

# An introduction to determination of mean Uterine Artery Doppler Pulsatility Index during pregnancy for Predicting Adverse Pregnancy Outcome

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## Abstract

**Objective:** Preeclampsia and IUGR are known as the main causes of two adverse complications of pregnancies. Recently, uterine artery Doppler evaluation in first and second trimester has been used for screening of the above pregnancy-related complications.

**Study design:** The goal of this study was to determine the most effective reference range value of mean PI in first, second and third trimesters in order to predict the adverse outcomes. This study was conducted in "Shariati" Hospital; Tehran medical University in the course of January 2014 and November 2017. Participants underwent ultrasound Doppler scans by a perinatologist and were followed up until delivery. Mean PI (as compared between preeclampsia and IUGR groups) and the reference range value of PI (Pulsatility Index) for predicting adverse outcomes were determined. Three hundred and fifty pregnant women were included in this study.

**Result:** Preeclampsia was detected in 132 (37.7%) and IUGR was seen in 134 (38.2%). Mean PI was significantly higher in preeclampsia and IUGR groups.

**Conclusion:** The reference range for mean PI for predicting IUGR was found to be 1.82 with sensitivity and specificity of 53.4% and 87.5% (AUC=0.804 P<0.0001). The reference range for mean PI for predicting Preeclampsia was found to be 1.77 with sensitivity and specificity of 61.1% and 87.6% (AUC=0.761 P<0.0001). Application of uterine artery Doppler could be helpful in prediction of adverse pregnancy outcome.

**Key words:** Mean PI, IUGR, preeclampsia, Doppler.

## Introduction

One of the main causes of maternal and neonatal mortality and morbidity is pre-eclampsia which affects 5-10% of all pregnancies [1]. Preeclampsia and IUGR are two pregnancy related complications. Impaired placentation is considered as an important cause of developing such complications. Abnormal invasion of trophoblasts causes increased impedance in spiral arteries which are the main branches of uterine arteries. Loss of the musculo-elastic properties during the formation of utero-placental arteries causes physiologic changes. These changes result in an increased blood flow to the placenta and the fetus [12]. A disturbance in this physiologic process leads to an increase in vascular resistance and impedance to blood flow [12]. Doppler evaluation of uterine arteries provide a valid means of assessing utero-placental resistance to blood flow[13].

Impaired placentation is considered as the main cause of preeclampsia [2]. Failure or inadequate trophoblastic invasion into the spiral arteries result in impaired placentation which may lead to an increase of impedance in spiral arteries [2]. Intrauterine growth restriction (IUGR) is an obstetric problem which affects 10-15% of all pregnancies[3].

On the other hand high resistant circulation has been considered to be associated with pregnancy related adverse effects such as preeclampsia and IUGR (Intrauterine growth restriction) [4].

Uterine artery (UtA) Doppler ultrasound is considered as a non-invasive modality which shows utero-placental perfusion [5]. The most common Doppler index currently in use widely is PI (Pulsatility Index).

Recently, uterine artery Doppler evaluation in first and second trimester has been used for screening of pregnancy related complications [5, 6] while the results show wide range of sensitivity and specificity [7, 8]. The goal of this study was to determine the reference range of mean PI during pregnancy for predicting adverse outcomes.

## Results

Three hundred and fifty pregnant women were included. Demographic characteristics are summarized in Table 1. One woman had history of smoking.

**Table 1: Demographic characteristics of patients.**

Variable	Value
Maternal age (year)	31.16 ± 7.18
Maternal weight (kg)	78.97±12.75
Systolic blood pressure (mmhg)	112.38±7.80
Diastolic blood pressure (mmhg)	71.65±7.10
Gravidity (median)	2.71±1.26
Parity (median)	0.77±0.82
Abortion (median)	0.83±0.90
Ectopic pregnancy	0.09±0.29
Birth weight	2698±780

## Material and method

We conducted this cohort study in “Shariati” Hospital (affiliated to Tehran University of Medical Sciences) between January 2014 and August 2017. The women were followed up until delivery. Women with singleton pregnancies with gestational age between 11 to 40 weeks were enrolled.

