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Uterine Artery Doppler Indices in the Second and Third Trimester in Women with Normal Singleton Pregnancy

Chijioke Chukwuemeka Umeokafor,[1] Chinekwu Skye Nwosu,[1] Eric Okechukwu Umeh,[1] Chisolum Ogechukwu Okafor,[1] Charles Ikechukwu Okafor,[2] Kenneth Chukwudi Eze,[1] Chijioke Brenda Nwammuo,[1] and Kelechi Collins Elendu.[1]

[1]Department of Radiology, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria.
[2]Department of Obstetrics and Gynaecology, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria.

ABSTRACT

Background: The maternal mortality rate has declined since 1990 but many women still die from pregnancy-related causes and during childbirth, especially in developing countries like Nigeria. Doppler ultrasound has a non-invasive, accurate method of evaluating the uterine arteries and it reflects any changes in placental perfusion through the Doppler velocimetry. **Objectives:** To determine the pulsatility index (PI), resistivity index (RI), end-diastolic velocity (EDV), peak systolic velocity (PSV), and systolic/diastolic ratio (S/D) of the right and left uterine arteries in the second and third trimesters of a normal singleton gestation. **Materials and Methods:** A study of 176 singleton pregnancies of patients 18yrs and above taken at 21-25 weeks and 31-35 weeks gestation for each patient. Blood pressure and urine protein were checked at each visit. **Results:** The right and left uterine arteries respectively in the second trimester; PI - 1.01+/-0.26, 1.03+/-0.27, RI - 0.598+/-0.07, 0.606+/-0.09, PSV - 88.33+/-44.70, 92.60+/-50.56, EDV - 38.46+/-22.01, 41.35+/-26.94, S/D - 2.43+/-0.58, 2.44+/-0.59. The right and left uterine arteries respectively in the third trimester; PI - 0.89+/-0.22, 0.88+/-0.21, RI - 0.55+/-0.07, 0.54+/-0.06, PSV - 106.69+/-57.66, 139.83+/-56.33, EDV - 50.14+/-23.91, 66.99+/-28.30, S/D - 2.15+/-0.49, 2.14+/-0.37. A statistically significant difference in the parameters from the second to the third trimester, an increase in the PSV and EDV value, and a decrease in the PI, RI, and S/D values. **Conclusion:** A valuable regional nomogram for singleton gestation has been established with which to compare Doppler indices values in high-risk pregnancies.

Keywords; Doppler Indices, Gestation, Pregnancies, Second, Third trimester, Right and left uterine arteries.

INTRODUCTION

Uterine artery Doppler velocimetry is a measure of the maternal side of the placental circulation. Thus in patients who develop preeclampsia, there is a pathological increase in placental vascular resistance which is detectable by abnormal Doppler flow studies of the maternal uterine vessels.[1] When compared with cardiotocography in terms of fetal surveillance, Doppler velocimetry is more specific and sensitive.[2] Uterine

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Correspondence:
Dr Nwosu Chinekwu .S.
Department of Radiology, Nnamdi Azikiwe University Teaching Hospital, Nnewi

Tel: *08033132512*
Email:
cs.nwosu@unizik.edu.ng

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artery Doppler interrogation is also important for monitoring high-risk pregnancies. This offers an avenue for identifying possible complications from insufficiency of uteroplacental circulation on both the mother (uteroplacental) and fetus (fetoplacental) either during pregnancy, labor, or delivery. The uteroplacental circulation is usually established at the end of the first trimester and begins with the flow of maternal blood into the intervillous space around the terminal villi through decidual spiral arteries. The functional unit of the fetal-maternal exchange of nutrients and oxygen occurs is the terminal villi.

