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Sono-fetal tibial length evaluation as a predictor of gestational age: A case of Nigerian population

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Abstract

Background: Accurate pregnancy dating is essential for guiding patients about the option of termination of pregnancy or in analysis of biochemical serum screening test and to ensure adequate management of pregnant women with the intention to reduce maternal morbidity and mortality, especially when considering the best parameter for estimating gestational age, it is important that the structure has little biological variation, and can be measured with high degree of reproducibility. This study was designed to evaluate the use of fetal tibia length as a tool for the estimation of gestational age among the Nigerian population.

Materials and Methods: This was a cross-sectional study, which involved 215 pregnant women selected using convenient sampling technique based on the inclusion criteria in a single private diagnostic centre in Port Harcourt. Ultrasound scan was done on each subject and fetal biometric parameters (Biparietal diameter, femur length and tibial length) and gestational age were assessed and documented. Data obtained were analyzed using descriptive and inferential statistics.

Results: The majority (n = 12) of the pregnant women had gestational age of 25 weeks. The mean values for BPD, FL and TL of those with 17th week GA were 36.70±1.035, 23.65±0.7 and 22.28±1.42 as the least mean values while the highest mean values were identified in patients that had 41 weeks of GA, which were 95.20±0.00, 79.40±0.00 and 58.00±0.00 for BPD, FL and TL respectively. There were no statistically significance mean differences between BPD (t = 225.17, p = 0.001), FL (t = 100.84, p = 0.001) and TL (t = -33.38, p = 0.001) and the estimated gestational age of 17 weeks.

Conclusion: The fetal tibial length (FTL) increases with advancing gestational age in apparently healthy fetus. The FTL can be strongly use as a tool for the prediction of fetal gestational age, where other parameters cannot be evaluated.

Keywords: Fetal, gestational age, ultrasound, tibial length

Introduction

Accurate pregnancy dating is essential for guiding patients about the option of termination of pregnancy or in analysis of biochemical serum screening test ^[1]. Ultrasound parameter is considered the most accurate parameter for pregnancy dating when compared to the clinical parameters such as the menstrual cycle or uterine size by obstetrician ^[2].

Ultrasound is an excellent imaging modality of choice for the evaluation of gestational age and as a routine integral part of prenatal care, which can change obstetric management plans and improves antepartum care ^[2]. Early antenatal ultrasound has shown to be an excellent tool for the assessment of gestational age ^[1, 2]. To ensure adequate management of pregnant women with the intention to reduce maternal morbidity and mortality, especially when considering the best parameter for estimating gestational age, it is important that the structure has little biological variation, and can be measured with high degree of reproducibility ^[3]. In recent past, the Biparietal Diameter (BPD) had been documented as a reliable technique for the estimation of gestational age especially in the second trimester. Several studies recently have reported parameters such as head circumference (HC), abdominal circumference (AC), femur length (FL), orbital diameters and others ^[3].

The ultrasonographic morphometry of the long bones of the limbs is coming to the forefront for the determination of fetal development and diagnosis of fetal anomalies [2, 4]. The entire bone lengths of the extremities have been showed to correlate with gestational age and so can be used as an indicator for skeletal dysplasia [2, 5]. A good number of studies have been done by using femur length, biparietal diameter, and abdominal circumference in Nigerian population for the estimation of gestational age, but there is paucity of data regarding the utilization of tibia length for gestational age evaluation in Nigerian population, as underestimation of femur length in cases of femur achondroplasia has a characteristic pattern of normal growth [2]. Therefore, this study was designed to evaluate the use of tibia length as a tool for the estimation of gestational age in the Nigerian population.

Materials and Methods

Study Design

This was a cross-sectional study, which involved 215 pregnant women attending antenatal ultrasound scan referred for fetal well-being assessment by their physicians in a single private diagnostic centre in Port Harcourt, Rivers State, Nigeria. An ethical clearance (TMD/PH/HREC-001/Vol.02) for this study was obtained from the management of the study centre, and the participant's consent was duly sought and obtained after adequate explanation of the procedure of the study. The participants participated voluntarily and the information obtained from them were held in strict confidence and used only for the purpose of this study. The sample size of 215 participants was determined using the formula for unknown population previously described in the studies conducted by Charans and Biswas [6], Israel [7] and Ogolodom *et al.* [8] below.

$$n = \frac{Z\alpha^2 pq}{d^2}$$

Where,

N = Desired sample size

Z α = Significant level usually set at 95% confidence level, Z α is 1.96 (two sided).

P = Proportion of the population with similar attributes under study 50% (0.5).

