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Original Article

Placental thickness in normal singleton pregnancies: correlation with gestational age and variation by implantation site in Kano, Nigeria

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Abstract

Background: Placental thickness (PT) is a simple sonographic parameter that reflects placental growth and functional integrity. Published literature presents inconsistent findings regarding the influence of placental implantation site on measured thickness. **Objective:** This study aimed to sonographically assess the relationship between PT and gestational age (GA), and to determine the variation in thickness according to placental location in normal singleton pregnancies. **Methodology:** A prospective cross-sectional study was conducted involving 381 pregnant women in the second and third trimesters attending antenatal clinics in Kano, Nigeria. Transabdominal ultrasound examinations were performed, and PT was measured at the level of umbilical cord insertion. Placental location and fetal biometric parameters were documented. Statistical analyses comprised descriptive statistics, Pearson correlation, and one-way ANOVA, with statistical significance defined as $p < 0.05$. **Results:** PT exhibited a moderate positive correlation with GA ($r = 0.50$, $p < 0.001$). Statistically significant variations in PT were noted across different placental locations ($F = 6.46$, $p < 0.001$). The postero-fundal and fundal placentas showed the highest average thickness values (3.69 cm and 3.49 cm, respectively), whereas anterior placentas had the lowest thickness (3.19 cm), indicating a mean difference of about 0.5 cm, which could affect the clinical interpretation of PT measurements. **Conclusion:** PT increases progressively with advancing GA and varies significantly depending on implantation site. Placental location should be considered when interpreting PT measurements during routine obstetric ultrasound examinations.

Keywords: *Gestational age, Obstetric ultrasound, Placental thickness, Placental location*

Introduction

The placenta is a highly specialized feto-maternal organ that serves as the essential physiological interface between the pregnant woman and the developing fetus. It is responsible for nutrient transport, gaseous exchange, metabolic waste elimination, endocrine secretion, and immunological regulation throughout the course of gestation.[1,2] At term, the placenta is characteristically discoid in morphology, measuring approximately 15–25 cm in diameter, 2–4 cm in thickness, and weighing in the range of 500–600 g.[1] Optimal placental development and function are therefore indispensable for appropriate fetal growth, while placental pathology is closely linked to adverse perinatal outcomes, including fetal growth restriction, preterm delivery, and elevated perinatal morbidity and mortality.[1–3]

Ultrasound remains the primary imaging modality for

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placental assessment in obstetric practice owing to its safety, non-ionizing nature, wide accessibility, and cost-effectiveness.[3,4] The placenta can be readily identified sonographically and becomes clearly delineated by the late first to early second trimester as a homogeneous structure of intermediate echogenicity. A hypoechoic retroplacental zone separating the placenta from the underlying myometrium is a recognized normal sonographic feature.[3–5]

Placental thickness has attracted growing interest as a simple, reproducible, and objective sonographic parameter reflecting placental growth. Numerous studies have established a positive correlation between PT and GA, particularly across the second and third trimesters, suggesting that PT may serve as a valuable adjunct in gestational age estimation when conventional fetal biometric indices are limited or inconclusive.[6–10]

Placental location is routinely recorded during obstetric ultrasound examinations to identify low-lying placentas, placenta previa, and abnormal implantation.[11] Beyond its diagnostic utility, the site of placental implantation may exert an influence on placental morphology and measured thickness. Differences in uterine perfusion, gravitational forces, and mechanical compression, particularly affecting anterior placentas, have been proposed as contributing factors to location-dependent variations in PT.[11–13] Nevertheless, studies examining this relationship remain relatively limited and report conflicting results: some report thinner anterior placentas relative to posterior or fundal placentas, while others find no significant location-dependent differences.[15–18] Investigations into the distribution of placental locations have consistently demonstrated that anterior and posterior placentation account for the majority of implantation sites, while fundal and other locations are encountered less frequently.[12–14]

Despite an accumulating body of evidence linking PT with GA, data specifically addressing the impact of placental location on thickness remain scarce, particularly within African populations. This highlights an urgent need for population-specific data to guide clinical interpretation of PT measurements. The present study therefore sought to examine the association between PT and GA, as well as to characterize variations in thickness according to implantation site in normal singleton pregnancies in Kano, Nigeria.