During pregnancy, modification of these vascular structures occurs with subsequent development of neovascularization within the placenta and fetus as well as redistribution of blood flow and alteration in circulating blood volume.[3]

Hypertensive disorders in pregnancy cause impairment of this normal vascular modification/remodeling leading to abnormal vascular perfusion which can be detected on the umbilical and uterine artery Doppler velocimetry. The vascular modifications can lead to some obstetric complications like preeclampsia, fetal intrauterine growth restriction (IUGR), intrauterine fetal death (IUFD), and placental abruption. In a normal pregnancy, impedance to blood flow in the uterine artery decreases as the gestational age increases[4] such that with hypertension in pregnancy, there will be an increase in vascular resistance at the uterine artery with attendant decreased placental perfusion.

There is a global effort aimed at reducing the high maternal and infant mortality rate in Nigeria and the world at large. The mortality rate in Nigeria, for example, hypertension, affects feto-maternal circulation. Thus, proper assessment of the feto-maternal circulation in normal singleton pregnancies using the uterine and umbilical arteries is necessary. Accurate prediction of the effect of hypertensive disorders in pregnancy on maternal circulation by careful examination of the uterine artery is therefore paramount to providing appropriate antenatal surveillance and therapy in an effort to improve perinatal outcomes. This study is to determine the Pulsatility index (PI), Resistivity index (RI), Peak systolic velocity (PSV), End diastolic velocity (EDV), and Systolic/ diastolic ratio (S/D) of the right and left uterine arteries of normal singleton pregnancy during the second and third trimesters.

MATERIALS AND METHODS

This is a prospective, longitudinal clinical study conducted at the Radiology Department of a Tertiary hospital. Ethical clearance was obtained from the ethical committee of the hospital before the commencement of the study. An informed, written, and signed consent was obtained from each of the subjects prior to data collection. All confirmed pregnant subjects of 18 years and above with singleton gestation irrespective of parity or previous obstetric history were included in this study at an appropriate gestational age (GA) of 21-25 weeks for the second and 31-35 weeks for the third trimester with normal blood pressure and urine protein test done at each visit prior to the ultrasound scan. No subjects with multiple gestations and long-standing medical conditions like diabetes or hypertension or uterine pathologies like uterine fibroids were admitted into the study

Sampling Size Determination: The sample size was determined using the formula**;**

$$n = \frac{Zr^2S^2}{E}$$

Where n = minimum sample size, Zr is the standard normal coefficient = 1.96 for 95% confidence interval, S is the standard deviation = 0.2 from a previous study[36] and E is the margin of error = 0.05 for I5% precision.(A)

The sample size of 141 was used for the study in order to account for or preclude attrition as well as to improve the statistical accuracy/reliability of the study.

Sampling Method

Consecutive recruitment of all pregnant subjects who met the criteria and gave consent to the study

was done until the sample size was reached. A proforma form was used to document the patient's demographic and obstetric data including Parity. At each visit of the scan at the second and third trimesters, the blood pressure was measured to rule out hypertension, and urine protein was ascertained using the dipstick urinalysis. In this study, we scanned patients at 21-25 weeks and 31-35 weeks of GA because of the following reasons; Pregnancy-induced hypertension does not occur before 20 weeks in women with previously normal blood pressure. While gestational diabetes usually develops around the 24th week of pregnancy and screening is done between 24-28 weeks of pregnancy, women at high risk are likely screened in the first trimester.

Study Population and Technique

A total of 141 singleton pregnant subjects referred to the Radiology Department for routine obstetrics ultrasound from the Antenatal clinic of the tertiary hospital were recruited into the study. For the patients with reliable dates of their last menstrual period (LMP), the gestational age was calculated. For the women unsure of their LMP, dating was based on earlier ultrasound scans done in the first 13 weeks of the pregnancy. These dates were confirmed with ultrasound estimation at the time of recruitment.

Equipment

A 2-D ultrasound machine ALOKA PRO SOUND SSD-3500SX (ALOKA Inc, Tokyo, Japan 2008) with Doppler capability fitted with a curvilinear transducer with a frequency of 3.5-5 MHz was used for this study. An initial scan was done to confirm single gestation, document obstetric parameters, and rule out any uterine or fetal anomaly.