Exclusion criteria were: gestational diabetes, immune disease, renal disease, treatment with aspirin or heparin, chromosomal or structural fetal abnormalities. We asked participants to fill out informed consent forms. Data regarding maternal age, weight, blood pressure, history of smoking, medical history, drug history, neonatal birth weight, maternal preeclampsia during pregnancy and IUGR were recorded.

Participants underwent ultrasound Doppler scans by a perinatologist using Accuvix XQ (Medison, Korea), Acuson Sequoia 512, Mountain View, (Siemens Medical Solutions CA and Philips IU 22) by means of trans-abdominal transducer. By placing the transducer on the lower quadrant of the abdomen, the performer conducted uterine artery Doppler examination. The angle of insonation was kept less than 30 degrees.

To obtain waveforms, the pulsed-wave Doppler was applied. After obtaining three consecutive waveforms on each examination, then PI was recorded for both right and left uterine arteries and the mean PI was calculated. Mean PI was compared with preeclampsia and IUGR groups and the reference range value of PI for predicting adverse outcomes was determined.

All data were analyzed using SPSS software version 20 (SPSS Inc., Chicago, IL, USA). Data were presented as Mean± SD . Independent sample t test was used for comparison of continuous variables. ROC curve was used to determine optimal reference range of mean PI. Area under the Curve (AUC) was calculated. P value less than 0.05 was considered as significant.

Table 2 shows the calculated reference intervals for mean uterine PI from 11w to 40w+6d:

**Table 2**

GA(Weeks)	5th centile	50 centile	95 centile
11	1.46	2.59	3.58
12	1.24	2.78	3.73
13	1.18	2.69	3.76
14	0.94	2.71	3.23
15	0.96	2.46	2.98
16	0.94	1.82	3.17
17	1.06	1.92	2.56
18	0.80	1.61	1.99
19	0.91	1.23	2.60
20	0.95	2.03	2.62
21	0.83	1.65	2.16
22	0.86	1.57	2.86
23	0.65	1.46	1.99
24	0.58	1.34	1.77
25	0.63	1.00	1.48
26	0.56	0.85	0.99
27	0.92	1.70	2.36
28	0.69	1.47	2.14
29	0.72	1.21	1.91
30	0.60	0.98	1.73
31	0.51	0.82	0.94
32	0.47	0.66	0.91
33	0.54	0.94	1.13
34	0.49	0.83	1.02
35	0.55	0.81	1.25
36	0.62	0.77	1.34
37	0.55	1.05	1.44
38	0.50	0.67	1.00
39	0.50	0.65	1.00
40	0.48	0.61	0.98
41	0.50	0.62	1.04

Mean PI was significantly higher in preeclampsia group (Table 4).

