

# Reference ranges Of Uterine Artery Doppler Indices (Pulsatility index and Resistivity index) in pregnant women of Eastern part of Uttar Pradesh INDIA

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## Research Article

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# Abstract

## Objective

Preeclampsia and eclampsia are one of major cause of maternal mortality. Various parameters like pulsatility index (PI) and resistivity index (RI) of color Doppler are helpful in detection of preeclampsia and intrauterine growth restriction. The reference ranges of the various parameters like uterine artery PI and RI are mainly from western countries. The reference range for Indian Population is lacking. So the objective of the study is to construct reference range of uterine artery for women from eastern India.

## Material and Method

In this study, total 201 pregnant patients were included. Color Doppler of normal pregnant women was done at 18 to 22 weeks and then followed up at 28 to 32 weeks gestation. The uterine artery PI and RI was measured during pregnancy. The obtained data were tabulated and 5th, 25th, 50th, 75th, 90th and 95th percentile was calculated. The reference range was constructed according to gestational age starting from 18 to 22 weeks and then from 28 to 34 weeks. Statistical analysis was performed using SPSS.

## Result

The main parameter observed are pulsatility and resistivity index of left and right uterine arteries first at 18 to 22 weeks and then followed up at 28 to 34 weeks. Our data suggests that as the gestational age increases both pulsatility and resistivity index decreases. The cut off value for reference range was taken up to 95th percentile. Anything above 95th percentile is abnormal. The reference range for left uterine artery pulsatility index was found to be 1.19 to 1.16 at 18 to 22 weeks, 1.09 at 28 weeks while 0.89 at 34 weeks. Similarly, the reference range for resistivity index was found to be 0.61 at 18 to 22 weeks while it decreases to 0.54 at 28 to 34 weeks.

## Conclusion

Reference range of uterine artery doppler indices for the local population is very useful tool to early prediction of Preeclampsia and IUGRs of that population and can aid in timely treatment of mother and baby. Our data shows decrease in pulsatility and resistivity index with increase in the gestational age.

# Introduction

Doppler plays an important role in early prediction and diagnosis of preeclampsia and intrauterine growth restriction. In 1983 Campbell and his group first described the association of PE with uterine artery waveform and the appearance of notching together with a high resistance index<sup>1</sup>. They observed that abnormal uterine waveform was associated with more protienuric hypertension. This Doppler is safe, non-invasive and generated the interest to analyze uterine artery till date.

During pregnancy, physiological changes occur at uterine vasculature. It has been shown that as the gestational age increases the resistance to blood flow in uterine vasculature decreases. This change in pregnancy is because of invasion of spiral arterioles by trophoblast<sup>2</sup> Women who failed to modify uterine artery blood flow by 20 weeks of gestation are at greater risk of pre-eclampsia. If there is absence of infiltration of spiral arteries by trophoblast then preeclampsia is very common<sup>3,4</sup>. The maternal side of fetoplacental circulation is seen by uterine artery parameters. The main parameters of Doppler used to measure these uterine blood flow are uterine artery pulsatility index (PI), and resistivity index (RI).

The present study aims to develop the reference range of uterine artery indices for the North-East Indian population. We normally use parameters of western countries but two populations are ethnically different and hence there is need to develop the reference range for our local population. In this study we made reference range of uterine artery pulsatility index (PI) and resistivity index (RI) at 18 to 22 weeks gestation and at 28 to 34 weeks gestation. Generally, at 18 to 20 weeks pregnant women are advised to opt for level-2 ultrasonography and hence color Doppler of uterine artery can be performed at that time without any difficulty. It will be cost effective and save extra visit to hospital. At 28 to 32 weeks gestation time when most of women go for routine screening for color Doppler to rule out IUGR and any other pathology in fetomaternal circulation, measuring pulsatility index (PI) and resistivity index (RI) will be cost effective as well as time saving. This study will provide reference range for our own population of eastern part of India and dependence on western data will be eliminated.

## **Materials And Methods**

### **Patient Recruitment**

This study was conducted in department of Obstetrics and Gynecology in collaboration with department of Radiology. It is a prospective observational study which includes patient recruited over a period of four years (Jan 2017 to Dec 2020). Ethical clearance was taken from Institutional Ethical Committee (EC/2086). Informed consent was taken from all the patients included in this study. A total of 250 patients have been examined in their 18-22 weeks of pregnancy for their pulsatility and resistivity index. The same patient were further followed up in their 28-34 week of pregnancy.

