

Evaluation of gestational age by fetal occipitofrontal diameter in second and third trimesters of pregnancy in Sudanese women

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ABSTRACT

Background and Objective: The accurate gestational age (GA) is critically important for pregnancy management, particularly for determining viability and growth in premature labor. The aim of this study was to evaluate the usefulness of occipitofrontal diameter (OFD) in estimation of GA in the second and third trimester of pregnancy.

Materials and Methods: In this cross-sectional prospective study, a total of 483 Sudanese pregnant women underwent the routine sonographic examination at different antenatal care centers in Khartoum state using curvilinear transducers 3.5 MHz. The fetal OFD, biparietal diameter (BPD), and femoral length (FL) were measured and correlated with GA. Equations were obtained from regression models to estimate the GA.

Results: In total, 384 singleton fetuses ranging between 12 and 40 weeks of gestation were enrolled. A statistically significant and strong relationship was found between OFD and GA, $R^2 = 0.85$. The model regression of OFD, BPD, and FL produced together with an accurate equation to estimate GA in second and third trimester with the equation; $GA (\text{weeks}) = 4.474 + 100 \times BPD + 0.118 \times OFD + 0.128 FL$ ($r = 0.909$, $n = 384$, $SE = 2.271$). The equation of GA from OFD alone was $GA = 3.663 + 286 \times OFD$ with $SE = 2.882$. The OFD can be used as a single lone parameter in the estimation of GA to give an accuracy of $SE \pm 2.882$ days, but when used in combination with the other two parameters, the accuracy increased to $SE \pm 2.770$ days.

Conclusion: Fetal OFD assessed by sonography may serve as a useful parameter in determining GA and evaluating fetal growth in the second and third trimesters of pregnancy.

Key words: Gestational age; occipital-frontal diameter; pregnancy; Sudanese.

Introduction

The accurate determination of gestational age (GA) is important for pregnancy management and determining viability in premature labor and postdates deliveries.^[1] Valid GA is very important in the management of high-risk pregnancies and in cases where termination is necessary.^[2] Accurate knowledge of fetal GA is fundamental throughout pregnancy. Thus, error in the GA estimation can result in

fetal prematurity and postmaturity. Extremes of fetal growth contribute disproportionately to the overall perinatal and infant morbidity and mortality.^[3,4]

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Ultrasound is a reliable imaging modality in the assessment of pregnancy as it allows real-time visualization and evaluation of fetal and maternal structures.^[5] GA estimates by last menstrual period (LMP) and ultrasound have been correlated.^[6] A variety of measurements have been suggested to establish and measure the GA.^[2,5] In second and third trimester, biparietal diameter (BPD), femoral length (FL), head circumference (HC), and fetal weight (FW) have been commonly used to assess GA.^[7] In the most recent studies, BPD, FL, and head circumference (HC) were used to estimate GA, although some studies reported that they were less accurate after 26 weeks of gestation.^[8] However, we did not find studies demonstrating the accuracy of occipitofrontal diameter (OFD) in the estimation of GA.

In the current study, it was observed the OFD bears a strong linear correlation with FL and BPD. From this correlation, we constructed regression models to estimate the GA. In previous studies, the OFD represented an important fetal biometric parameter to determine the cephalic index (CI), which is a significant factor to detecting deformities of fetal head shape such as dolichocephaly and brachycephaly.^[9,10] The OFD is a function of HC, and it is easily and rapidly measured at the same level of BPD. However, the different fetal presentations are not always favorable for BPD assessment, and because the fetus sometimes faces its placenta, the fetal head position becomes in OF position. This needs difficult maneuver to establish an accurate BPD measurement. Some previous studies proposed that the fetal presentation is significantly influenced by placenta localization.^[11,12] For this reason, and in these occasions, OFD represent an accurate fetal biometry for estimating the GA.

The aim of this study was to evaluate the usefulness of OFD to estimate the GA to construct a nomogram of OFD in second and third trimesters of pregnancy for the local population. This may be useful to assess the GA when the duration of pregnancy is unknown.

Materials and Methods

This was a cross-sectional study conducted from March 2013 up to April 2016 in Khartoum state. A total of 483 Sudanese pregnant women were selected using convenient sampling. The sonographic examination was performed by expert Sonologists and Obstetricians. Every pregnant woman was scanned six times (3 scans/semester). Interobserver error was considered. Means and standard deviations of fetal biometrics (OFD, FL, and BPD) were calculated and stored for comparison.

The participants were certain about the date of their last menstrual period (LMP) and underwent routine sonographic

examination for antenatal care. The study was conducted at different antenatal care Centers in Khartoum State (Capital of Sudan) which lies in central Sudan and provides basic health care in the country. Informed consent was taken from the participants. The study was approved by the ethical committee of the Alzaiem Alazhari University.