Materials and methods

Study Design and Study Area

This was a prospective cross-sectional study involving 381 pregnant women who attended the Radiology Departments for obstetric ultrasound examinations at Aminu Kano Teaching Hospital, Muhammad Abdullahi Wase Teaching Hospital, and Murtala Muhammad Specialist Hospital in Kano metropolis, Kano State, Nigeria, and who satisfied the predefined inclusion criteria. Kano is a major urban center in Northern Nigeria with a diverse population and a number of public and private healthcare institutions providing antenatal and obstetric ultrasound services.

Study Population

The study population comprised pregnant women with normal singleton pregnancies who attended for routine obstetric ultrasound during the study period. Participants were recruited consecutively following confirmation of eligibility and provision of informed consent.

Inclusion and Exclusion Criteria

Women with confirmed singleton pregnancies in the second or third trimester with reliably established gestational age were eligible for inclusion. Only pregnancies without known maternal or fetal complications were considered. Exclusion criteria encompassed multiple gestations, fetal anomalies, placental abnormalities (including placenta previa, placenta accreta, placental infarcts, and subchorionic hematomas), hypertensive disorders of pregnancy, diabetes mellitus, intrauterine growth restriction, polyhydramnios, oligohydramnios, and any systemic maternal condition known to affect placental morphology, poor image quality, or inability to obtain adequate measurements.

Sample Size

The minimum required sample size was determined using Cochran's formula for cross-sectional studies:

$$n = Z^2pq / d^2$$

Where n is the minimum sample size, Z is the standard normal deviate corresponding to a 95% confidence level (Z = 1.96), p is the estimated prevalence taken as 0.5 to maximize the sample size in the absence of a precise prior estimate, q = 1 − p = 0.5, and d is the tolerable margin of error (0.05). Substituting these values: $n = (1.96)^2 \times 0.5 \times 0.5 / (0.05)^2 = 384$. The final enrolled sample of 381 participants represents those who met the inclusion criteria after accounting for incomplete data and exclusions during recruitment. A post hoc sensitivity analysis confirmed adequate statistical power

(>80%) for the primary ANOVA comparisons across five placental location groups at the observed effect size (F = 6.46).

Ultrasound Examination and Measurement Technique

Ultrasound examinations were conducted using a Nortek C3 ultrasound system (Nortek Medical Systems, China) fitted with a 3.75 MHz curvilinear transducer. The system underwent regular quality assurance and calibration checks as per institutional protocol. All participants were examined in the supine position with adequate abdominal exposure. Placental thickness was measured at the level of the umbilical cord insertion site, where the placental substance appeared most uniform and homogeneous. In the uncommon instances where cord insertion was marginal or difficult to visualize, measurements were obtained at the thickest point of the placenta perpendicular to both the chorionic and basal plates. Measurements were obtained with deliberate exclusion of the myometrium and retroplacental venous structures, and care was taken to avoid regions of placental contraction. Each measurement was recorded in millimeters and subsequently converted to centimeters, with gestational age documented in weeks.

Data Collection

Sociodemographic and obstetric data, including maternal age and gestational age, were obtained and documented using a structured data collection form. Ultrasound measurements were performed by trained sonographers with over ten years' experience in obstetric scanning, adhering to a standardized protocol to minimize inter-observer variability. Intra-observer and inter-observer reliability were not formally assessed in this study, and this is acknowledged as a limitation. Gestational age was established using standard fetal biometric parameters including biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL); a composite average GA was computed for each fetus. Placental location was classified as anterior, posterior, fundal, antero-fundal, or postero-fundal. A placenta was classified as fundal when its central mass was confined primarily to the uterine fundus without appreciable extension along either the anterior or posterior uterine wall. A placenta was classified as antero-fundal when it predominated in the fundal region with significant extension onto the anterior uterine wall (estimated >50% of the placental mass involving the fundal and anterior segments), and postero-fundal when fundal predominance occurred with significant posterior wall extension on the same basis.

Ethical Considerations

Ethical approval for the study was secured from the Kano State Ministry of Health Research Ethics Committee (Approval No.: MOH/Off/797/T. I/831; Approval Date: 10th July, 2018). Written informed consent was obtained from all participants before enrollment, and confidentiality of all participant data was strictly upheld throughout the study.

Statistical Analysis

Data entry and analysis were performed using the Statistical Package for the Social Sciences (SPSS), version 20.0. Descriptive statistics were used to summarize participant characteristics, PT measurements, and placental location distributions. Continuous variables were expressed as mean ± standard deviation (SD). Pearson correlation analysis was applied to assess the association between PT and GA, while one-way analysis of variance (ANOVA) with Scheffe post hoc testing was employed to compare PT across the different placental location categories. The Scheffe test was specifically selected for its conservative nature and its ability to control for Type I error across multiple pairwise comparisons. Statistical significance was defined as $p < 0.05$.