**Table 3: Mean PI in preeclampsia and normal group**

	Preeclampsia	Normal	P value
Mean PI	1.77±0.81	1.07±0.62	<0.001

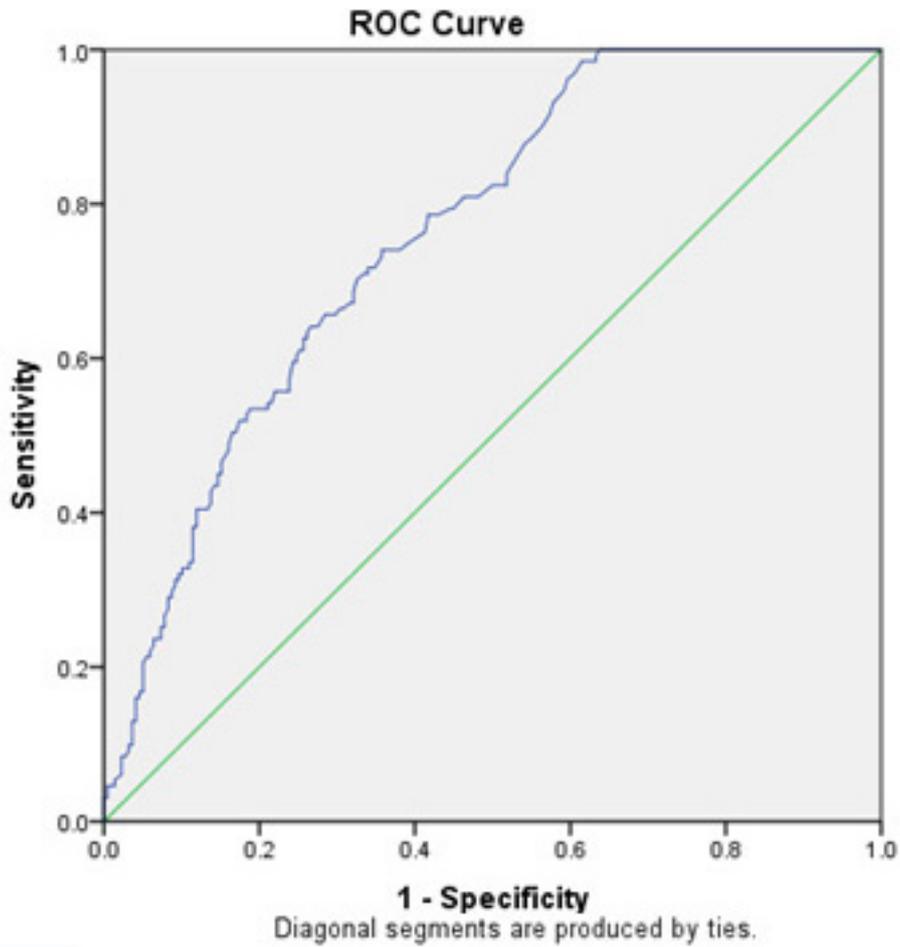
Mean PI was significantly higher in IUGR group (Table 4).

**Table 4. Mean PI in IUGR and normal group**

	IUGR	Normal	P value
Mean PI	1.82±0.76	1.05±0.62	<0.001

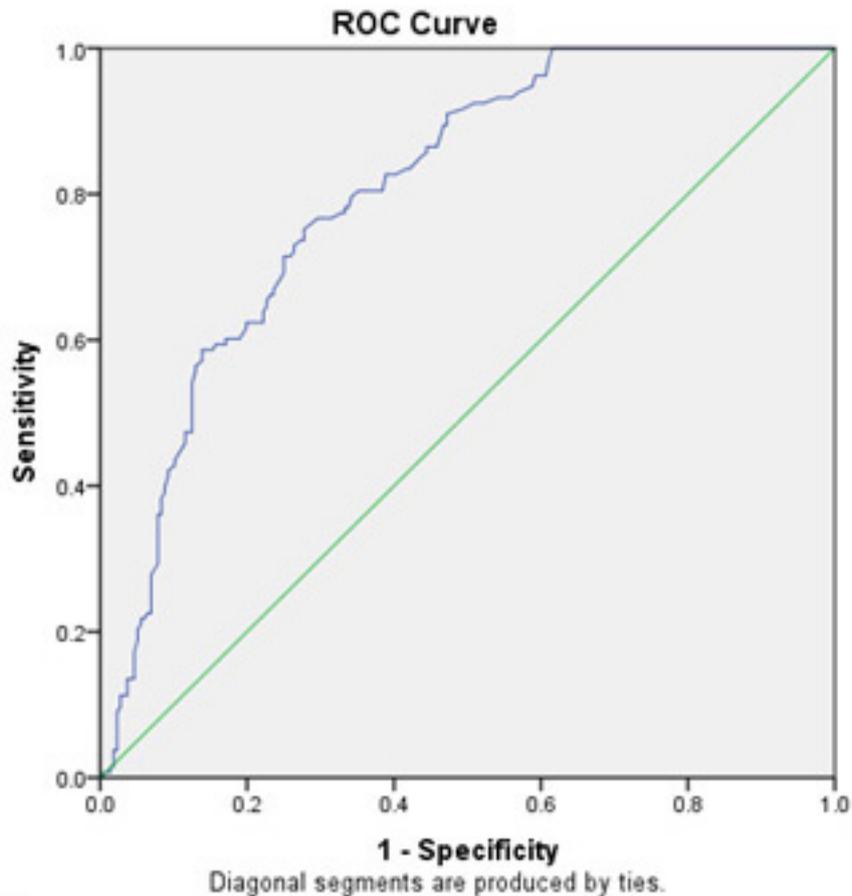
We concluded that the best reference range value for mean PI for predicting Preeclampsia is 1.77 with sensitivity and specificity of 61.1% and 87.6% (AUC=0.761 P<0.0001) (Figure 1 - next page).

