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Research Article

Determination of Fetal Gestational Age in Singleton Pregnancies: Accuracy of Ultrasonographic Placenta Thickness and Volume at a Nigerian Tertiary Hospital

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ABSTRACT

To determine the accuracy of placenta thickness and volume in the correct determination of gestational age among normal singleton pregnancies in Nigerians. In this perspective cross-sectional study, four hundred and twenty-three (423) consenting healthy singleton pregnant women within 13-40weeks gestational age (GA) with regular menstrual cycle and known last menstrual period were recruited and grouped into 27 groups based on their ultrasound GA. All participants had an obstetric ultrasound, and the main outcome variables were placenta thickness, placenta volume, and ultrasound GA. The data generated were analyzed, and P values ≤ 0.05 were statistically significant in this study. Four hundred and eight (408) normal singleton pregnant women with an average age of 29.6(+/-5) years completed the study. One hundred and seventy-seven (43.4%) were between 26-30 years, while 149(36.5%) were aged 31 years and above. The placenta thickness showed a strong positive linear relationship between GA (Y-axis) and placenta thickness (in mm) (x-axis) with a best-fit line of Y -= -0.19 + 1x. The placenta volume values (X) also had a positive but non-linear. There is a linear relationship between placenta thickness and GA and curvilinear relationships between placenta volume and GA. Routine assessment of placenta thickness and volume could serve as an effective alternative means of dating normal pregnancy in women with unreliable dates of the last menstrual period.

Keywords: *Gestational age, Placenta thickness, Placenta volume, Ultrasonography.*

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INTRODUCTION

Accurate gestational age (GA) measurement is essential in pregnancy. Traditionally, GA is estimated using the first day of the last menstrual period (LMP), which assumes that ovulation occurs on day 14 of the menstrual cycle. Irregular menses, unknown or uncertain dates, oral contraceptive use, or recent pregnancy or breastfeeding may all influence the accuracy of this method of calculating GA (Papageorghiou *et al.*, 2016).

Ultrasonographic gestational age estimate using the composite of the fetal biometry parameters (biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC), and femur length (FL) is commonly and routinely used to estimate the fetal gestational age(Mongelli, 2016). However, fetal biometry requires devotion of adequate time to have accurate measurements (Hafner *et al.*, 2006). Apart from these, the different techniques of measurement, positional problems, and some medical conditions (such as preterm rupture of membrane (PROM) known to give inaccurate BPD) may all diminish the accuracy of the gestational age estimation using these parameters (Wolfson *et al.*, 1983). Furthermore, the biometric methods of estimating the GA could predict the gestational age accurately in the first and early second trimester, but as pregnancy advances, they become less accurate (Butt *et al.*, 2014). Presently, there is no single fetal measurement that can accurately estimate the fetal gestational age in the late second trimester and third trimester –the widely accepted practice is an average of measured fetal indices to estimate the gestational age(Mongelli et al., 1996).

Previous studies have corroborated that biometric indices, though most commonly used, vary with underlying medical conditions like intrauterine growth restriction and show potential discrepancies, especially during gestational age assessment in the third trimester (Fisher, 2015; Nair *et al.*, 2019). Measurement of fetal biometric parameters is known to be prone to inaccuracy of ± 3 weeks in the third trimester (Fisher, 2015; Nair *et al.*, 2019).

Studies have shown that diminished placental size precedes fetal growth retardation as IUGR is associated with impoverished villous development and fetoplacental angiogenesis(Mayhew *et al.*, 2004). Also, morphological changes within the placenta precede growth restriction in the fetus by two weeks (Mayhew *et al.*, 2004). The placental thickness and volume measurements on ultrasound, apart from being used to predict chromosomal anomalies and diseases such as pre-eclampsia, thalassemia, and other complications of pregnancy(Hafner *et al.*, 2006), also correlates well with the gestational age in singleton gestations (Karthikeyan *et al.*, 2012; Mathai *et al.*, 2013; Adhikari *et al.*, 2015; Kaushal *et al*, 2015; Suganya *et al*, 2015).

Although ultrasonography and Magnetic Resonance Imaging are medical imaging modalities used for placental measurement, however, the availability, affordability, and safety of ultrasonography pregnancy have made it a commonly used imaging modality (Algebally *et al.*, 2014). When performed with quality and precision, ultrasound alone is more accurate than a "certain" menstrual date for determining gestational age in the first and second trimesters (≤ 23 weeks) in spontaneous conceptions, and it is the best method for estimating the delivery date(Falatah *et al.*, 2014). Placenta thickness (PT) measurement is a simple, clinically useful, and less error-prone means of estimating fetal gestational age (Elchalal *et al.*, 2000). PT is especially beneficial in our environment, where a significant percentage of pregnant women are either not aware of their date of last menstrual period or are having irregular menstrual cycles (Taipale and Hiilesmaa, 2001).

