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The reliability of biparietal diameter and femoral length in estimation the gestational age using ultrasonography

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Abstract: Background: Assessment of fetal gestational age with ultrasound provides high accuracy and reliability, as ultrasound is safe, easy operating and cheap. Objectives: to predict the GA with BPD and FL, to derive equations from linear regression analysis of GA with BPD and FL this could be applied to determine the fetal GA, to compare between BPD and FL. Methods: there were 100 normal pregnancies (singleton) had been selected for the study during the second and third trimesters. They were scanned with ultrasound using 3.5 MHz probe applying the obstetrics protocol to measure the fetal biometrics. The length of femoral diaphysis was measured from upper end to lower end excluding epiphysis. The biparietal diameter was measured from the fetal skull when being in oval shape; two thalami should be equal in size. The diameter was drawn from inner to outer margins of the skull perpendicular to the thalami. Results: statistical tests such as correlation and linear regression had been used to get the correlation coefficients and linear equations. There was a strong positive correlation between gestational age and femoral length and biparietal diameter (r = 0.97, r = 0.98). The estimation of gestational age from biparietal diameter could be calculated from the equation GA= 3.385+0.359BPD, and the estimation of gestational age could be calculated from the equation GA= 7.890 + 0.388FL. The most accurate most accurate equation to estimate the fetal gestational age was derived from the equation GA= 4.970 +0.157FL+0.218BPD. Conclusion: The estimation of gestational age with fetal biparietal diameter and femoral length still remain the most common measurements to assess the fetal growth. Evaluation of gestational age with biparietal diameter and femoral length joined together is more accurate than biparietal diameter and femoral length when used separately.

Keywords: Reliability, Biparietal, Femoral, Estimation, Gestational Age, Ultrasonography

1. Introduction

The ultrasound plays a great role to assess the fetal growth with measuring the fetal biometry. In all pregnancies, it is necessary to determine gestational age with fetal biometry. In relation to this, measurement of femur length (FL) and biparietal diameter (BPD) are accurate fetal biometries which are commonly applied in second and third trimester. This study aims to confirm the reliability of BPD and FL in evaluating the gestational age (GA) using ultrasonography.

Accurate estimation of fetal age is important for appropriate antennal care. The estimation of GA by ultrasound is based on the known relationship between fetal age and size [1].The fetal ultrasonographic biometric data can be evaluated by referring to standard growth curves derived from large numbers of normally growing fetuses.

In routine ultrasonography, the Sonologist measures the BPD, Head circumference (HC), Abdominal circumference (AC) and FL in estimating the GA and estimate date of delivery [2].The use of all four fetal biometric indices are recommended beyond 20 weeks for reduction of variability [3].In second trimester BPD, HC, AC and FL can predict GA with fair accuracy (±10 – 14 days). The BPD is transverse width of the head at its widest distance (from inner to outer

border of the parietal bone). It is best used after 12 weeks. The accuracy of BPD is ±1 to 1.1 weeks at 14-20 weeks, ±1.6 weeks at 20-26weeks and 2.4 weeks at 26-30 weeks. The accuracy is ± 3-4weeks after 30 weeks [4].The FL is a repeatable measurement with accuracy similar to the BPD. It is affected by skeletal dysplasias. It is best measured after 14 weeks. These biometric measuring are used to assess the GA and fetal weight, evaluate fetal growth and to confirm whether fetal growth restricted or macrosomia customary.

Fetal femur diaphysis length and biparietal diameter are readily accessible and reproducible sonographic measurement of fetal growth and gestational age [5].From approximately 14 weeks of gestation, the use of femur diaphysis length for estimation of fetal age provides a range of varying from ± 7 days prior to 2o weeks' gestation to ±16 days in scans performed after 36 weeks' gestation. Likewise, the use of BPD for prediction of GA varies in accuracy between ±8 days before 20 weeks' gestation to ±15 days after 24 weeks [6].Clinical sonographic practice, however, periodically encounters discrepancies in gestational age assessment between FL and PBD beyond that explainable by measurement error [7].Although studies have reported the possibility of anthropometric differences in fetuses and neonates by race and maternal size [8],the possible role of maternal height and race in determining discrepancies between femur length and biparietal diameter remains unclear [9].

2. Materials and Methods

This is a practical study conducted in Khartoum state (Al mutakamil Clinic Center) from the period of May to July 2012. There were 100 pregnancies in the 2nd and 3rd trimesters had been selected for the study. They had attended in the ultrasound department for routine antenatal care. Ultrasonographic evaluation was performed with expert Sonologist using the international obstetric protocol by ultrasound machine (3.5MHz probe).

Women with multiple gestation, diabetes, or growth retardation were excluded from the study. The gestational age was estimated from the BPD and FL together. The BPD was measured in the axial plane of fetal head where the skull being in oval shape at the level of two thalami. Measurements were made from the outer to inner margins of the fetal skull. The femur diaphysis was measured from the origin to the distal end of the shaft excluding the cartilages. Statistical Package for Social Sciences (SPSS) version 16 was utilized for statistical analysis. P-values less than 0.05 were considered to be significant.

