ARTÍCULO ORIGINAL

Flujometría Doppler Anormal de Arterias Uterinas y Predicción de Preeclampsia.

Abnormal Doppler Flowmetry of Uterine Arteries and Prediction of Preeclampsia.

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SUMMARY

Objetive: To determine the diagnostic accuracy of abnormal Doppler flow of uterine arteries in the second trimester of gestation using sensitivity, specificity, positive predictive value and negative predictive value of the proto-diastolic notch, resistance index, systole/diastole index (S/D), and pulsatility index to assess the positive likelihood ratio (LR +) and prediction of the risk of presenting preeclampsia. **Methods:** prospective, longitudinal cohort study. A total of 669 pregnant women were studied by pulsed Doppler of the uterine arteries and spectral analysis without considering risk selection. 93 (13.9%) presented with preeclampsia. **Results:** sensitivity between 58 and 71%; specificity between 62 and 95%. A positive predictive value between 20 and 69%. A negative predictive value between 90 and 95%. The best predictor of preeclampsia in this population was the pulsatility index, with a sensitivity of 71%, 95% specificity, and a positive likelihood ratio (LR+) of 13.6. **Conclusion:** Abnormal Doppler flowmetry of uterine arteries in the second trimester of gestation is a good predictor of preeclampsia in a population not selected for risk.

Key words: Doppler flowmetry, uterine arteries, preeclampsia prediction. (Source: MeSH).

RESUMEN

Objetivo: Determinar la exactitud diagnóstica del flujo Doppler anormal de las arterias uterinas en el segundo trimestre de gestación, mediante la sensibilidad, especificidad, valor predictivo positivo y valor predictivo negativo del notch proto diastólico, Índice de Resistencia, Índice Sístole/ Diástole(S/D) e Índice de Pulsatilidad para valorar la Razón de Verosimilitud positiva (LR +) y la predicción del riesgo de presentar preeclampsia. **Métodos:** Estudio de cohorte prospectivo, longitudinal. Se estudiaron mediante Doppler pulsado de las arterias uterinas y análisis espectral a 669 gestantes, sin tener en cuenta selección de riesgo, 93 (13,9%) presentaron preeclampsia. **Resultados:** Sensibilidad entre 58-71% Especificidad 62- 95%. Valor predictivo positivo entre 20 - 69%. Valor predictivo negativo entre 90 - 95%. El mejor predctor de preeclampsia en esta población fue el Índice de Pulsatilidad con una Sensibilidad de 71% y 95 % de Especificidad y Razón de verosimilitud positiva (LR+) de 13,6. **Conclusión:** La flujometría Doppler anormal de arterias uterinas en el segundo trimestre de gestación, tiene buena predicción de preeclampsia en población no seleccionada por riesgo.

Palabras Clave: flujometría Doppler, arterias uterinas, predicción de preeclampsia. (Fuente: DeCS BIREME).

INTRODUCTION

Worldwide, the incidence of hypertensive disease of gestation ranges between 3-10% [1-3]. On the other hand, in a multicenter investigation carried out in Peru, an incidence between 10 to 14.2% of preeclampsia was reported, within which, the highest values were reported in Lima with 14.2% and then Trujillo with 13.8% [4]. In Latin American countries, it is even reported as the second cause of maternal death [5-7]. Furthermore, mortality due to hypertensive disease of pregnancy in Peru in 2020 was 21.4%, exceeding mortality due to obstetric hemorrhage, which was reported at 19.5% [5]. The assessment of the blood flow wave of the uterine arteries constitutes a marker of trophoblastic invasion and remodeling of the uterine vessels; intermittent perfusion at the end of gestation induces placental oxidative stress, which occurs in late stages of gestation and explains late-onset preeclampsia [8].

The blood flow of the maternal uterine arteries is crucial in maintaining the intrauterine environment and the nutrients and oxygen that the fetus should receive, and its branches, especially the spiral arteries, are morphologically adapted and vasodilated by the two trophoblastic invasions, the first wave between the eighth and tenth week, and the second wave at 18 weeks of gestation [7,8]. Doppler ultrasound is the most used non-invasive technique in hemodynamic evaluation; abnormal findings of uterine artery flow are associated with the prediction of preeclampsia [2,9].