Most of the literature on the utilization of placental thickness is, however, from Asians and Americans. There are also few reports in some African countries. However, few documented studies from the South East in Nigeria partly explore the relationship between PT, PV, and GA. (Adeyekun, 2012; Agwuna *et al.*, 2016). There exists a paucity of data and studies correlating placenta thickness and volume with gestational age in our environment despite its documented benefits. Thus, we aim to explore the potential of using ultrasonographic placenta thickness and or volume in the accurate determination of GA, particularly where the LMP is unknown or irregular. We, therefore, investigated the placenta thickness and volume as a parameter for estimating the gestational ages of fetuses in healthy singleton pregnancies in our environment. We also developed a chart of placental thickness as a predictor of gestational age. We hypothesized that a positive correlation exists between gestational age and placental thickness and volume for this study.

MATERIALS AND METHODS

Study design: We conducted a prospective cross-sectional study at the ultrasound suites of the antenatal clinic and Radiology department of a tertiary, referral Hospital in Nigeria. The study duration was between October 2019 and March 2020.

Ethical consideration: Approval for this research work was obtained from the Joint Institutional Review Board of the University of Ibadan and University College Hospital Ibadan with UI/UCH Ethics number: UI/EC/18/0269

Participants and selection: Cases were healthy singleton pregnant women with gestational age from 13 weeks to 40 weeks. We categorized the pregnant women into twenty-seven (27) groups based on their gestational age (13weeks to 40 weeks). We recruited a total of 423 women using the sample size formula for a cross-sectional study (Naing *et al*., 2006) and an attrition rate of 10%.

In this study, we adopted a simple random probability sampling technique to include all consenting singleton pregnant women between 13- and 40-weeks GA, with certain known last menstrual period and history of regular menstruation that had none of the exclusion criteria.

We excluded women with maternal diseases like; Gestational Diabetes, Hypertension (Systemic hypertension and Pregnancy-induced hypertension), maternal anemia, pregnancies with fetal anomalies, placenta previa, other placental anomalies, those with poorly visualized placenta, multiple pregnancies, and women whose last menstrual period are not known or had irregular menstrual periods.

For each participant, the actual gestational age at recruitment was calculated from the date of the last menstrual period (LMP). The demographic information and the parity of the recruited women were recorded into a prepared datasheet. All pregnant women recruited from the antenatal clinic and referred for routine ultrasound were scanned. All scans were performed, and all measurements were taken and recorded by the same radiologist with vast experience in obstetric ultrasonography to avoid inter-observer errors.

Data collection: Ultrasound examination was performed using a GE©Voluson P6 ultrasound scanner [Manufactured 2013 in the USA] with a 3.5 MHz curvilinear transducer. At the ultrasound session, participants were in the supine position, and the subjects' abdomen was exposed from the xiphisternum to the pubic symphysis. An adequate amount of coupling gel was applied to reduce the tissue air interface. The transducer was placed over the skin surface, and the placenta was subsequently located.

The placenta thickness was measured as the widest perpendicular distance between the umbilical/placental point of cord insertion and the placenta- myometrial interface excluding the retro placental area, to the precision of 1 mm, Colour Doppler interrogation of the umbilical artery was used to reconfirm the site of umbilical cord insertion before taking measurements. The placenta measurements were taken when the uterus is relaxed and not contracting as contraction increases placental thickness. The myometrial and placenta veins were excluded from the measurements. All in accordance with the technique of Schwartz et al. (Schwartz, Wang and Parry, 2012) and Karthikeyan et al. (Karthikeyan *et al.*, 2012). The measurement was done three times, with the average calculated and recorded for each participant.

The placental volume was derived using the concave-convex shell formula in line with the technique of Azpurua et al., the placenta volume(V)= $(\pi T/ 6) \times [4H(L-T) + L(L-4T) + 4T^2])$ (Azpurua *et al.*, 2010). L refers to the maximum width of the placenta H is the maximal height of the arc and T to the

thickness of placental tissue at the maximal height of the arc of placenta tissue. All measurements were acquired three times, and the average was calculated and recorded.

Each of the fetal biometry parameters (BPD, HC, AC, and FL) was measured using the standard techniques (Benacerraf, 2007). The measurements were done three times, with the average calculated and recorded.

Statistical Analysis

The main outcome variables were placenta thickness, placenta volume, and GA. We used descriptive statistics, including mean, standard deviation, median and interquartile range (IQR), to summarize our data. We analyzed the data collected using SPSS 20 statistical software (SPSS Inc. USA).