2.1. Method of Ultrasonography Measurement of Femur Length

The probe was slided caudally from the AC section until the iliac bones were visualized. At this point, a cross-section of one or both femurs was usually seen. The upper femur should be selected for measurement. The lower femur is frequently difficult to image clearly because of acoustic shadowing from fetal structures anterior to it.Keeping the echo from the anterior femur in view, rotate the probe slowly until the full length of the femur is obtained. Then we need to make a small sliding movement after each rotational movement to bring the probe back onto the femur. To ensure that we have the full length of the femur and that the section is not oblique, soft tissue should be visible beyond both ends of the femur and the bone should not appear to merge with the skin of the thigh at any point. The end-points of the femur are often difficult to define when the femur is imaged lying horizontally but are much easier to define when the bone lies at a slight angle (5–15degree to the horizontal). The angle of the bone relative to the horizontal was manipulated by dipping one end of the probe gently into the maternal abdomen. The measurement of the femur was made from the center of the 'U' shape at each end of the bone. This represents the length of the metaphysis. The measurements had been obtained from three separate images of the same femur. These should be within 1 mm of each other [11].

2.2. Method of Ultrasonographic Measurement of Biparietal Diameter

The BPD was always assessed in the axial plane of fetal head where the skull being in oval shape at the level of two thalami. The fetal head was scanned with ultrasound using a probe of 3.5MHz. Transverse (axial) section was made through the fetal skull. To get accurate sections for measuring the BPD, the following structures had been visualized on the ultrasound images:

- Oval shaped skull, with intact skull bones and smooth margins.
- A long midline equidistant from the proximal and distal skull echoes
- The cavum septum pellucidum bisecting the midline one-third of the distance from the synciput to the occiput
- The two anterior horns of the lateral ventricles, symmetrically placed about the midline
- All or part of the posterior horns of the lateral ventricles symmetrically placed about the midline. In earlier gestations (15–20 weeks), the optimal view of the posterior horn is usually obtained in this section [11].

3. Results

The study population was made up of 100 pregnant women in the second and third trimesters that had been scanned with ultrasound to assess the fetal age with measuring the biparietal diameter and femoral length. Statistical tests such as correlation and linear regression had applied between the variables of the study. Table (1) shows the general descriptive statistic of the main study variables (FL,BPD and GA) the mean values of these variables were 15.14mm, 16.71mm and 6.19weeks for FL, BPD and GA respectively. Statistical linear correlation test was taken between FL, BPD and GA. As demonstrated in table (2).Strong correlation is regarded when $r < o.7$ and weak correlation when $r > 0.5$.

Table 1. *Shows the descriptive statistics of the study variables.*

Column1	N	Minimum	Maximum	Mean	Std. Deviation
femoral length	100	12.78	77.00	52.92	15.41
Biparietal Diam.	100	26.0	95.6	69.71	16.71
Gestational age	100	15.00	38.00	28.44	6.190
Total number	100				

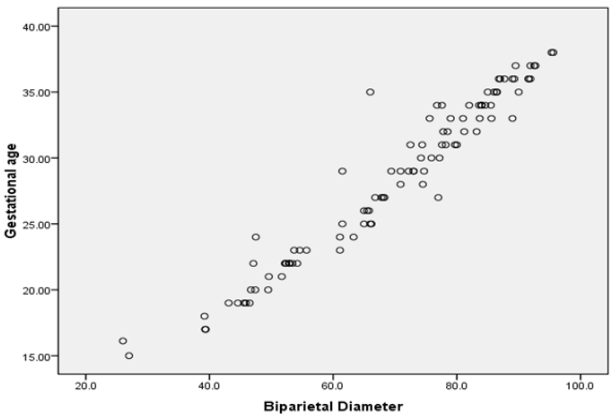

Figure 1. *Shows the correlation between biparietal diameter (mm) and gestational age (weeks). GA= 3.385+0.359BPD.*

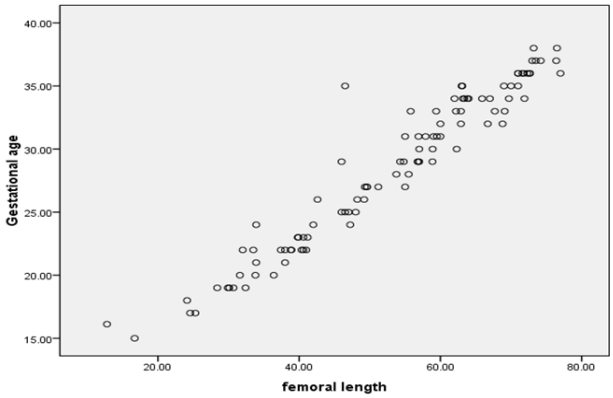

Figure 2. *Shows the correlation between femoral length (mm) and gestational age (week). GA= 7.890 + 0.388FL.*

Table 2. *shows the correlation analysis between gestational age (weeks), BPD and FL (mm).*