In a review and metanalysis of 74 articles on preeclampsia and Doppler of uterine arteries evaluated in the second trimester, taking into account the abnormal average Pulsatility Index (PI) and the presence of proto-diastolic notch, a Likelihood Ratio (LR) of 21 is reported [10]. It has been shown in a meta-analysis of 27 studies that included 12,994 pregnant women evaluated by Doppler velocimetry of the uterine arteries as a predictor of preeclampsia and intrauterine growth restriction. The patients were divided into two groups: high risk and low risk. The positive likelihood ratio (LR+), in the low-risk group with Doppler velocimetry of altered uterine arteries, was 6.4 (5.7-7.1, 95% CI). In patients in the high-risk group, the likelihood ratio for having preeclampsia was 2.8 (2.3-3.4, 95% CI) [11].

There are, therefore, controversies in the effectiveness of the detection of preeclampsia by Doppler analysis of the uterine arteries and the abnormalities of its different spectral analysis indices. The objective of the present study was to determine the diagnostic accuracy of the four criteria of the Doppler Flowmetry spectral analysis of the uterine arteries in the second trimester and its prediction of preeclampsia.

MATERIALS AND METHODS

Design: A prospective, observational, longitudinal cohort descriptive study was carried out on pregnant women between 22 and 26 weeks who attended the outpatient clinic of Hospital II Chocope for prenatal care during the years 2010 to 2013.

Study population: All pregnant women who attended the outpatient clinic for prenatal care between weeks 22 and 26, without considering the risk of developing hypertensive disease.

Procedure: Following the methodology established by the International Society of Ultrasound in Gynecology and Obstetrics (ISUOG) [12], the transducer was placed transabdominally in the iliac fossae, and the uterine artery was identified at its crossing. virtual", with the external iliac artery. High speeds were used (between 30-50 cm/second), the insonation angle was less than 30 degrees.

The flow velocity waves of the uterine arteries are evaluated with four criteria: One qualitative criterion, the presence of unilateral or bilateral proto-diastolic notch, and three quantitative criteria: Resistance index Pulsatility index S/D index (Systole/Diastole).

To assess the diagnostic accuracy, the likelihood ratio (Likelihood ratio) was taken because they are values inherent to it and independent of the prevalence of the disease. We consider the positive likelihood ratio (LR +) greater than 10 and the negative likelihood ratio (LR -) < 0.1 as highly relevant for decision making [13].

Pulsed Doppler flowmetry was performed with a Mindray DC3 color Doppler ultrasound machine, in triplex mode, and with software for resistance, pulsatility, and systole/diastole indices. The proto-diastolic notch was evidenced by the notch obtained in the spectral analysis.

The program called Statistical Package for the Social Sciences (SPSS) version 15.0 was used to determine the sensitivity, specificity, positive and negative predictive values, obtaining positive and negative likelihood ratios to choose the certainty criteria.

Ethical considerations: This research was approved by the Ethics Committee of the Faculty of Medicine of the National University of Trujillo. The pregnant women undergoing the study signed an informed consent to accept the diagnostic test using color Doppler ultrasound.

RESULTS

669 pregnant women who attended the outpatient Obstetrics Clinic of Hospital II Essalud Chocope were screened. Of this total population, 93 pregnant women presented preeclampsia, which represents an incidence of 13.9%. The maternal age of pregnant women under 19 years of age and over 35 years of age corresponded to 49.5%. According to parity, nulliparas corresponded to 69.8%. Of the total number of pregnant women diagnosed with preeclampsia, those in the preterm preeclampsia group corresponded to 66.6%.

The diagnostic accuracy of the presence of unilateral or bilateral proto-diastolic notch (**Table 1**) for the prediction of preeclampsia presented a Sensitivity (S) of 63.4% and a Specificity (S) of 92.5%; Likewise, the Positive Predictive Value (PPV) is 57.8%; and the Negative Predictive Value (NPV) 94.0%; while the Success Rate was 88.5%, the Likelihood Ratio (+)8.49 and the Likelihood Ratio (-)0.40.

Table 1. Patients according to Unilateral or Bilateral Protodiastolic Notch Results and their relationship with the prediction of preeclampsia.

Notch Protodiastólico	Preeclampsia				Total
	Presence		Absence		
	N°	%	N°	%	
Positive (+)	59	63.4	43	7.5	102
Negative (-)	34	36.6	533	92.5	567
Total	93	100	576	100	669

$X^2_{MN} = 0.83; p > 0.05$

Regarding the diagnostic accuracy of the resistance index > 0.62 (**Table 2**) for the prediction of preeclampsia, a Sensitivity (S) of 61.3% and a Specificity (S) of 91.5% were evident; Likewise, the Positive Predictive Value (PPV) is 53.8% and the Negative Predictive Value (NPV) is 93.6%; while the success rate was 87.3%; the Likelihood Ratio (+) 7.20 and the Likelihood Ratio (-) 0.42

Table 2. Patients according to resistance index results > 0.62 and its relationship with the prediction of preeclampsia.