Analysis of variance (ANOVA) was used to test the association between placenta location and placenta thickness. Correlation between quantitative variables was tested using Pearson's and Spearman's Rank correlation as appropriate. A simple regression analysis was done to show the relationship between gestational age and placenta thickness/placenta volume. A p-value of < 0.05 was regarded as significant, while a confidence interval was set at 95%

RESULTS

Four hundred and eight (408) pregnant women from the initial 423 women completed the study, giving an attrition rate of 3.54%. One hundred and seventy-seven (43.4%) of the participants were between 26-30 years. The gravidity in 157 (38.5%) participants was two and one (1) among 144 (36.3%) participants. Also, the participants were mostly nulliparous 180/408 (44.1%), while in 147 (136.0%) participants, their parity was one. 211/408 (51.7%) were second-trimester gestations and 197/408(48.3%) third-trimester pregnancies. The detailed sociodemographic characteristics of the subjects are as shown in Table 1.

The mean BPD, HC, AC, and FL, placenta thickness, and volume distribution for second and third-trimester values are shown in table 2. Average BPD, HC, AC, and FL for the second trimester were 46.1 ± 13.9mm, 168 ± 48.4mm, 146 ± 49.8mm, and 33.1 ± 13.3mm, respectively, while average BPD, HC, AC, and FL for the third trimester were 82.6 ± 9.40mm, 299 ± 30.0mm, 295 ± 39.4mm, and 65.0 ± 7.44mm respectively. Furthermore, the mean thickness of the placenta was significantly larger in the third trimester compared to the second trimester, with similar findings observed in the placenta volume (Table 2).

The placenta showed a consistent linear increase in the thickness with advancing GA throughout the pregnancy from 13 weeks to 39 weeks + 6 days, as shown in Table 3. Ultrasound placenta thickness (PT) of pregnant women in the second and third trimester had a strong positive correlation with LMP derived gestational age (R^2= 0.973, p<0.001) and sonographic gestational age (R^2= 0.981, p<0.001), respectively. Similarly, there was a strong positive correlation between LMP derived gestational age and sonographic gestational age (R^2= 0.989, p<0.001). Furthermore, the inter-rater reliability between LMP gestational age, sonographic gestational age, and the predicted placenta thickness gestational had an excellent agreement. The inter-rater reliability (IRR) of sonographic gestational age and predicted placenta thickness gestational age had an excellent agreement (average measured IRR= 0.993; 95%CI: 0.991-0.994) shown in Table 4.

Table 1:
Sociodemographic characteristics of the study population

Variables		Frequency (N= 408)	Percentage %
Age (Years)	≤ 20	10	2.5
	21 to 25	72	17.6
	26 to 30	177	43.4
	> 30	149	36.5
ETHNICITY	Yoruba	320	78.4
	Igbo	58	14.2
	Hausa	13	3.2
	Others	17	4.2
GRAVIDITY	One	144	35.3
	Two	157	38.5
	≥Three	107	26.2
PARITY	Nulliparous	180	44.1
	1	147	36.0
	2 or more	81	19.9
RELIGION	Muslim	126	30.9
	Christianity	282	69.1
OCCUPATION	Civil servant	107	26.2
	Self-employed	220	53.9
	Unemployed	59	14.5
	Others	22	5.4
Gestational Age (weeks)	Second Trimester (13-26 wks)	211	51.7
	Third Trimester (27 - 40 wks)	197	48.3

Table 2:
Placenta thickness and Ultrasound fetal growth biometrics by GA

Parameters	**13 to 26 weeks GA**		**27 to 40 weeks GA**	
	Mean ± SD (mm)	Median (IQR) (mm)	Mean ± SD (mm)	Median (IQR) (mm)
BPD	46.1 ± 13.9	49.5 (36.8; 63.1)	82.6 ± 9.40	84.8 (78.3; 92.1)
HC	168 ± 48.4	181 (135; 232)	299 ± 30.0	310 (285; 328)
AC	146 ± 49.8	160 (117; 218)	295 ± 39.4	306 (274; 337)
FL	33.1 ± 13.3	35.2 (25.6; 45.9)	65.0 ± 7.44	66.7 (62.9; 71.9)
Placenta thickness	20.5 ± 4.41	22.0 (17.0; 25.8)	33.2 ± 3.87	34.1 (31.2; 37.3)
Placenta volume	85.1 ± 54.8	98.0 (33.0; 152)	209 ± 55.7	195 (174; 234)

BPD = Biparietal diameter; HC – Head circumference; AC = Abdominal circumference;
FL – Femur length and IQR = Inter-quarter range, GA= Gestational age.

Table 3:
Mean Values of Placental Thickness (in mm) between 13 Weeks and 39 Weeks + 6 Days.