#### **Case Definition**

Healthy pregnant women in 18-22 weeks of gestation

#### **Inclusion and Exclusion criteria**

Normal pregnant women in second trimester of pregnancies were included for the study. Pregnant lady with abnormalities like eclampsia, preeclampsia and others were excluded from the study.

#### **Follow Up**

At the start of study there were 250 patients but in 50 patients follow up could not be done at 28 to 32 weeks so these patients were not included.

The whole study is accomplished in two steps:

1. Selection of 250 patients from the study population
2. Exclusion of 50 patients due to lack of follow-up
3. A total of 200 cases were finally included in the study and analysed

### **Measurement of pulsatility and resistivity index**

Color Doppler of pregnant ladies at 18 to 22 weeks and then followed up color Doppler done at 28 to 34 weeks. This was cost effective because patient did not have to spend extra money as there was no funding in this study. This color Doppler was done for early prediction of preeclampsia. The patients who have normal pregnancy and normal color Doppler values were included in the study. The patient having anti-phospholipid syndrome and patient on aspirin therapy were excluded from the study. The patients having fetuses with growth restriction and congenital anomalies are also excluded.

The uterine artery Doppler can be done by two routes. It can be done trans-vaginally as well as by trans-abdominally. The uterine artery is identified on color Doppler. Uterine artery appears to cross the external iliac artery. The angle of insonation was kept less than 30 degree. Doppler gate was put on the entire width of vessel. Then PI and RI of both left and right uterine artery were measured. Uterine artery parameters are not changed by fetal movement and maternal respiration. The angle of insonation should be as close to 0 degree as possible.

### **Formulae to calculate Pulsatility and Resistivity index**

**Pulsatility index = S-D/ Timed average velocity**

**Resistivity Index = S-D/S**

**S = Peak systolic velocity**

**D = End Diastolic velocity**

All the observations were recorded in the excel sheet and SPSS was used for statistical analysis.

We calculated 5<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup> and 95<sup>th</sup> percentile for pulsatility index and resistivity index of left and right uterine artery. These percentiles were calculated for each group of gestational age i.e first group from 18 to 22 then in second group of same patients from 28 to 34 weeks of gestation.

### **Statistical analysis**

The data was statistically analyzed using software SPSS v 17.0 for windows.

# Results

In this study nomogram tables for left and right uterine artery pulsatility and resistivity index for Indian population were made. There are total 8 tables. Out of which four tables for right uterine artery and four tables for left uterine artery. In each artery pulsatility and resistivity index is measured first starting from 18 weeks to 22 weeks and then from 28 weeks to 34 weeks.

Reference range tables:

In Table 1 pulsatility index of left uterine artery starting from 18 weeks to 22 weeks is shown. We can see that as the gestational age increases the value of pulsatility index decreases. But at 21 weeks it has shown some rise but again at 22 weeks it decreases. So any value above 1.19 at 18 weeks and  $> 1.16$  at 22 weeks is abnormal.

Table 1  
Pulsatility index of Left uterine artery group 1 ( 18-22 weeks)

Gestational age (Weeks )	Percentile					
	5th	25th	50th	75th	90th	95th
18	.5160	.6600	.8300	1.0350	1.0800	<b>1.1910</b>
19	.4200	.6800	.7850	.9050	1.1140	<b>1.1500</b>
20	.4300	.6650	.8100	.8100	1.0440	<b>1.1660</b>
21	.5000	.6400	.7800	.8500	1.1480	<b>1.1900</b>
22	.3830	.5800	.6800	.8000	1.0500	<b>1.1685</b>

Table 2  
Pulsatility index of Right uterine artery group 1 ( 18-22 weeks)

Gestational age (Weeks )	Percentile					
	5th	25th	50th	75th	90th	95th
<b>18</b>	.4535	.7200	.9000	.9800	1.0900	<b>1.1800</b>
<b>19</b>	.3875	.6800	.9200	1.1975	1.3200	<b>1.3275</b>
<b>20</b>	.4300	.5700	.7600	.9300	1.1060	<b>1.2900</b>
<b>21</b>	.3700	.6350	.7900	.9625	1.0080	<b>1.0500</b>
<b>22</b>	.3775	.5125	.7050	.8600	.9500	<b>1.0275</b>

Tab 2 shows that PI of right uterine artery also decreases from 1.3 to 1.02 as the gestational age increases.