The uterine artery Doppler Technique

The patient was placed in a semi-recumbent position with a slight lateral tilt to minimize the risk of developing supine hypotension due to Inferior vena cava (IVC) compression. The patient's abdomen was properly exposed from the xiphisternum to the pubic symphysis and a coupling gel was applied. The uterine artery was located via the trans-abdominal route by placing the curvilinear transducer longitudinally on the skin over the right iliac fossa just medial to the iliac crest and the beam focused on the lower para-cervical area with a medial angulation.[6] On B-mode, the external iliac vessels were first identified as two linear parallel sonolucent structures anterior to the psoas muscle. After that, the uterine artery was identified on color mode as it crossed the external iliac vessels [6] almost just after its origin from the internal iliac artery. One centimetre (cm) above this point of crossing over was the sampling point. The wall filter was kept low (50-60Hz) and an appropriate angle of insonation was set above 20^0 and below 60^0. Both uterine arteries were examined. Measurements were made on three consecutive uniform waveforms after a recording of at least six consecutive spectral waveforms of similar size and shape.[6] Flow velocity waveforms (FVWs) obtained from the right and left uterine arteries were computed automatically. The ultrasound machine program displayed the individual cardiac cycles and also computed the PSV, EDV, RI, and PI indices. The S/D ratio was calculated by dividing the PSV by the EDV. Three such flow velocity waveforms (FVWs) were obtained for each artery and the average values for the flow velocity and indices were recorded.

Data Management

Data obtained from the study were analyzed using SPSS (Statistical Package for Social Sciences, IBM, version 21.0 New York, U.S.A., 2011). Socio-demographic characteristics of patients were presented in frequency tables and gestational age distribution was presented in a bar chart. All continuous variables were represented as mean and standard deviation. An Independent sample T-test was used to test for significant differences between variables of both left and right uterine arteries. P-values less than 0.05 was considered to be statistically significant (confidence level = 95%).

RESULTS

One hundred and seventy-six participants that met the inclusion criteria were enrolled after giving informed consent to participate in the study. One hundred and forty-one patients (80.1%) had both first and second scans in the second and third trimesters respectively. The mean gestational age at which the women were scanned in the second trimester was 23.75 weeks±1.32 while that for the third trimester was 31.80 weeks±0.95. Thirty-five patients were lost to follow-up for varying reasons ranging from outright refusal, miscarriages, relocation, etc. giving an attrition rate of 19.9%. The mean age of the women in the cohort was 31.6± 5 years with an almost equal number of them being nulliparous 71 women (51.4%) while multiparous were 70 women (49.7%).

One hundred and twenty women (85.1%) had tertiary education as the highest level of education, twenty women (14.2%) had secondary education and one woman (0.7%) had primary education. All the women were Christians. Most of the women were married (140) while one woman was single. The women showed varying occupations; 73 (51.8%) women were civil servants being the most common, traders were 49 (34.8%), artisans were 12 (8.5%), and least common were students 7 (5.0%).

The mean values and standard deviations of the PI, RI, PSV, EDV, and S/D ratio of the right and left uterine arteries in the second and third-trimester scans are shown in,

t-value= Independent t-test

The values of the right uterine artery are slightly lower than that on the left for all the Doppler indices, but no statistically significant difference is noted.

t-value= Independent t-test. * means statistically significant

There is a statistically significant difference between the left and right uterine artery indices in the third trimester, as noted in the PSV and EDV values.

The S-K test of normality showed that all the variables had a normal distribution.