Gestational age	N	Mean ± SD	95% CI for Mean	Percentiles					Min	Max
				10th	25th	50th	75th	90th		
13 to 13+6 days	14	13.9 ± 1.28	13.2; 14.7	12.8	13.1	13.6	14.3	16.4	12.8	17.7
14 to 14+6 days	15	14.2 ± 0.34	14.0; 14.4	13.8	14.0	14.2	14.3	14.8	13.8	15.1
15 to 15+6 days	15	15.8 ± 1.23	15.1; 16.5	14.9	15.1	15.6	16.0	17.7	14.8	19.9
16 to 16+6 days	15	16.7 ± 1.28	16.0; 17.4	15.6	16.2	16.5	16.9	18.7	14.8	20.9
17 to 17+6 days	15	17.3 ± 0.54	17.0; 17.6	16.7	16.9	17.2	17.4	18.3	16.5	18.3
18 to 18+6 days	15	19.2 ± 2.37	17.9; 20.5	17.3	18.2	18.5	19.1	24.7	16.0	25.0
19 to 19+6 days	15	21.3 ± 1.77	20.3; 22.3	19.1	19.8	20.9	22.6	24.1	19.0	24.4
20 to 20+6 days	15	21.9 ± 2.30	20.6; 23.2	18.9	20.8	21.5	22.9	26.2	18.8	27.9
21 to 21+6 days	15	23.6 ± 2.37	22.3; 24.9	21.3	21.5	22.9	25.5	27.8	20.9	28.2
22 to 22+6 days	15	22.4 ± 1.71	21.5; 23.4	20.0	21.2	22.0	23.9	25.0	19.8	25.8
23 to 23+6 days	16	22.6 ± 2.26	21.4; 23.8	17.6	22.5	23.0	23.6	25.4	17.0	26.0
24 to 24+6 days	15	25.2 ± 2.32	23.9; 26.5	23.1	24.2	24.3	25.0	30.0	22.0	30.9
25 to 25+6 days	15	25.6 ± 0.58	25.2; 25.9	24.8	25.2	25.4	26.1	26.4	24.7	26.8
26 to 26+6 days	16	26.5 ± 0.55	26.2; 26.8	25.9	26.1	26.4	26.9	27.5	25.8	27.8
27 to 27+6 days	15	27.2 ± 1.08	26.6; 27.8	26.1	26.3	27.1	27.8	29.0	26.0	30.1
28 to 28+6 days	16	28.3 ± 0.50	28.0; 28.6	27.6	28.0	28.2	28.6	29.1	27.5	29.2
29 to 29+6 days	15	29.4 ± 1.02	28.8; 30.0	27.8	29.0	29.3	30.1	31.1	27.0	31.2
30 to 30+6 days	15	30.9 ± 1.20	30.3; 31.6	29.7	30.3	30.6	31.5	33.1	29.5	34.4
31 to 31+6 days	15	30.8 ± 0.67	30.5; 31.2	29.7	30.4	31.0	31.3	31.7	29.4	31.9
32 to 32+6 days	15	31.6 ± 1.25	30.9; 32.3	29.6	30.8	31.8	32.8	33.1	29.5	33.2
33 to 33+6 days	15	33.2 ± 0.91	32.7; 33.7	32.0	32.3	33.1	33.9	34.6	31.8	34.8
34 to 34+6 days	16	34.5 ± 1.72	33.6; 35.4	33.0	33.9	34.1	34.9	36.9	32.2	40.3
35 to 35+6 days	15	35.4 ± 0.85	34.9; 35.8	34.0	34.9	35.3	36.1	36.6	33.6	36.7
36 to 36+6 days	15	36.8 ± 0.80	36.4; 37.3	35.8	36.2	36.7	37.8	38.1	35.6	38.3
37 to 37+6 days	15	37.5 ± 0.90	37.0; 38.0	36.2	36.7	37.4	38.2	38.8	36.1	39.0
38 to 38+6 days	15	38.1 ± 0.66	37.7; 38.4	37.1	37.6	38.0	38.5	39.1	36.9	39.2
39 to 39+6 days	15	39.0 ± 0.43	38.8; 39.3	38.4	38.7	39.1	39.4	39.7	38.3	39.7

N = Number of subjects; CI = Confidence interval; Min =Minimum; Max =Maximum

Table 4:
Correlation between LMP Gestational age, USS Gestational age, Placenta thickness, Placenta volume, and fetal growth biometrics

Parameters	Gestational Age 13 to 40 weeks							
	PT	BPD	HC	AC	FL	PV	USS GA	LMP GA
PT	1.000							
BPD	0.975	1.000						
HC	0.971	0.989	1.000					
AC	0.976	0.986	0.987	1.000				
FL	0.939	0.944	0.943	0.949	1.000			
PV*	0.948	0.960	0.964	0.962	0.950	1.000		
USS GA	0.981	0.989	0.988	0.994	0.948	0.948	1.000	
LMP GA	0.973	0.978	0.978	0.984	0.940	0.959	0.967	1.000

*Spearman's rank correlation coefficient. BPD = Biparietal diameter; HC – Head circumference; AC = Abdominal circumference; FL – Femur length; PT = Placenta thickness; PV = Placenta volume, GA = Gestational age; LMP = Last menstrual period and USS = ultrasound.