Preeclampsia					
Resistance Index > 0.62	Presence		Absence		Total
	N°	%	N°	%	
AND (+)	57	61.3	49	8.5	106
NO (-)	36	38.7	527	91.5	563
Total	93	100	576	100	669

$X^2_{MN} = 1.69; p > 0.05$

On the other hand, the diagnostic accuracy of the pulsatility index > 1.60 (**Table 3**) for the prediction of preeclampsia had a Sensitivity (S) of 71.0%; as well as a Specificity (E) of 94.8%; Likewise, a Positive Predictive Value (PPV) of 68.8% and a Negative Predictive Value (NPV) of 95.3% were evident, at the same time, a Success Rate of 91.5%, Likelihood Ratio (+) of 13.63 and Likelihood ratio (-) 0.31

Table 3. Patients according to pulsatility index results > 1.60 and its relationship with the prediction of preeclampsia.

Preeclampsia					
Pulsatility Index > 1.60	Presence		Absence		Total
	N°	%	N°	%	
AND (+)	66	71	30	5.2	96
NO (-)	27	29	546	94.8	576
Total	93	100	576	100	669

$X^2_{MN} = 0.07; p > 0.05$

Finally, the Diagnostic Accuracy of the S/D ratio > 2.60 (**Table 4**) for the prediction of preeclampsia presents a Sensitivity (S) of 58.1% and a Specificity (S) of 61.6%; Likewise, the Positive Predictive Value (PPV) was 19.6% and the Negative Predictive Value (NPV) was 90.1%; while the Success Rate was 61.1%, the Likelihood Ratio (+) 1.51 and the Likelihood Ratio (-) 0.68

Table 4. Patients according to results of systole / diastole index > 2.60 and its relationship with the prediction of preeclampsia.

Preeclampsia					
Systole / Diastole Index > 2.60	Presence		Absence		Total
	N°	%	N°	%	
AND (+)	54	58	221	38.4	275
NO (-)	39	42	355	61.6	394
Total	93	100	576	100	669

$X^2_{MN} = 126.0; p > 0.05$

DISCUSSION

La preeclampsia es una complicación del embarazo, Preeclampsia is a complication of pregnancy, related to a high rate of maternal and perinatal morbidity and mortality [5-7].

Uterine artery Doppler velocimetry is a non-invasive method to evaluate uteroplacental circulation and has been proposed as a screening test for preeclampsia and fetal growth restriction alone or in combination with clinical data and serological biomarkers [1,14-17].

The incidence of preeclampsia found in this study is 13.9% of patients, which is similar to the 10-15% reported by Pacheco et al [4]. In general, an incidence of preeclampsia is established between 5 and 10% [4,6,18]; We must inform that the pregnant women studied are not selected, but when analyzed they are a risk population, which would explain this high incidence compared to other investigations.

When studying the qualitative criteria of a notch presence, whether unilateral or bilateral, we found a Sensitivity of 63% and a Specificity of 92%, the PPV 58% and the NPV 94%, the Likelihood Ratio (+) is 8.5 and the Ratio Likelihood (-) is 0.4

In a study with 120 pregnant women, 65% sensitivity and 66% specificity were reported, if we associated the PI >1.6 with the presence of a notch or notch [19] and this differs from what was reported by [20] who reported 41%. sensitivity and 83% specificity.

It is found that the notch associated with abnormal pulsatility index has a Likelihood Index (LR +) of 21, this association being considered very strong for clinical decision [10].

Regarding the Resistance Index (RI) > 0.62, we report that this criterion has a Sensitivity of 61%, Specificity of 91%, Positive Predictive Value PPV 54% and Negative Predictive Value NPV 93%. The positive likelihood ratio (LR +) 7.2 and the negative likelihood ratio (LR -) 0.4. This criterion is characterized by similar sensitivity and specificity of the notch. When analyzing these Indices, the LR (+) is considered good, but the LR (-) is only rated as regular [21].

In a study carried out on 11,667 pregnant women, 59% of pregnant women detected preeclampsia by the Resistance Index with p > 90, for early-onset preeclampsia, were reported [22].