Factors	Gestational age	femoral length	Biparietal Diameter
Gestational age Pearson correlation	1	966**	.970**
Significance(2-tailed)		.000	.000
Total number	100	100	100
femoral length Pearson correlation	.966**	1	.981**
Significance(2-tailed)	.000		.000
Total number	100	100	100
Biparietal Diameter Pearson correlation	.970**	.981**	1
Significance(2-tailed)	.000	.000	-
Total number	100	100	100

Table 3. *Regression equations of gestational age prediction from fetal measurements (biparietal diameter and femoral length).*

Fetal measurements(mm)	Regression equation	R^2
FL	GA= 7.890 + 0.388FL	0.934
BPD	GA= 3.385+0.359BPD	0.941
FL&BPD	GA= 4.970 +0.157FL+0.218BPD	0.938

R2: correlation square

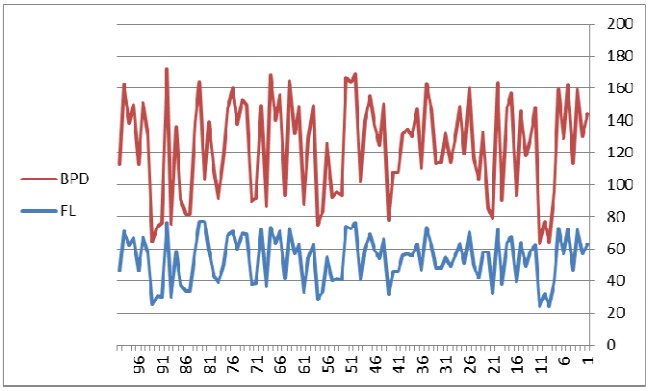

Figure 3. *The correlation between BPD and FL (mm).*

4. Discussion

The relationship between femoral length, biparietal diameter and gestational age had been studied in this article. In this study the FL and BPD (100 noromal fetuses) had been measured in utero using real time sonography. Statistical analysis of the data demonstrated that the femur length curve is similar to the biparietal diameter growth curve. Predicted values of femoral length and biprietal diameter were comparable to the results of other studies. Predicted menstrual age values in weeks for specific BPD and FL measurement in millimeter (mm) were calculated and presented in figures 1&2.

This study presents quantitative assessment of prenatal growth profile using biparietal diameter and femoral length. They were measured with ultrasound in the second and third trimesters to determine the gestational age. There were 100 pregnancies were scanned with the ultrasound; BPD and FL length were accurately measured.

In table (1) showed the descriptive statistics of GA, BPD and FL of the study population and revealed the mean, standard error and standard deviation. It was noted that the

mean diameters of the BPD and FL were 69.70cm and 52.92cm which were significantly different (p-value = 0.000). The BPD is growing faster in third trimester more than FL. This result is consistent with the fact that, as the gestational age increases; both femoral length and biparietal diameter will increase consequently. The correlation analysis showed a strong positive correlation between BPD and FL (r= 0.981), the correlation between FL and GA was 0.966 which is a strong and high. On the other hand, the correlation between BPD and GA was 0.970 which is a strong and higher than that of FL(r =0.966), but the difference is not significant.These results were consistent with a study done by Shalev et al [12] who studied the effectiveness of FL measurement from 12 to 40 week's gestation as a means of assessing fetal age, was tested and compared with that of bi-parietal diameter. He had studied the measurement of FL and BPD from 471 pregnant women with confirmed dating, using real-time scanning with a 3.5 MHz transducer frequency. Using a freeze frame and electronic calipers, the mean value of three consecutive measurements of the femur, when vizualized with its characteristic appearance, was recorded. Linear regression analysis with the correlation coefficient of the femur growth-curve (r = 0.989), and that of the BPD (r = 0.985). These results are similar to our study which confirmed that r=(r =0.966) of correlation between FL and GA, which is not so different. The correlation between BPD and FL(r=0.970) is also showed no significant difference from the result Shehy et al who reported that r=0.980.

Regression analysis had been used to derive equations that join the GA with BPD and FL. In figure (1), the equation which was derived from the relationship between BPD and GA was; GA= 3.385+0.359BPD with value of R^2 = 0.941. This equation showed no big difference of equation reported by Fuson et al who stated that GA =2.412+ 0.131BPD. He studied 1411 pregnancies for fetal biometrics [10].In this study, the equation of estimating the GA from FL was GA= 7.890+0.388FL which derived from linear regression. Another equation joining the BPD and FL with the GA, this provides high accuracy to determine the fetal GA. The equation stated that GA= 4.970 +0.157FL+0.218BPD, this showed no wide difference of an equation reported by Fuson et al who stated that GA=5.688+0.470BPD+0.505FL [10].Practically, this equation provides accurate estimation of GA more than the other two equations which use FL or PBD separately.

The ultrasonography measurement of BPD and FL provides accurate determination of fetal GA. The application of measurement of BPD and FL joined together provides higher accuracy than to each one separately in estimating the fetal GA.

5. Limitations of the Study

Like other manuscripts, our study has limitation. Some pregnancies believed that ultrasound is very dangerous to the fetus like x- rays. It is very difficult to change their concept that ultrasound is safe and has no hazard to the fetus. Some of them refused the ultrasound investigation at first time.

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