We further conducted a regression analysis between gestational age (Y) of 13-40 weeks and placenta thickness(x) in mm to depict the best fit line. It shows a positive linear relationship with a best-fit line equation of Y= - 0.19 + 1x (Figure 1). Following regression analysis, placenta volume values (X) also had a positive but non-linear relationship with GA between 13 and 40 weeks of pregnancy with the best fit line equation of $Y= 11.88 +0.12X – 0.000102X^2$ as shown in Figure 2.

The nomogram chart of the placenta thickness versus GA and placenta volume versus GA among the studied population was developed and shown in Figures 3 and 4, respectively

DISCUSSION

This study shows the usefulness of placental ultrasound parameters (thickness and volume) in determining gestational age, compared to the traditional parameters with a reported inaccuracy of ± 3 weeks in the third trimester(Fisher, 2015; Nair *et al.*, 2019).

The placental thickness corresponded to ultrasound gestational age in weeks in this index study. Earlier studies by Adhikari *et al.* (Adhikari *et al.*, 2015) and Karthikeyan *et al.* (Karthikeyan *et al.*, 2012) also demonstrated a fairly linear relationship between ultrasound gestational age and placenta

thickness. Mittal *et al.* (Mathai *et al.*, 2013) also found an increasing trend in the values of placental thickness in millimeters with an increase in ultrasound gestational age.

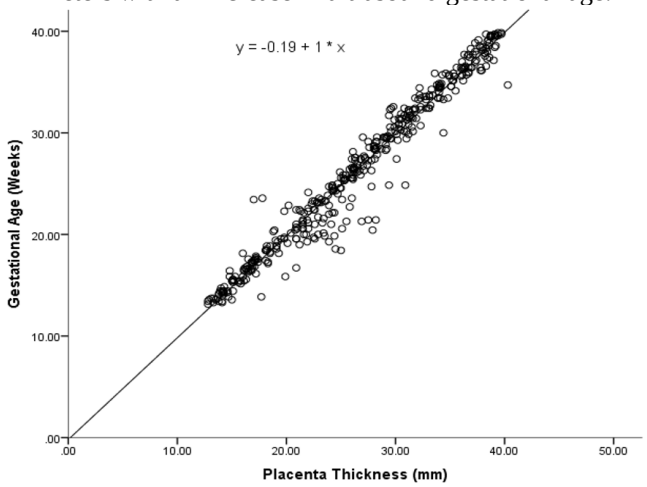

Figure 1:
Scatter plot of Ultrasound Gestational Age (13 to 39 weeks) and placenta thickness (mm).

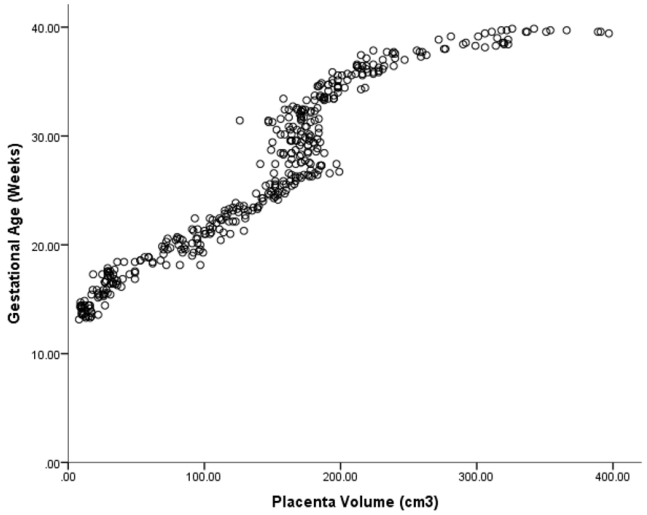

Figure 2:
Scatter plot Gestational Age (combined 13 to 40 weeks) and Placenta Volume (cm^3)

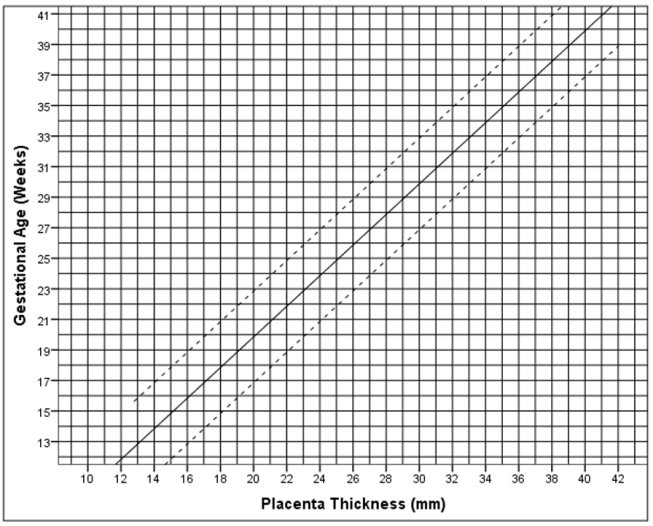

Figure 3:
Nomogram showing the mean, 5th and 95th percentiles of placenta thickness and gestational age in weeks