D = Margin of error tolerated or absolute error = 6.69% (0.0669)

Q = 1-p = 1-0.5 = 0.5

n = (1.96)² x 0.5 x 0.5 / (0.0669)²

n = 0.9604 / 0.00447

n = 215

Participants that met the inclusion criteria, which include pregnant women who were sure of their last menstrual period (LMP), those having singleton apparently normal fetuses between 12 to 36 weeks of gestation, those with no medical pathology, those without any history of vaginal bleeding and those who had not taken oral contraceptive for at least three months before conception were selected into the study using convenient sampling technique. All pregnant women that had multiple fetuses, and do not meet the above inclusion criteria were not included in this study.

Equipment for data collection and scanning technique

i. Equipment

The equipment used for data collection in this study includes; Mindray 2200. Ultrasound machine, 3.5 MHz and 5MHz sector and curvilinear transducers. The acoustic gel as a coupling agents and data capture sheet.

ii. Scanning Technique used for data Collection

The ultrasound examinations were performed in transabdominal plane by the researchers using the Mindray 2200 coupled with 3.5-5MHz transducer. All the participants were scanned in a supine position. However, a left lateral decubitus position was also used to relieve the compression effect of the gravid on the inferior vena cava in cases of advanced pregnancy and prolonged scanning. The scanning techniques adopted in this study include longitudinal, transverse and oblique planes. The measurement of the tibia length was done across the two blunt ends, based on the method described by previous researcher [9].

First, the fetal lie and presentation were identified by a longitudinal plane scan using fetal spine. Sonographically, the tibia and fibula bones appear as highly echogenic linear structures, parallel to each other and casting acoustic shadows distal to the buttocks. Towards the late second and third trimesters, both the tibia and fibula bones are shorter and thinner than the femur bone. The tibia is medially located and thicker than the fibula. These two bones are separated by an anechoic free space. Both the longitudinal and parallel of the tibia were obtained in freeze frame in relation to the fibula. The tibia lengths were obtained between the two blunt ends. The measurement was done without including the proximal tibia epiphysis seen at 29 weeks to 36 weeks [10]. The Biparietal Diameter (BPD) measures was taken from outer to inner edges in a transverse image of the fetal skull at the level of the thalamus and crown septum pellucidum as previously documented by Campbell and Newminal [11]. The femur length measurement taken from the major trochanter to the external condyle in line with the method described by O'Brien *et al.* [12].

Method of data analysis

Data such as the measured fetal tibia length, Biparietal Diameter, femur length and abdominal circumference were fed into the computer and analyzed with statistical package for social sciences (SPSS) version 21. The analyzed data were presented in tables against the derived gestational age, and were presented as mean and standard deviation values. Inferential statistic was done using (Pearson's correlation test and independent T-test) and the level of statistical significance was set at p-value < 0.05.

Results

A total of 215 pregnant women were scanned with the majority 56.3% (n = 121) within the age group of 25-34 years (Figure 1). The majority (n = 12) of the pregnant women had gestational age of 25 weeks. The mean values for BPD, FL and TL of those with 17th week GA were 36.70±1.035, 23.65±0.7 and 22.28±1.42 as the least mean values while the highest mean values were identified in patients that had 41 weeks of GA, which were 95.20±0.00, 79.40±0.00 and 58.00±0.00 for BPD, FL and TL respectively (Figure 2). There were no statistically

significance mean differences between BPD ($t = 225.17, p = 0.001$), FL ($t = 100.84, p = 0.001$) and TL ($t = -33.38, p = 0.001$) and the estimated gestational age of 17 weeks (Table 1 and Figure 3).

The result of the comparative mean tibial length values from different other studies revealed that the mean value of the TL for 17th weeks GA in this study was 22.275 while Queenan *et al.* 1980 [13], reported mean value of 23.40 for the same GA. Achebe *et al.* 2019 [9] in their study, documented TL means value of 24.17 for the same GA. In this study, the mean value for GA 19weeks, 20weeks, 21weeks, 22 weeks and 28 weeks were 31.900, 34.267, 40.529, 33.588 and 48.038 respectively. Queenan *et al.* 1980 [13] and Achebe *et al.* 2019 [9], reported mean values of 46.00, 30.70 and 29.75 respectively for GA of 20 weeks (Table 4.3). Zeba Khan and Faruqi 2006 [14] reported mean TL value of 64.00 and 68.50 for 36 weeks and 40 weeks of GA as against the mean values of 60.488 and 73.233 in this study for 36 weeks and 40 weeks GA respectively (Table 2). In this study, there were strong positive and statistically significance correlations of estimated gestational age with

TL($r=0.743, p= 0.000$), FL ($r= 0.882, p = 0.000$) and BPD ($r = 0.863, p = 0.000$) (Table 3).