The mean right and left uterine artery PI in the second trimester was 1.01±0.26 and 1.03±0.27, RI was 0.598±0.07and 0.606±0.09, PSV was 88.33±44.70cm/s and 92.60±50.56cm/s, EDV was 38.46±22.01cm/s and 41.35±26.94cm/s while the S/D ratio was 2.43 ±0.58 and 2.44 ± 0.59 respectively. There was no statistically significant difference between the velocimetric indices on the right and left uterine arteries in the second trimester. In the third trimester, the mean right and left uterine artery PI was 0.89 ±0.22 and 0.88 ±0.21, RI was 0.55±0.07 and 0.54±0.06,

Table 1: Showing the distribution of sociodemographic variables among the 141 women.

Socio-demographic Variables	Frequency	Percentage
Educational status		
Primary	1	0.71
Secondary	20	14.18
Tertiary	120	85.11
Marital status		
Married	140	99.29
Single	1	0.71
Occupation		
Artisan	12	8.51
Civil servant	73	51.77
Student	7	4.96
Trader	49	34.75
Ethnicity		
Igbo	140	99.29
Yoruba	1	0.71
Religion		
Christianity	141	100
Parity		
Multiparous	70	49.65
Nulliparous	71	50.35
TOTAL	**141**	**100**

Table 2: Showing the normal ranges of theDoppler Indices of the right and left uterine artery for the second trimester.

Parameter	Left uterine artery (Mean±STD)	Right uterine artery (Mean±STD)	t-value	p-value
Pulsatility index (PI)	1.03±0 .27	1.01±0.26	0.506	0.612
Resistivity index (RI)	0.606±0.09	0.598±.07	0.785	0.432
Peak Systolic velocity (PSV: cm/s)	92.60±50.56	88.33±44.70	0.751	0.453
End diastolic velocity (EDV: cm/s)	41.35±26.94	38.46±22.01	0.987	0.324
Systolic/Diastolic (S/D)	2.44±0.59	2.43±0.58	0.170	0.865

Table 3: Showing the normal ranges of Doppler indices for the right and left uterine arteries in the third trimester.

Parameter	Left uterine artery (Mean±STD)	Right uterine artery (Mean±STD)	t-value	p-value
Pulsatility index (PI)	0.88±0.21	0.89±0.22	-0.305	0.760
Resistivity index (RI)	0.54±0.06	0.55±0.07	-1.072	0.284
Peak Systolic Velocity (PSV)	139.83± 56.33	106.69±57.66	4.881	0.000*
End diastolicvelocity (EDV)	66.99± 28.30	50.14±23.91	5.400	0.000*
Systolic/Diastolic(S/D)	2.14±0.37	2.15±0.49	-0.259	0.795

PSV was 106.69±57.66cm/s and 139.83±56.33cm/s, EDV was 50.14±23.91cm/s and 66.99±28.30cm/s while the S/D ratio was 2.15± 0.49 and 2.14± 0.37. There was a statistically significant difference between the PSV and EDV on the right and left uterine arteries in the third trimester with the left uterine indices being higher than the right. The other parameters were not significantly different between the right and left uterine arteries. In the third trimester scan, there was an increase in the PSV and EDV values while the PI, RI, and S/D showed a decrease when compared with the second-trimester indices.In comparing the mean left uterine artery Doppler indices in the second and third trimesters,

There is a statistically significant difference between all the parameters for the left uterine artery between the second and third trimesters.

There was a statistically significant difference between all the indices, the PSV and EDV increased while the PI, RI, and S/D decreased from the second to the third trimesters. Similar Doppler velocimetric changes were also noted on the right uterine artery

There is a statistically significant difference exists from the second to the third trimester

The mean of the left and right uterine arteries in the second and third trimesters were also compared.

The mean PI was 1.023 and 0.892, RI was 0.602 and 0.550, PSV was 90.470cm/s and 123.263cm/s, EDV was 39.911cm/s and 58.565cm/s while the S/D was 2.438 and 2.149 respectively.

Table 4: Independent sample t-test showing the mean levels of parameters of the Left uterine artery in the second and third trimesters.