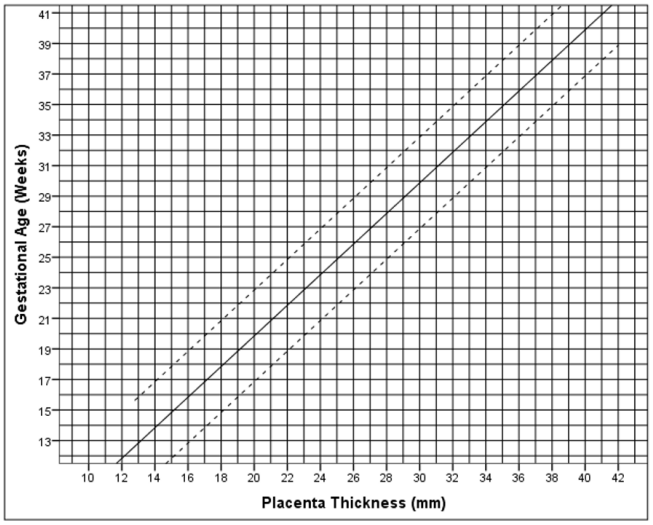

Figure 4:
Nomogram showing the mean, 5th and 95th percentiles of placenta volume and gestational age in weeks

Furthermore, regression analysis of this index study revealed placenta thickness between 13 to 39 weeks of pregnancy, the best fit curve was (GA = -0.19 + 1*Placenta thickness (mm)); There was a strong positive correlation between placenta thickness (PT) and gestational age (GA) of the pregnant women between gestational age of 13 – 39 weeks. Our observation is similar to the observations of Kaushal (Kaushal *et al.*, 2015) et al. and Suganya et al. (Suganya *et al.*, 2015) which also demonstrates a strong positive correlation between gestational age based on LMP and placenta thickness (R^2= 0.998 p<0.001 and R^2= 0.973 p<0.001 respectively). Thus, indicating an increase in the placenta thickness as GA advances. It, therefore, underscores the fact that placenta thickness is a reliable predictor of GA.

Maathai *et al.* (Mathai *et al.*, 2013) suggested that placenta thickness can be a marker for growth retardation in the fetus. This study reported that placenta thickness varies with fetal growth and that reduced placenta parameters are potential markers for early detection of fetal growth restrictions.

While this index study was not focused on growth retardation, it developed a nomogram of normal placenta thickness from which gestational age can be derived such that any deviation from the normal can be detected.

This study observed an increase of 1-2mm in placenta thickness per week, the same as increased gestation in most patients. This is particularly so with GA between 27 and 39 weeks when there was a steady increase of 1mm, almost matching the gestational age in weeks, similar to what Suganya *et al.* (Suganya *et al.*, 2015) observed in their study that the placental thickness also almost matched the gestational age in weeks from 20 weeks to 35 weeks of gestation. Anupama *et al.* (Jain *et al.*, 2001)also reported that placental thickness almost matched gestational age from 27 weeks to 33 weeks of gestation among the studied population.

In this study, we calculated the placenta volume using the derived Kliman concavo-convex shell formula (Azpurua *et al.*, 2010), which has been validated by Higgins et al. (Higgins

et al., 2015)and Azpurua *et al.*(Azpurua *et al.*, 2010) and found to produce similar results to the 3-dimensional ultrasonography (3DUS) using the Virtual Organ Computer-Aided Analysis (VOCAL) software (Metzenbauer *et al.*, 2002), which is not readily available on most ultrasound machines

Isakov *et a*l. (Isakov *et al.*, 2018) observed a parabolic relationship between placental volume and gestational age with the following best-fit equation: EPV = (0.372 GA - 0.00364 GA^2) ^{3} in their study. This index study shows a sigmoid shaped curve when a scatter plot was drawn between placenta thickness and volume, which means there was a correlation between placenta volume and ultrasound GA but not as linear as that of placenta thickness; There is a curvilinear part of the curve observed at a gestational age of 27-40 weeks and a fairly linear part at 13-26weeks. There was also a strong correlation between placenta volume and gestational age of the participants between gestational age 13 to 26 weeks (r=0.979, p<0.001) and 27 to 40 weeks (r=0.865) Nowak O M *et al.* (Nowak *et al.*, 2010) (R^2=0.82)), Titapant and Cherdchoogieat (Titapant and Cherdchoogieat, 2014) (R^2=0.76) and Guyomard et al. (Guyomard *et al*., 2013) (R^2= 0.58), observed similar findings in their studies.

Based on the observed relationship between GA and placenta thickness and volume, the hypothesis for this study, that there is a positive correlation between placenta thickness and volume with GA.is therefore accepted.

One of the limitations of this study was the difficulty in assessing the entire span of posteriorly sited placentae.