Results

A total of 381 pregnant women meeting the eligibility criteria were enrolled, with a mean ± SD age of 28.40 ± 6.02 years and a mean GA of 32.15 ± 5.13 weeks. The demographic and fetal biometric parameters of the study cohort are presented in Tables 1 and 2, respectively.

Table 1: Maternal and obstetric characteristics of the study participants (n = 381).

Variable	n	Mean ± SD
Age (years)	381	28.40 ± 6.02
Gravidity	381	4.89 ± 3.00
Parity	381	3.47 ± 2.78
Number of previous miscarriages	381	0.42 ± 0.86

Table 1 presents the maternal and obstetric characteristics of the study participants. The mean ± SD age was 28.40 ± 6.02 years. The mean ± SD values

for gravidity, parity, and number of previous miscarriages were 4.89 ± 3.00, 3.47 ± 2.78, and 0.42 ± 0.86, respectively, indicating a predominantly multiparous cohort. The high mean gravidity and parity values reflect a multigravid population, which may affect generalizability to primigravid women.

Table 2: Fetal biometric parameters and placental thickness measurements (n = 381).

Variable	n	Mean ± SD	Range (Min–Max)
Gestational age (weeks)	381	32.15 ± 5.13	15–40
Placental thickness (cm)	381	3.36 ± 0.72	1.95–4.87

The mean ± SD GA of the cohort was 32.15 ± 5.13 weeks, spanning the second and third trimesters. The mean ± SD PT was 3.36 ± 0.72 cm (Table 2).

Table 3: Distribution of placental locations among the study participants (n = 381).

Placental Location	Frequency	Percentage (%)
Anterior	183	48.0
Posterior	95	24.9
Postero-fundal	40	10.5
Fundal	37	9.7
Antero-fundal	26	6.8
Total	381	100.0

Table 3 illustrates the distribution of placentas by implantation site. Anterior placentation was the most frequently encountered location, accounting for 48.0% (183/381) of cases, followed by posterior (24.9%), postero-fundal (10.5%), fundal (9.7%), and antero-fundal (6.8%) placentas.

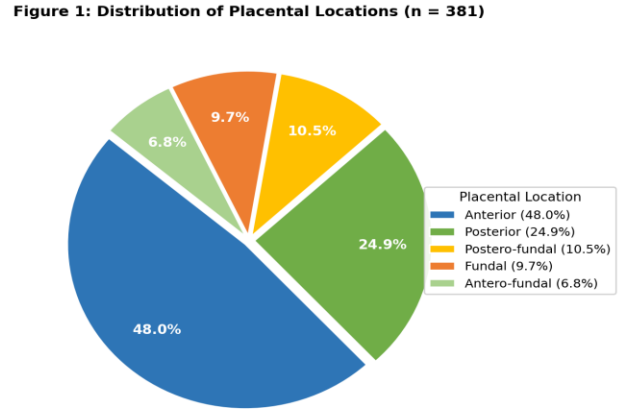

Figure 1: Distribution of placental locations among the study participants (n = 381).

Table 4: Pearson correlation between placental thickness and fetal biometric parameters.

Variable	r	p-value
Gestational age (GA)	0.500	< 0.001
Biparietal diameter (BPD)	0.165	< 0.001
Femur length (FL)	0.135	0.008

Table 4 demonstrates that PT exhibited a moderate positive correlation with GA ($r = 0.50$, $p < 0.001$), with a coefficient of determination ($r^2 = 0.25$) indicating that GA accounts for approximately 25% of the variance in PT. This contextualizes the utility of PT as a supplementary rather than standalone parameter for GA estimation. Weak but statistically significant positive correlations were additionally observed between PT and both BPD ($r = 0.165$, $p < 0.001$) and FL ($r = 0.135$, $p = 0.008$); however, given the very low r values (<0.20), these correlations are of limited clinical significance.

Table 5: One-way ANOVA of placental thickness across placental location groups.

Source	Sum of Squares	df	Mean Square	F	p-value
Between groups	12.55	4	3.14	6.46	< 0.001
Within groups	182.76	376	0.49		
Total	195.31	380			

Table 6: Post hoc analysis (Scheffe test) – mean placental thickness (cm) by placental location.