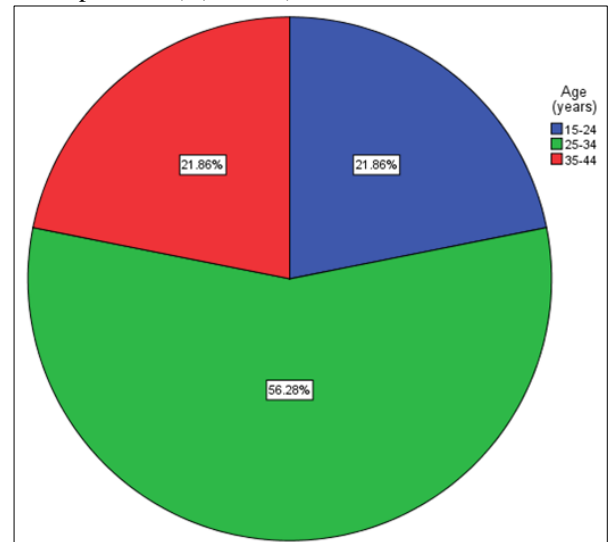


Fig 1: The percentage distribution of the maternal age groups

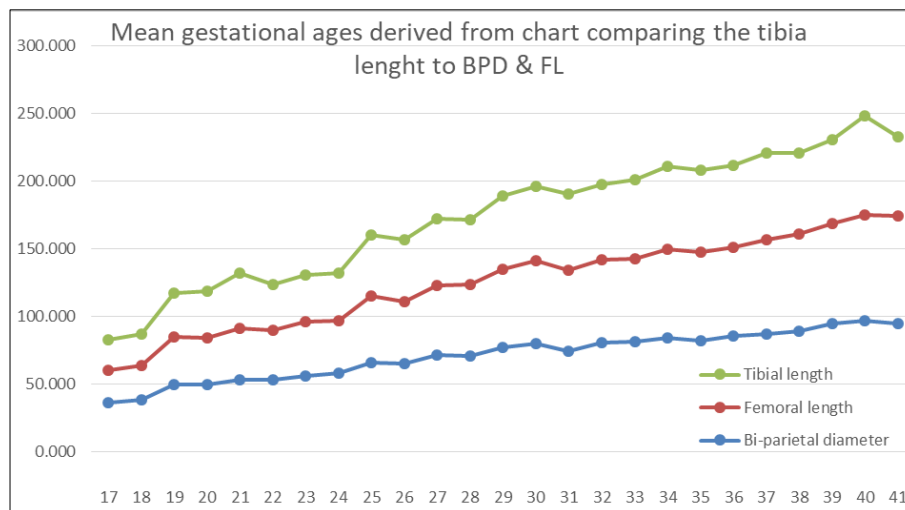


Fig 2: Line Graph of Mean gestational ages derived from chart comparing the TL to BPD and FL.

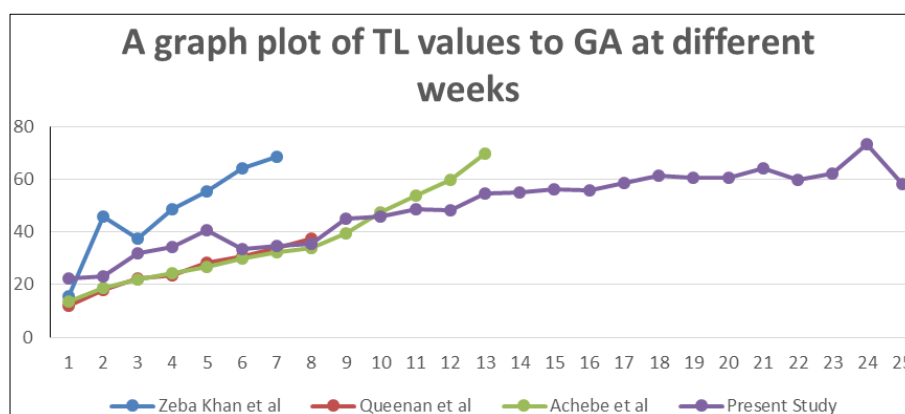


Fig 3: Line graph of TL values from various studies to GA at different weeks.

Discussion

Ultrasound evaluation of gestational age has currently formed an integral component of obstetric practice, traditionally, the biparietal diameter (BPD) had been documented as a reliable method and the first fetal

parameter used for the determination of fetal age. In recent times, several fetal parameters such as head circumference (HC), abdominal circumference (AC), femur length (FL) foot length, ear size, orbital diameters fetal tibial length and others [1].