Taken together, there is an excellent linear correlation between placenta thickness and gestational age (ultrasound and LMP) with a curvilinear relationship between gestational age (ultrasound and LMP) and placenta volume in our environment, similar to a lot of many previous studies. The placenta size is a useful/reliable alternative means of dating pregnancy and improving obstetric care.

We, therefore, recommend routine assessment of placenta thickness and or volume in the antenatal management of normal pregnant women for fetal dating, particularly in the third trimester and where women are unsure or could not remember their LMP.

REFERENCES

Adeyekun, A. A. (2012): Ultrasound assessment of placental thickness and its correlation with gestational age in normal pregnancy: a preliminary report. Sahel Med J. 2012;15(1):10–5.

Adhikari, R., Deka, P.K., Tayal, A. & Chettri, P.K. (2015): Ultrasonographic Evaluation of Placental Thickness in Normal Singleton Pregnancies for Estimation of Gestation Age. *International Journal of Medical Imaging*, 3(6):143–147. doi: 10.11648/j.ijmi.20150306.16.

Agwuna, K.K., Eze, C.U., Ukoha, P.O. & Umeh, U.A. (2016): Relationship between Sonographic Placental Thickness and Gestational Age in Normal Singleton Fetuses in Enugu, Southeast Nigeria. *Annals of medical and health sciences research*, 6(6): 335–340. doi: 10.4103/amhsr.amhsr_457_15.

Algebally, A.M., Yousef, R.R.H., Badr, S.S.H., Al Obeidly, A., Szmigielski, W. & Al Ibrahim, A.A. (2014): The value of ultrasound and magnetic resonance imaging in diagnostics and prediction of morbidity in cases of placenta previa with abnormal placentation. *Polish journal of radiology*, 79:409–16. doi: 10.12659/PJR.891252.

Azpurua, H. Funai, E., Coraluzzi, L., Doherty, L., Sasson, I., Kliman, M., *et al.* (2010): Determination of Placental Weight Using Two-dimensional Sonography and Volumetric Mathematic Modeling. *American Journal of Perinatology*, 27(2):151–155. doi: 10.1055/s-0029-1234034.

Benacerraf, B. R. (2007): *ACR–ACOG–AIUM PRACTICE Guideline for the performance of obstetrical ultrasound*. Available at: https://www.pedrad.org/Portals/5/Subspecialties/OB Ultrasound practice guidelines.pdf.

Butt, K., Lim, K., Bly, S., Cargill, Y., Davies, G., Denis, N., *et al.* (2014): Determination of Gestational Age by Ultrasound. *Journal of Obstetrics and Gynaecology Canada*, pp. 171–181. doi: 10.1016/S1701-2163(15)30664-2.

Elchalal, U., Ezra, Y., Levi, Y., Bar-Oz, B., Yanai, N., Intrator, O. *et al.* (2000): Sonographically Thick Placenta: a Marker for Increased Perinatal Risk—a Prospective Cross-sectional Study', *Placenta*, 21(2–3):268–272. doi: 10.1053/plac.1999.0466.

Falatah, H. A., Awad, I.A., Abbas, H.Y., Khafaji, M.A., Alsafi, K.G.H. & Jastaniah, S.D. (2014): Accuracy of Ultrasound to Determine Gestational Age in the Third Trimester. *Open Journal of Medical Imaging*, 04(3):126–132. doi: 10.4236/ojmi.2014.43018.

Fisher, S. J. (2015): Why is placentation abnormal in preeclampsia? *American Journal of Obstetrics and Gynecology*, 213(4): S115–S122. doi: 10.1016/j.ajog.2015.08.042.

Guyomard, A., Guillarme, M., Ferdynus, C., Franceschini, C., Rousseau, T. & Sagot, P. (2013): Reference ranges and distribution of placental volume by 3D VOCAL analysis between 11weeks and 13weeks 6days. *J Ultrasound Med*, 32: 1477–1382. doi: 10.7863/ultra.32.8.1477.

Hafner, E., Metzenbauer, M., Hofinger, D., Stonek, F., Schuchter, K., Waldhor, T. *et al.* (2006): Comparison between the three-dimensional placental volume at 12 weeks and uterine artery impedance/notching at 22 weeks in screening for pregnancy-induced hypertension, pre-eclampsia and fetal growth restriction in a low-risk population. *Ultrasound in Obstetrics and Gynecology*, 27(6), pp. 652–657. doi: 10.1002/uog.2641.

Higgins, L. E., De Castro, N.R., Addo, N., Wareing, M., Greenwood, S.L., Jones, R.L, *et al.* (2015): Placental features of late-onset adverse pregnancy outcome', *PLoS ONE*, 10(6): e0129117. doi: 10.1371/journal.pone.0129117.