Placental Location	n	Mean PT (cm)	Subset 1 (α = 0.05)	Subset 2 (α = 0.05)
Anterior	183	3.19	3.19	
Antero-fundal	26	3.25	3.25	
Fundal	37	3.49	3.49	3.49
Posterior	95	3.50	3.50	3.50
Postero-fundal	40	3.69		3.69
Within-subset significance			0.193	0.630

Tables 5 and 6 revealed a statistically significant difference in PT across the various placental locations ($F = 6.46$, $p < 0.001$). Post hoc Scheffe analysis identified two distinct homogeneous subsets. Anterior and antero-fundal placentas formed the lower-thickness subset (mean PT: 3.19 cm and 3.25 cm, respectively), whereas postero-fundal placentas formed the upper subset (mean PT: 3.69 cm). Fundal and posterior placentas occupied an intermediate position, appearing in both subsets (mean PT: 3.49 cm and 3.50 cm, respectively). Anterior placentas were significantly thinner than postero-fundal placentas, with no statistically significant difference identified between posterior and fundal placentas.

Discussion

The present study identified a moderate positive correlation between PT and GA ($r = 0.50$, $p < 0.001$), confirming that PT increases progressively and consistently with advancing gestation. The coefficient of determination ($r^2 = 0.25$) indicates that GA explains approximately 25% of the variance in PT, underscoring that PT alone is insufficient for precise gestational age estimation and should be employed as a supplementary rather than primary dating parameter. This finding is consistent with the observations of Badu et al.[19], who reported a moderate positive correlation between PT and GA in primigravid women in the third trimester at a Nepali teaching hospital ($r = 0.645$, $p < 0.001$), and with Acharya et al.[20], who documented a Pearson correlation coefficient of 0.49 specifically within the third trimester ($r = 0.89$ across both second and third trimesters combined, $p < 0.001$), noting that the correlation was appreciably weaker in the third trimester compared to the second. The agreement between the present study and these moderate-correlation reports is physiologically plausible: as gestation advances into the third trimester, the rate of placental growth begins to plateau relative to the rapid expansion seen in the second trimester, as the placenta approaches its functional and structural maturity. Consequently, the correlation between PT and GA is expected to moderate with advancing gestation.

In contrast, other previously published studies have reported stronger correlations between PT and GA. Banik et al. reported a strong positive correlation in a Manipuri population[8], and Sharami et al. similarly demonstrated a strong positive PT–GA relationship

across a large retrospective cohort.[9] The stronger correlation coefficients reported in these studies may be attributable to several methodological and population-level differences. Notably, both included participants across both second and third trimesters with relatively larger proportions of second-trimester cases, a period during which the PT–GA relationship is inherently steeper and more linear. As demonstrated by Acharya et al.[20], the Pearson correlation coefficient for PT and GA was considerably higher in the second trimester ($r = 0.81$) than in the third ($r = 0.49$), a statistically significant difference ($z = 4.6$, $p < 0.001$). Since the present study enrolled predominantly third-trimester participants (mean GA: 32.15 weeks), the resultant correlation coefficient was expectedly moderate. Furthermore, differences in study population characteristics, sample size, parity distribution, equipment specifications, and measurement technique may collectively account for the variation in correlation strength across studies. These factors notwithstanding, the direction of the association remains consistent: PT increases with advancing GA across all cited studies, affirming its potential as a supplementary sonographic parameter for gestational age estimation.

The study further identified statistically significant variation in PT across different placental locations ($F = 6.46$, $p < 0.001$). Postero-fundal placentas displayed the greatest mean thickness (3.69 cm), while anterior placentas recorded the lowest mean values (3.19 cm). These findings are consistent with the observations of Sharami et al.[9], who reported that PT was measurably reduced in the anterior position relative to posterior or fundal positions, particularly during the second and third trimesters. Comparable results were reported by Durnwald and Mercer[16], who noted that anterior placentas appeared thinner compared with those in posterior or fundal locations; and by Strzelecka et al.[15], who similarly documented location-dependent differences in 2D PT measurements. While these studies were conducted in different populations and employed somewhat different gestational windows, their consistent direction of effect lends cross-population validity to the current findings. In contrast, Menon et al. found no statistically significant association between placental location and thickness.[17] This discrepancy may be attributable to the smaller sample size in that study, which may have lacked adequate statistical power to detect a moderate location effect, as well as differences in gestational age distribution and measurement methodology. The physiological plausibility of the observed differences is well-supported: anteriorly implanted placentas are subject to greater external mechanical compression from the anterior abdominal wall, reduced distension space, and potentially altered perfusion dynamics, all of which may collectively reduce their measured thickness relative to placentas implanted on the posterior or fundal uterine wall.[15,16]