Table 1: Showing the mean estimated GA and the TL obtained from patients on ANC

EGA weeks	No of Measurements	Variables	Mean±SD of TL, BPD, FL calculated from the chart in mm	T	P
17	4	BPB	36.70±0.35	-225.17	<0.001*
		FL	23.65±0.74	-100.84	<0.001*
		TL	22.28±1.43	-33.38	<0.001*
21	7	BPB	53.29±8.62	-6.55	<0.001*
		FL	38.31±7.73	-7.16	<0.001*
		TL	40.53±11.25	-2.09	0.075
25	12	BPB	65.78±7.79	-5.16	<0.001*
		FL	49.30±6.78	-13.08	<0.001*
		TL	45.19±7.32	-2.39	0.034*
29	10	BPB	76.97±6.39	-3.88	0.003*
		FL	57.78±7.67	-3.84	0.003*
		TL	54.63±6.73	-1.58	0.148
33	5	BPB	81.30±8.03	-2.31	0.069
		FL	61.32±7.76	-3.19	0.024*
		TL	58.40±8.02	0.07	0.95
41	2	BPB	95.20±0.00		
		FL	79.40±0.00		
		TL	58.00±0.00		

*Significant at $p < 0.05$

Table 2: Showing the comparative mean tibial length values from different other studies

Gestational age	Zeba Khan <i>et al.</i> 2006 ^[14]	Queenan <i>et al.</i> 1980 ^[13]	Achebe <i>et al.</i> 2019 ^[9]	Present Study
13	-	12.10	13.42	-
15	-	17.80	18.60	-
16	15.50	22.20	22.10	-
17	-	23.40	24.17	22.275
18	-	-	-	22.967
19	-	28.30	26.75	31.900
20	46.00	30.70	29.75	34.267
21	-	33.90	32.30	40.529
22	-	37.30	33.89	33.588
23	-	-	-	34.860
24	37.5	-	39.40	35.620
25	-	-	-	45.192
26	-	-	-	45.750
27	-	-	-	48.680
28	48.75	-	47.42	48.038
29	-	-	-	54.630
30	-	-	-	54.817
31	-	-	-	56.255
32	55.50	-	53.70	55.643
33	-	-	-	58.400
34	-	-	-	61.473
35	-	-	-	60.620
36	64.00	-	59.85	60.488
37	-	-	-	64.316
38	-	-	-	59.574
39	-	-	-	62.057
40	68.50	-	69.80	73.233
41	-	-	-	58.000

Table 3: Correlations between values of EGA, TL, BPD, and FL

Correlations						
		TL	FL	BPD	EGA	
Spearman's rho	TL	Correlation Coefficient	1.000	.832**	.788**	.743**
		Sig. (2-tailed)	.	.000	.000	.000
		N	215	215	215	215

	FL	Correlation Coefficient	.832**	1.000	.939**	.882**
		Sig. (2-tailed)	.000	.	.000	.000
		N	215	215	215	215
	BPD	Correlation Coefficient	.788**	.939**	1.000	.863**
		Sig. (2-tailed)	.000	.000	.	.000
		N	215	215	215	215
	EGA	Correlation Coefficient	.743**	.882**	.863**	1.000
		Sig. (2-tailed)	.000	.000	.000	.
		N	215	215	215	215

** . Correlation is significant at the 0.01 level (2-tailed).

In our study, the fetal tibial length increases as the gestational age of the fetus increases. This is in harmony with the findings of the studies conducted by Queenan *et al.* 1980^[13], Exacoustos *et al.* 1991^[15], Zeba and Faruqi 2006^[14], which also reported linear growth of the fetal tibial length with gestational age. However, our mean value varies due to the different sample sizes used in our different studies. According to Zeba and Faruqi 2006^[14], the maximum group of the long bones was noted from 4th to 6th months.

There was no statistically significance mean difference between the values of the fetal tibial length and other fetal parameter such as BPD and FL in this study. This implies that the tibial length is as good as other fetal parameter for the estimation of fetal GA when compared the mean values of the fetal tibial length obtained in this study with that of previous studies. It was observed that there were differences in the values across the gestational ages. In general the mean values of the TL were slightly higher in this study than some of the previous studies. This variation in our findings could be ascribed to the different sample size, geographical actions and nature of the different studies.

The result of this study revealed that there were strong positive correlations between all the fetal parameters measured and the GA. This mean that the fetal parameters growth rates, corresponds to the increasing GA of the fetal. This finding is consistent with the finding of the study carried by Achebe *et al.* 2019^[9]. In Achebe *et al.* 2019^[9] study, which was conducted to evaluate sonographically the usefulness of tibial length as an alternate to the femur length for GA estimation, also reported a strong correlations with statistically significance ($p < 0.05$). This implies that the TL increases with advancing fetal gestational age.

Conclusion

The fetal tibial length (FTL) increases with advancing gestational age in apparently healthy fetus. The FTL can be strongly use as tool for the prediction of GA, where other parameters cannot be evaluated. The outcome of this study should be use when estimating the GA especially in the population of this study.

Conflict of interest: There was no conflict of interest among the authors.

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