The results expressed by the S/D Index are the ones with the least certainty. Sensitivity 58% Specificity 61%, LR (+) 1.5 and LR (−) 0.88, both are classified as having poor clinical decision usefulness [13,21].

The sensitivity and specificity reported for the Pulsatility Index, with a cut-off point > 1.6 after 22 weeks of gestation was 71% and 95%. Positive predictive value PPV 68% and Negative predictive value NPV 95% Likelihood ratio LR (+) 13.6 and Likelihood ratio LR (-) 0.31, these results coincide with those reported by several researchers and constitute the main index associated with preeclampsia [1,2,17,23,24].

The positive likelihood ratio (LR +) 13.6 is considered highly relevant and the negative likelihood ratio (LR −) 0.31 is only of regular use in clinical decision making. Currently, most authors point to the average Pulsatility Index p > 95 as the best criteria for Doppler flowmetry of the uterine arteries in predicting preeclampsia [2,10,25,26].
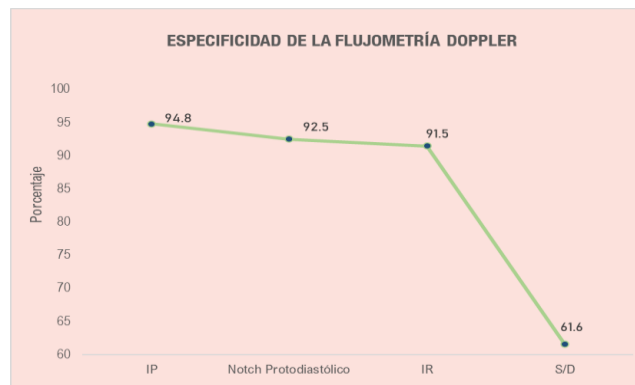
In general, and taking the four criteria established in our research, the sensitivity obtained by the Doppler ultrasonographic criteria and its spectral analysis vary between 58 -71% and on average 63.4%. The specificity between 62-95% and on average 85.1%

The data reviewed express greater certainty if high-risk populations are selected. We must emphasize that in our research the population studied has two risk factors for preeclampsia, the extreme age groups of reproductive age (<19 years and >40 years) and nulliparity close to 70%. The Pulsatility Index is reported as the most reliable due to its Positive Likelihood Ratio (LR +) of 13.6, which tells us that for every positive that is detected in patients without

preeclampsia, approximately 14 cases are detected in patients who do have preeclampsia, considering it a highly relevant value and that would give reliability to subsequent follow-up tests. The Negative Likelihood Ratio of 0.31 tells us that for every 3 patients who test negative in the group of patients with preeclampsia, 100 patients are detected as negative in the group of patients without preeclampsia.
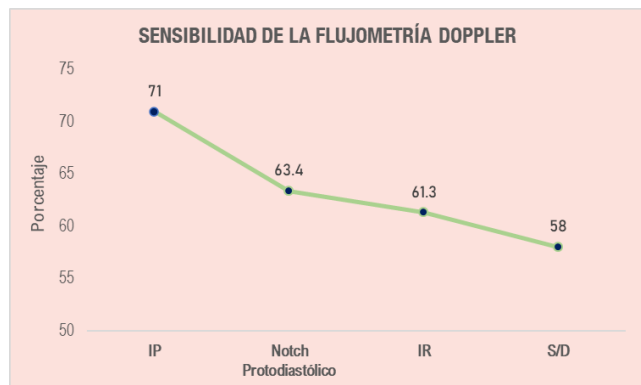
Figure 1. Sensitivity of abnormal Doopler flowometry of the uterine arteries in the prediction of preeclampsia.

Figure 2. Specificity of abnormal Doopler flowometry of the uterine arteries in the prediction of preeclampsia.

CONCLUSIONS

The results obtained in this investigation allow us to conclude:
- The results of the pulsed Doppler spectral analysis of uterine arteries in the second trimester in unselected pregnant women allow predicting preeclampsia with good diagnostic accuracy.
- Of the four criteria studied: the Pulsatility Index is the one with the most diagnostic accuracy, establishing itself as highly relevant, of clinical utility for decision making.

Following the line of research, future research is proposed: to analyze the Pulsatility Index of the uterine arteries in pregnant women in the first trimester, considering P >95 abnormal, focusing on those at risk of suffering from preeclampsia (maternal history and abnormal mean arterial pressure). This evaluation should be repeated in the second trimester to corroborate or rule out the risk of preeclampsia.

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