Parameter	Left uterine artery		t-value	p-value
	Second trimester (Mean±STD)	Third trimester (Mean±STD)		
Pulsatility index (PI)	1.03±0 .27	0.88±0.21	4.811	0.000*
Resistivity index (RI)	0.606±0.09	0.54±0.06	6.490	0.000*
Peak Systolic velocity	92.60±50.56	139.83± 56.33	-7.407	0.000*
End diastolic velocity (EDV)	41.35±26.94	66.99± 28.30	-7.788	0.000*
Systolic/Diastolic (S/D)	2.44±0.59	2.14±0.37	5.091	0.000*

Table 5: Independent sample t-test showing the mean levels of parameters of the right uterine artery in the second and third trimesters.

Parameter	Right uterine artery		t-value	p-value
	Second trimester (Mean±STD)	Third trimester (MeanSTD)		
Pulsatility index (PI)	1.01±0.26	0.89±0.22	4.109	0.000*
Resistivity index (RI)	0.598±07	0.55±0.07	4.763	0.000*
Peak Systolic velocity	88.33±44.70	106.69±57.66	-2.987	0.003*
End diastolic velocity (EDV)	38.46±22.01	50.14±23.91	-4.265	0.000*
Systolic/Diastolic (S/D)	2.43±0.58	2.15±0.49	4.292	0.000*

Table 6: Independent sample t-test showing the mean levels of parameters of both the Left and Right uterine arteries in the second and third trimesters.

Parameter	Left and Right uterine artery		t-value	p-value
	Second trimester (Mean±STD)	Third trimester (Mean±STD)		
Pulsatility index (PI)	1.023±0.267	0.892±0.219	6.323	0.000*
Resistivity index (RI)	0.602±0.085	0.550±0.069	7.969	0.000*
Peak Systolic velocity	90.470±47.69	123.263±59.27	-7.238	0.000*
End diastolic velocity (EDV)	39.911±24.60	58.565±27.48	-8.492	0.000*
Systolic/Diastolic (S/D)	2.438±2.14	2.149±0.439	6.618	0.000*

DISCUSSION

Understanding and assessing the normal physiology of the uteroplacental circulations in pregnancy is very important. In this longitudinal study, we have documented the normal mean values of the right and left uterine Doppler indices in normal singleton pregnancies in the second and third trimesters.

These normal uterine artery Doppler velocimetric values were obtained by a longitudinal study that

involved the same patient being scanned at the second and third trimesters. Olatunji et al[7] noted that a longitudinal study is better at determining vascular changes in pregnant women due to some factors that affect pregnancy. This study recruited a relatively larger number of subjects (one hundred and seventy-six) when compared with most of the studies in the literature. Some of these studies employed a cross-sectional method and made use of an average sample volume of twenty patients for each GA from about 20-40 weeks.[8-10] The relatively larger sample volume used in this study should improve the reliability of the results thus giving a better representation of the population.

Adekanmi et al[11]also did a longitudinal study but their sample size was 81 women. They reported lower PI, PSV, EDV, and S/D with an almost equal value of RI indices. This may be because of the smaller sample size when compared with this study of 141 women.

The mean uterine artery RI values recorded in this study, are similar to the ones reported by Lakhkar et al[12] while the PI and S/D are higher than that that reported by Lakhkar. Reasons for the differences might be attributed to the equipment, the gestational age of insonation as well as the number of uterine arteries that were interrogated. Lakhkar et al sampled one uterine artery if the placenta was unilateral and sampled both uterine arteries if the placenta was central. If the placenta is unilateral, there is increased perfusion in the ipsilateral uterine artery so as to ensure adequate blood supply to the placental bed. This is reflected in Doppler indices by some reduction in RI as well as an increase in PSV and EDV when compared with the contralateral side.