The observed mean difference of approximately 0.5 cm between anterior and postero-fundal placentas in the current study is consistent with, though slightly smaller than, the 0.7 cm difference reported by Lee et al. between anteriorly and posteriorly or fundally located placentas.[18] The modest discrepancy between these figures may reflect differences in gestational age distribution, study population characteristics, and equipment calibration. Nonetheless, both studies converge on the clinically important conclusion that anterior placentation is consistently associated with lower PT measurements. A mean difference of 0.5 cm carries direct clinical relevance: when PT measurements approach established diagnostic thresholds for placental thinning or thickening, a 0.5 cm location-dependent discrepancy could determine whether a measurement is classified as normal or abnormal. Clinicians should therefore apply location-specific reference ranges rather than uniform cut-off values when evaluating PT.

About placental location distribution, anterior placentation was the most prevalent in the present study (48.0%), followed sequentially by posterior (24.9%), postero-fundal (10.5%), fundal (9.7%), and antero-fundal (6.8%) placentas. This distribution is consistent with data from other Nigerian cohorts. Adekanmi et al. documented anterior placentation in approximately 48% of pregnancies, with posterior placentas comprising 39%.[12] Obiozor et al. reported a similar predominance of anterior placentation in a tertiary hospital in Southeastern Nigeria.[13] In the Nepalese study of Acharya et al.[20], anterior placentation was similarly the most common location (55%), followed by posterior (35%), with a combined anterior and posterior frequency of 90%, exceeding the 72.9% recorded in the present study. Badu et al.[19] reported posterior placentation as most frequent (35%) in their Nepali primigravid cohort, followed by anterior (31%) and fundal (21%), reflecting a different distribution from the present study, possibly attributable to differences in parity, gestational age distribution, and geographic population characteristics. Alikhani et al. similarly found that anterior and posterior placentas together accounted for over 80% of implantation sites.[14] These cross-

population similarities suggest that the anterior and posterior predominance of placental implantation is a broadly consistent biological phenomenon, possibly related to the greater vascular density and endometrial receptivity of the anterior and posterior uterine walls.

Minor discrepancies in reported placental location frequencies across studies may be attributed to differences in gestational age at assessment, maternal body habitus, parity, uterine anatomy, and variations in study design. Nonetheless, the consistent predominance of anterior and posterior placentation across diverse populations reinforces the importance of accounting for implantation site when interpreting PT measurements. Failure to consider placental location during clinical assessment may lead to erroneous interpretation and potential misdiagnosis, particularly in cases involving anterior placentas, which are predisposed to appearing thinner, and posterior or fundal placentas, which may appear thicker, even under entirely normal physiological conditions.

This study is subject to certain limitations. The cross-sectional design precludes the assessment of causal relationships between placental location and PT, as well as within-subject changes over the course of gestation. The study was conducted within Kano metropolis, which may limit the generalizability of the findings to rural populations or other geopolitical zones of Nigeria. The inclusion of predominantly multigravida participants may also influence PT measurements differently from primigravid cohorts, as evidenced by the contrast with the exclusively primigravid study of Badu et al. [19]. Intra-observer and inter-observer reliability were not formally assessed, representing an additional limitation. Furthermore, PT was measured at a single time point; diurnal variation and uterine contraction status at the time of measurement were not assessed and may contribute to measurement variability. Additionally, the study cohort was predominantly third-trimester, which limits generalizability to earlier gestations. The findings may not apply to pregnancies with associated complications. Future multicenter longitudinal studies incorporating both primigravid and multigravida participants, with formal reliability assessments, are warranted to validate these findings and to establish gestational-age-specific and location-specific reference intervals applicable to the Nigerian obstetric population.

Conclusion

Placental thickness increases progressively with advancing gestational age and exhibits considerable variation according to implantation site. Postero-fundal and fundal placentas demonstrate the greatest mean thickness, whereas anteriorly implanted placentas tend to be measurably thinner, with a mean difference of approximately 0.5 cm. The coefficient of determination ($r^2 = 0.25$) further indicates that PT alone explains only a quarter of the variance in GA, reinforcing its role as a supplementary rather than standalone estimation tool. These findings highlight the necessity of incorporating placental location into the clinical interpretation of PT measurements during routine obstetric ultrasound assessments, and support the development of location-specific normative reference standards.

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Conflict of interest

The authors declare no conflict of interest. No funding was received for the conduct of this study.

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