitual molar pregnancy. *International Journal of Gynecology & Obstetrics*. 2003;83(2):179-186.
- [13] Luise C. Outcome of expectant management of spontaneous first trimester miscarriage: observational study. *BMJ*. 2002;324(7342):873-875.
- [14] Lin L, Bernardes L, Hase E, Fushida K, Francisco R. Is Doppler ultrasound useful for evaluating gestational trophoblastic disease?. *Clinics*. 2015;70(12):810-815.
- [15] Wiafe YA, Odoi AT, Dassah ET. The Role of Obstetric Ultrasound in Reducing Maternal and Perinatal Mortality. *Ultrasound Imaging Med Appl*. 2011;1: 207-234.
- [16] Amin NS, Yassen RN, Abd-EL-Kareem HF, Ahmed Abd Al-Jabbar Al-Sabbagh AA. Artery Doppler Blood flow in Cases of Hydatidiform Mole and its Correlation with β -HCG. *Iraqi J Comm Med* 2014;1:1-9.
- [17] Al-Waely FAJ. Evaluation of Doppler ultrasound study in first trimester threatened abortion and anembryonic pregnancy. *The Medical Journal of Basrah University*. 2005;23:5-9.
- [18] Lurain J. Gestational trophoblastic disease I: epidemiology, pathology, clinical presentation and diagnosis of gestational trophoblastic disease, and management of hydatidiform mole. *American Journal of Obstetrics and Gynecology*. 2010;203(6):531-539.
- [19] Özkan M, Ozyazici E, Emiroglu B, Özkara E. Can we measure the spiral and uterine artery blood flow by real-time sonography and Doppler indices to predict spontaneous miscarriage in a normal-risk population?. *Australasian Journal of Ultrasound in Medicine*. 2015;18(2):60-66.
- [20] El Behery MM, Mansour SM, Siam S, Seksaka MA. Uterine artery Doppler and urinary hyperglycosylated HCG as predictors of threatened abortion outcome. *Middle East Fertility Society Journal* 2013;18:42-6.
- [21] Anita, B., Mala, S. & Indrani, G. Divergent systolic diastolic ratio of the uterine arteries and its significance. *J Obstet Gynecol India*. 2010; 60, 320-325.

To cite this article: Abdulla T, Hassan Q, Abood H. Diagnostic Evaluation of Uterine Artery Doppler Imaging for the Prediction of Early Abnormal Pregnancy. *Al-Kindy College Medical Journal*. 2021;17(2):91-94.