Chambers et al[13]noted a significant decrease in the resistivity index from signals obtained from the placental side of the uterus compared with those derived from the non-placental side. The differential placental location might also explain the differences in the PSV and EDV values on the right and left uterine arteries with the left values being higher on the left side than the right as recorded in this study.

The mean RI, EDV, and S/D of the uterine arteries in the second and third trimesters in this study are similar to the work done at Ibadan by Adekanmi et al[11] However, the recorded PSV and PI values were higher than that recorded by Adekanmi et al in both the second and third trimesters. The differences might be due to the number of pregnant women involved in both studies and the methodology. They recruited one hundred and two (102) singleton pregnant women and only eighty-five (85) women had second and third-trimester scans. This study involved 141 singleton pregnant women who were scanned in the second and third trimesters. The higher number of singleton pregnant women involved in this study might also explain the differences.

The mean RI values of the uterine arteries recorded in this study were significantly different from the work done in Thailand by Kumarnavicius et al[10] They also reported lower uterine artery indices between 0.3 to 0.5 across 21-25 weeks and 0.3 to 0.42 across 31-35 weeks. They enrolled a smaller sample size of 20 patients in each GA. This might be responsible for the low Doppler indices. Other contributory factors might be the methodology, equipment, and racial differences.

The mean uterine artery PI, RI, PSV, EDV and S/D values of this study at 21-25 weeks and 31-35 weeks show significant changes. There is a significant reduction of the RI, PI, and S/D with an increase in PSV and EDV values between the second and third trimesters. These noted significant differences, reflect the decreased vascular resistance and increased blood perfusion to the placental bed as normal pregnancy advances.[14,15] Such findings have also been corroborated by so many other authors.[9-12, 14,15]

Comparing this study and the work done by Bahlmann et al,[16] the mean values of the RI and PI in the second trimester as well as the RI values of the third trimester recorded in this study were higher. However, similar PI values were recorded by both studies in the third trimester. Methodology and racial differences are possible reasons for the variation. Peixoto et al[17] in Brazil used the trans-

vaginal approach in assessing the uterine artery in the second trimester, they reported mean PI values that were similar to the values recorded in this study. This may be because both methods show ease in the assessment/sampling of the vessels.

Gomez et al[9] in Brazil in measuring the mean uterine artery PI, found a mean PI (95th) percentile between 1.79 and 2.70 at 11 weeks and 0.70 and 0.99 at 34 weeks GA becoming more stable up until 41 weeks with a PI of 0.65 and 0.89. The mean uterine artery PI values in the second and third trimesters in this study were also similar to the values recorded by Gomez et al[9] who recruited about 20 singleton pregnant women for each gestational age from 11- 41 weeks gestational age. They also studied the sequential changes in the blood flow pattern of the uterine artery between the 1st and 2nd trimester of gestation together with relation to pregnancy outcome and found that pregnancies complicated by hypertensive disorders and/or IUGR showed a significantly higher mean PI in each of the two intervals studied as well as a significantly higher prevalence of bilateral notch.

Oloyede et al [18] at Lagos recorded mean second-trimester uterine artery PI, RI, and S/D of 1.09, 0.59, 2.56 on the right side and 0.81, 0.65, and 2.57 on the left side respectively. These values are similar to the ones recorded in this study. The reason for the similarity may be due to a similar methodology. The similarity in methodology includes the same pattern of visualizing the lower para-cervical area while visualizing the uterine artery as it crosses the external iliac vessels and insonating 1cm distal to the point of apparent crossing which was also employed in this study.

Oloyede et al[18]also assessed the mean PI, RI, and S/D ratio of the right and left uterine artery between the 22nd and 23rd weeks GA of 435 pregnant women including those with normal and abnormal pregnancy outcomes. They found that the mean PI in the right and left uterine arteries for those with normal outcomes were 1.09 and 0.81, with a range of 0.53 - 1.58 and 0.58 - 1.83 respectively. The RI mean was 0.59 and 0.65, with a range of 0.37-1.16 and 0.41 - 0.82 on both the right and left respectively. Also, there was a statistically significant difference between the right and left uterine PI values. These values were similar to that reported in our study.