Table 3  
Pulsatility index of Left uterine artery group2 ( 28 to 34 weeks)

Gestational age (Weeks)	Percentile					
	5th	25th	50th	75th	90th	95th
<b>28</b>	.6400	.6500	.7350	.9525	1.1800	<b>1.1900</b>
<b>29</b>	.5000	.5425	.7450	.9925	1.0500	<b>1.0500</b>
<b>30</b>	.3400	.5700	.6700	.8400	1.0100	<b>1.1400</b>
<b>31</b>	.4230	.6050	.6900	.7675	1.0380	<b>1.1520</b>
<b>32</b>	.3900	.5825	.6800	.8175	.8900	<b>1.1200</b>
<b>33</b>	.2040	.5500	.6600	.9250	1.1040	<b>1.1310</b>
<b>34</b>	.3500	.4500	.5800	.8225	.8500	<b>.8500</b>

As shown in tab 3 the trend of Pulsatility Index of left uterine artery decreases from 1.19 to 0.8500 as the gestational age progresses from 28 weeks to 34 weeks

Table 4  
Pulsatility index of right uterine artery group 2 ( 28-34 weeks)

Gestational age (Weeks)	Percentile					
	5th	25th	50th	75th	90th	95th
<b>28</b>	.4600	.4900	.6100	.7200	.9740	<b>1.0400</b>
<b>29</b>	.4700	.5375	.7400	.7925	.8100	<b>.8100</b>
<b>30</b>	.3705	.5075	.6900	.8175	.9590	<b>1.1410</b>
<b>31</b>	.4790	.5650	.6500	.7600	.7840	<b>.8390</b>
<b>32</b>	.4200	.5200	.6200	.8175	.9100	<b>.9290</b>
<b>33</b>	.3935	.4450	.5900	.8200	.9800	<b>1.0680</b>
<b>34</b>	.4400	.4700	.5500	.8200	.8900	<b>.8900</b>

As seen in tab 4 the PI of Right uterine artery also decreases from 1.04 to 0.8900. but there is slight increase from 29 week to 30 weeks and then from 32 to 33 weeks.

Table 5  
Resistivity index left uterine artery group 1 (18-22 weeks)

Gestational age (weeks)	Percentile					
	5th	25th	50th	75th	90th	95th
18	.3900	.4600	.5600	.5900	.6100	<b>.6140</b>
19	.3400	.4500	.5000	.5800	.6140	<b>.6200</b>
20	.3670	.4625	.5250	.5550	.6000	<b>.6100</b>
21	.3800	.4600	.5050	.5300	.5960	<b>.6200</b>
22	.3000	.4300	.4650	.5300	.6000	<b>.6100</b>

In tab 5 the value of Resistivity Index ranges from 0.6140 to 0.6100. Anything above these values i.e >95th percentile is abnormal.

Table 6  
Resistivity index of right uterine artery group 1 (18-22)

Gestational age (weeks)	Percentile					
	5th	25th	50th	75th	90th	95th
18	.4000	.5000	.5800	.6000	.6300	<b>.6300</b>
19	.3600	.4275	.5300	.6050	.6220	<b>.6400</b>
20	.3005	.4125	.4800	.5575	.6000	<b>.6190</b>
21	.3300	.4125	.5200	.5775	.6100	<b>.6100</b>
22	.2900	.3900	.4800	.5600	.5800	<b>.5800</b>

As seen in tab 6 The RI of right uterine artery is 0.6300 at 18 weeks and 0.5800 at 22 weeks. It also shows that as the gestational age advances there is decrease in the value of resistivity index.