Figure 1



We also concluded that the best reference range value for mean PI for predicting IUGR is 1.82 with sensitivity and specificity of 53.4% and 87.5% (AUC=0.804 P<0.0001) (Figure 2).

Figure 2



## Discussion

The result of this study showed that mean PI of uterine arteries is significantly higher in pregnancies complicated with IUGR and preeclampsia.

In a former study in 2013, authors had evaluated mean PI of uterine arteries in 435 normal pregnant women at 18-24 and 30-34 weeks of gestation and had reached results very close to those of our study [2]. In the mentioned study the mean of uterine arteries in pregnancy with adverse outcomes was 1.27 compared with 0.99 in normal pregnancies ( $p < 0.001$ ) [2]. Another study, by Saloni et al reported mean PI in normal pregnancies as 0.7 and 0.8 in women with adverse pregnancy outcome (preeclampsia, SGA, gestational hypertension)[9].

Barati et al evaluated Doppler index of uterine artery in 379 pregnant women with gestational age between 16 and 22 weeks and found that 17 cases (4.5%) had abnormal uterine artery Doppler index. They followed those cases and observed that Pre-eclampsia occurred more significantly in groups with abnormal Doppler index than normal indexes. They considered the reference range value of 1.45 as the best value for mean PI for predicting adverse pregnancy outcome with a sensitivity of 79% and specificity of 95.5%[10].

In that study, the best value for mean PI for predicting preeclampsia is 1.45 with sensitivity and specificity of 93% and 91% in the first trimester while the best value for mean PI for predicting preeclampsia is 1.43 with sensitivity and specificity of 100% and 82% in the second trimester.

Becker et al evaluated uterine artery Doppler indexes in 7,508 pregnant women between 20 and 23 weeks of gestation and reported a significant relationship between the increase of impedance and the increase of adverse pregnancy outcomes such as pre-eclampsia, IUGR, intrauterine/neonatal deaths, and preterm delivery[11].

In the above study, mean PI of uterine arteries was significantly higher in the IUGR group than the normal group. The best value for mean PI for predicting IUGR was 1.62 with sensitivity and specificity of 96% and 83% in the first trimester and the best value for mean PI for predicting IUGR was 1.14 with sensitivity and specificity of 100% and 62% in the second trimester.

In a different study conducted by Oloyede, 430 pregnant women with gestational age between 22nd and 23rd weeks underwent uterine artery ultrasound evaluation. They reported mean PI of 0.9 in normal pregnancies and 1.2 in pregnancies complicated by adverse outcomes (impaired placentation, mainly IUGR and preterm birth). The difference was not statistically significant.[12].

Our study mainly focused on comparing the uterine artery Doppler indexes in first, second and third trimesters simultaneously. We conducted this study in a tertiary hospital with a single perinatologist in charge. With regard to the results of the afore cited studies, the small difference

in uterine artery PI seen in our study may be attributed to a degree of demographic features in the limited number of women in our study.

The mean PI obtained from our study for predicting IUGR was 1.82 with sensitivity and specificity of 53.4% and 87.5% (AUC=0.804  $P < 0.0001$ ). The mean PI for predicting Preeclampsia was found to be 1.77 with sensitivity and specificity of 61.1% and 87.6% (AUC=0.761  $P < 0.0001$ ).

## Conclusion

Application of uterine artery Doppler as an easy and available diagnostic method can be helpful in the prediction of adverse pregnancy outcome that potentially causes catastrophic maternal or neonatal morbidities and mortalities. Upon identifying the high risk pregnant women, we would be able to reduce the possible catastrophies by using proper medication and known therapies.

## Recommendation

Regarding the importance of maternal morbidity and mortalities in women afflicted with pre-eclampsia and also regarding neonatal health and their quality of future life in IUGR cases, we have found it wise and of cost benefit to measure mean uterine artery PI during screening tests in pregnancy in an effort to find high risk cases. We must note that our PI findings relate to a small group and cannot be generalized to the whole Iranian population. This issue can be the subject of further academic work.

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