Bahlmann et al [16] in Germany reported a mean uterine PI of 0.89, 0.65, and mean RI of 0.45, 0.35 at 18 weeks and 42 weeks respectively. Peixoto et al [17] using the trans-vaginal approach in Brazil, reported a mean PI value that ranged from 1.14 at 20 weeks and 0.95 at 24 weeks. Both studies showed a decrease in PI and RI values as the pregnancy advanced which is in keeping with that reported in this study even though the values varied.

Sciscione and Haynes,[5] reported that the criteria for an abnormal uterine artery Doppler waveform include the persistence of a diastolic notch and an elevated RI above 0.58 or a cut-off above the 75th percentile. Uterine artery Doppler velocimetry has been shown to be predictive of pre-eclampsia and pregnancy outcomes.[19] The FASTER study by Plasencia et al[20] reported that a uterine artery Doppler RI value above the 75th percentile at 10-14 weeks' gestation is predictive of a 5.5-fold higher likelihood of subsequent growth restriction than those with a lower value.

Gomez et al [9] also evaluated the uterine artery PI in the first trimester and identified 30.8% of pregnancies that subsequently developed severe pregnancy complications using the 95th percentile as a cut-off. A study by Papageorghiou et al[21] combined maternal history with uterine artery Doppler to determine a patient's specific risk, and identified 67.5% of women with uterine artery Doppler abnormalities who subsequently developed preeclampsia. The findings by Plasencia et a[20] working with 3107 singleton pregnant subjects in London reported that Doppler measurement of uterine artery PI at 11-13 weeks and observation of the change in PI between 11-13 weeks and 21-24 weeks can be used for effective screening for preeclampsia. They also noted that the expected decrease in uterine artery PI between 11-13 weeks and 21-24 weeks is steeper in pregnancies with a normal outcome than those developing pre-eclampsia. A recent meta-analysis also concluded

that a PI with notching had the best predictive value for pregnancy outcomes.[22] These studies [5, 9, 20-22] all showed the importance of normal uterine artery Doppler values data to enable the identification of patients at risk as early as in the first trimester. Utero-placental insufficiency mostly from hemorrhage (39%) and maternal hypertensive (9.1%) disorders have been reported to contribute to the largest cause of maternal death in developing countries.[23]

The uterine artery indices reported in this study have shown some varying degrees of similarities and differences between other works done by different authors. Although some of the uterine artery Doppler indices reported in this work are different from other works, one thing is common, and that is the demonstration of the normal physiology of increased placental/uterine perfusion as gestation advances through the Doppler principle. This is evidenced by the decrease in the PI, RI, and S/D as well as an increase in PSV and EDV from the second to third trimesters. These results are consistent with that in previous studies done by several authors. The strength of the study is that it will provide baseline normal reference values that will be used in the future for assessing high-risk pregnancies. The limitation is that pregnancy outcome was not recorded in those who completed the study (as it was beyond the scope of the study).

CONCLUSION

The mean reference values for the PI, RI, PSV, EDV, and S/D ratio in the second and third trimesters for the right and left uterine arteries have been established in this study. They showed a reduction of PI, RI, and S/D ratio with an increase in PSV and EDV from the second to third trimester with advancing gestational age. It will be necessary that uterine artery Doppler indices be done routinely as part of the normal ante-natal care of pregnant women to increase the feto-maternal outcome of the patients.

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Author contribution - Conception and study design: UCC, UEO, OCO, OCI, and EKC; Data acquisition: UCC, CSN, NCBI, and EKC; Data interpretation and analysis: UCC, OCO, and CSN; Manuscript writing: UCC and CSN; Revision of manuscript: OCO, UEO, OCI, and EKC.

Data availability - The data used to support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest - None

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