Table 7  
Resistivity index left uterine artery group 2( 28-34 weeks)

Gestational age (weeks)	Percentile					
	5th	25th	50th	75th	90th	95th
28	.4400	.4500	.4750	.5000	.5310	<b>.5400</b>
29	.4000	.4000	.4600	.5400	.5400	<b>.5400</b>
30	.3500	.4250	.4600	.4925	.5440	<b>.5500</b>
31	.3300	.4275	.4600	.4725	.4850	<b>.4900</b>
32	.3150	.4050	.4500	.5050	.5300	<b>.5400</b>
33	.3700	.4250	.4400	.4900	.5280	<b>.5600</b>
34	.4500	.4500	.5100	.5300	.5400	<b>.5400</b>

The RI of of rt uterine artery is 0.5400 at 28 weeks and 0.4900 at 31 weeks. In almost all groups the 95th percentile value is 0.5400

Table 8  
Resistivity index of right uterine artery group 2 (28 -34 weeks)

Gestational age ( weeks)	Percentile					
	5th	25th	50th	75th	90th	95th
28	.3600	.3850	.4800	.5200	.5600	<b>.5600</b>
29	.3900	.4025	.4500	.5125	.5300	<b>.5300</b>
30	.3000	.4175	.4600	.5200	.5610	<b>.5700</b>
31	.3800	.4325	.4600	.4975	.5300	<b>.5525</b>
32	.3100	.3900	.4400	.5050	.5500	<b>.5600</b>
33	.3225	.3800	.4450	.5450	.5550	<b>.5600</b>
34	.3200	.3675	.4350	.5600	.5600	<b>.5600</b>

In tab 8 the resistivity index of right uterine artery is 0.5600 at 28 weeks and also at 34 weeks. It has initially shown decrease but later it remain constant.

## Discussion

Preeclampsia and eclampsia are major cause of maternal mortality and morbidity<sup>5</sup>. Uterine arterial flow changes during gestational period and can be used as a parameter to diagnose the preeclampsia and eclampsia. Doppler is very important investigation during pregnancy. It is an established method for the

monitoring fetal health as well as mother uterine health. Uterine artery Doppler plays an important role in early diagnosis of preeclampsia and IUGR. At 18 to 22 weeks routine anomaly scan is done and at 28 to 34 weeks ultrasound with color Doppler is done to rule out any growth restriction in fetus. Only these gestational ages were taken because it is cost effective and reduces unnecessary visit to hospital. Pulsatility index has been considered as the excellent parameter of Doppler study. The present study has formulated the reference range for uterine artery Doppler PI and RI at gestational age 18 to 22 weeks and also for gestational age 28 to 34 weeks in Indian population. The studies for reference ranges for Indian population are very scanty.

In present study, we have shown that the pulsatility index of left uterine artery decreases as the gestational age increases (Table 1). Our findings correlates with the findings of by Merz E et al.

<sup>6</sup> and also by Gómez O et al. <sup>7</sup>. The same result have been obtained by Peixoto AB et al. <sup>8</sup>

The values of 95th percentile for pulsatility index are lower in our study as compared to Merz E et al.<sup>6</sup> and Gómez O et al. <sup>7</sup>. If the color Doppler is done transabdominally the value of PI is less as compared to if done transvaginally<sup>9</sup>. The resistivity index also decreases as the gestational age increases from 18 to 22 weeks which is also supported by Merz E et al. <sup>6</sup>.

In follow up at 28 to 34 weeks both resistivity index and pulsatility index also decreases or remain constant with increase in the gestational age. From this study we formulated 5th to 95th percentile values for Indian population. Any value above 95th percentile will be abnormal<sup>10</sup>. Alves JAG et al. has also developed the reference range values for uterine artery pulsatility index and resistivity index

## Limitation Of The Study

The color Doppler in all patients was not done from department of Radiology. Many color Doppler were done from outside also. So inter observer variation was there. The machine used for doing color Doppler is also different at different centers. It was difficult to convince normal patient to do follow up color Doppler because it was costly and there was no funding in this study. This is small sample size. It need more sample size and multi centre trial for better result and formulation of reference range.

## Conclusion

Doppler is very good investigation for diagnosis of preeclampsia and IUGR so that timely management can be done for better outcome. The reference range of uterine artery pulsatility index and resistivity index for our populations are very useful for early prediction and diagnosis in obstetrics. In this study new charts for pulsatility and resistivity index of uterine artery were made at gestational age from 18 to 22 weeks and also for gestational age 28 to 34 weeks. The 95th percentile value may act as a cut off to detect abnormalities.

# Declarations

**Conflict of interest:** There is no conflict of interest.

**Funding :** There is no funding

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