Isakov, K. M. M., Emerson, J.W., Campbell, K.H., Galerneau, F., Anders, A.M., Lee, Y.K., *et al.* (2018): Estimated Placental Volume and Gestational Age. Am J Perinatol. 35(8):748-757. doi: 10.1055/s-0037-1615285. Epub 2017 Dec 27. PMID: 29281842.

Jain A., Kumar, G., Agarwal, U. & Kharakwal, S. (2001): Placental thickness–a sonographic indicator of gestational age. *J of Obst and Gyne of India.*, 51(3):48–9.

Karthikeyan, T., Subramaniam, R.K., Johnson, W. & Prabhu K. (2012): Placental thickness & its correlation

to gestational age & foetal growth parameters- a cross-sectional ultrasonographic study.', *Journal of clinical and diagnostic research : JCDR*, 6(10): 1732–5. doi: 10.7860/JCDR/2012/4867.2652.

Kaushal, L., Patil, A. & Kocherla, K. (2015): Evaluation of placental thickness as a sonological indicator for estimation of gestational age of foetus in normal singleton pregnancy. *International Journal of Research in Medical Sciences*. 333(3):1213–1218. doi: 10.5455/2320-6012.ijrms20150534.

Mathai, B. M., Singla, S.C., Nittala, P.P., Chakravarti, R.J. & Toppo, J.N. (2013): Placental thickness: its correlation with ultrasonographic gestational age in normal and intrauterine growth-retarded pregnancies in the late second and third trimester. *Journal of obstetrics and gynaecology of India*, 63(4): 230–3. doi: 10.1007/s13224-012-0316-8.

Mayhew, T. M., Wijesekara, J., Baker, P.N. & Ong, S.S. (2004): Morphometric evidence that villous development and fetoplacental angiogenesis are compromised by intrauterine growth restriction but not by pre-eclampsia. *Placenta*, 25(10): 829–833. doi: 10.1016/j.placenta.2004.04.011.

Metzenbauer, M., Hafner, E., Schuchter, K. & Philipp K. (2002): First-trimester placental volume as a marker for chromosomal anomalies: preliminary results from an unselected population. *Ultrasound Obstet Gynecol. 19: 240–242*.

Mongelli, M. (2016): Evaluation of Gestation. *Medscape*, pp. 1–7. Available at: https://emedicine.medscape.com/article/259269-overview.

Mongelli, M., Wilcox, M. & Gardosi, J. (1996): Estimating the date of confinement: ultrasonographic biometry versus certain menstrual dates. *American journal of obstetrics and gynecology*, 174(1 Pt 1): 278–81.

Naing, L., Winn, T. & Rusli, B. N. (2006): Practical Issues in Calculating the Sample Size for Prevalence Studies. *Archives of Orofacial Sciences*. 1: 9–14.

Nair, V. V., Nair, S. S. & K, R. (2019): Study of placental location and pregnancy outcome. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, 8(4): 1393. doi: 10.18203/2320-1770.ijrcog20191187.

Nowak, P. M., Nardozza, L,.M.M., Araujo Júnior, E., Rolo, L.C., Guimarães Filho, H.A. & Moron, A.F. *et al*. (2010): Avaliação do volume da placenta no primeiro trimestre de gestação por meio da ultrassonografia tridimensional utilizando o método XI VOCAL. *Radiologia Brasileira*, 43(2): 81–84. doi: 10.1590/S0100-39842010000200006.

Papageorghiou, A. T., AT, Kemp, B., Stones, W., Ohuma, E.O., Kennedy, S.H., Purwar, M., *et al.* (2016): Ultrasound-based gestational-age estimation in late pregnancy. *Ultrasound in Obstetrics & Gynecology*, 48(6):719–726. doi: 10.1002/uog.15894.

Schwartz, N., Wang, E. & Parry, S. (2012): Two-dimensional sonographic placental measurements in the prediction of small-for-gestational-age infants. *Ultrasound in Obstetrics and Gynecology*, 40(6): 674–679. doi: 10.1002/uog.11136.

Suganya, B., Mallika, A. & Sangeereni, S. (2015): Estimation of Gestational Age By Ultrasonographic Measurement of Placental Thickness. *International Journal of Modern Research and Reviews*, 3(10): 889–891.

Taipale, P. & Hiilesmaa, V. (2001): Predicting delivery date by ultrasound and last menstrual period in early gestation. *Obstetrics and gynecology*, 97(2): 189–94.

Titapant, V. & Cherdchoogieat, P. (2014): Nomogram of placental thickness, placental volume and placental vascular indices in healthy pregnant women between 12 and 20 weeks of gestation. *J Med Assoc Thai.* 97(3):267-73. 97(3): 267–73.

Wolfson, R. N., Zador, I.E., Halvorsen, P., Andrews, B., Sokol, R.J. (1983): Biparietal diameter in premature rupture of membranes: errors in estimating gestational age.', *Journal of clinical ultrasound.* 11(7): 371–4