The sonographic procedure

Ultrasound investigation was done early at four and five weeks of gestation for all the participants to confirm the accurate date of the pregnancy. The participants were scanned in the supine position with the ultrasound machine using 3.5 MHz curvilinear transducers. A standard ultrasound machine was utilized for the investigations called SONOACE-CONVEX ARRAY CA, version LOGIQ 9.

The OFD was measured perpendicular to the falx cerebri at the midline at the widest region of the hemispheres of the fetal brain. The posterior horns of the lateral ventricles, hypothalamus, and the cavum pellucidum are visible at this level, and the head is typically oval in shape. The intersection of the calipers was placed on the outer border of the occipital thinner side of skull table (occipitofrontally) at the longest part of the skull. At this level, the image was saved [Figure 1]. The measurement of OFD was repeated, and the average was taken. To achieve this, an axial view of the fetal head at the level of the thalami was taken as close as possible to the horizontal [Figure 1]. Measurements of BPD were taken perpendicular to the OFD. Then measurement of the FL was also acquired in the same obstetrical manner [Figure 2].

The inclusion criteria included normal Sudanese pregnant women in second and third trimester with normal singleton pregnancy and known last menstrual period. The exclusion criteria were multiple pregnancies, pregnancies with confirmed congenital abnormalities, pregnancies



Figure 1: A sonogram demonstrates the measurement of fetal OFD which is perpendicular to BPD

complicated by hypertension and preeclampsia, maternal diabetes mellitus, and chronic maternal diseases.

Statistical analysis

The data were analyzed using statistical software program (SPSS, version 16, Chicago, USA). Quantitative data were described as means \pm standard deviation. Pearson correlation test was used to find correlation of GA with the fetal biometrics (OFD, FL, and PBD). Linear quantitative regression analysis was used to derive models for estimation of GA from OFD, FL, and BPD.

Results

A total of 384 normal singleton pregnant women were recruited. The mean and standard deviation of their age and parity were 30.6 ± 7.52 years and 1.6 ± 0.49 , respectively. It was found that the OFD was not significantly correlated with maternal age, maternal body mass index (BMI) and parity (*P* values = 0.13, 0.26, and 0.69, respectively), as shown in Table 1. The fetal biometric BPD, FL, and OFD were measured from all participants, as shown in Figures 1 and 2. The GA is plotted against OFD, as shown in Figure 3. A linear correlation was observed between OFD and BPD and FL [Figures 4 and 5].

GA was strongly correlated with OFD, BPD, and FL with *R* = 0.92, 0.93, and 0.92, respectively, as shown in Table 2. The addition of OFD to FL and BPD provides stronger correlation than the other parameters alone (*R* = 0.95). Sets of equations were obtained from regression models to estimate the GA from fetal biometrics: OFD, BPD, and FL. Table 3 reveals a nomogram which was constructed for estimating the GA (weeks) from OFD (mm) at 12 to 40 weeks of gestation.

Discussion

This was one of the few studies that demonstrated the accuracy of OFD in the estimation of the GA in second and third trimesters of pregnancy in our country. Accurate estimation of GA is a key issue in pregnancy.^[13] The OFD is one of the important fetal biometrics that is used to measure GA

and fetal weight. It is a function of HC and is easily and rapidly measured at the same level at which the BPD is measured. In the present study, we formulated a set of equations obtained from regression models of OFD, FL, and BPD to estimate the GA. We also constructed regression equations that can be used to determine the GA in the second and third trimesters of pregnancy.

Snijders *et al.*^[14] studied the measurements of BPD and OFD. For each of the measurements, regression analysis was applied examining linear, quadratic, and cubic models for association with GA, the standard deviation of the OFD increased with GA. Such findings were reported by Juozas



Figure 2: A sonogram shows the measurement of fetal FL in the third trimester

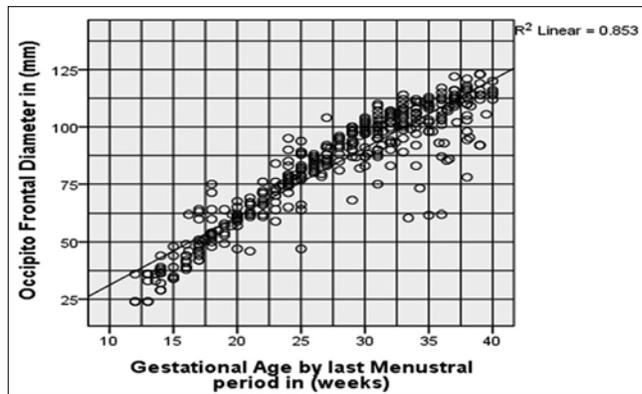


Figure 3: Linear correlation of OFD with GA (LMP), regression of GA with OFD

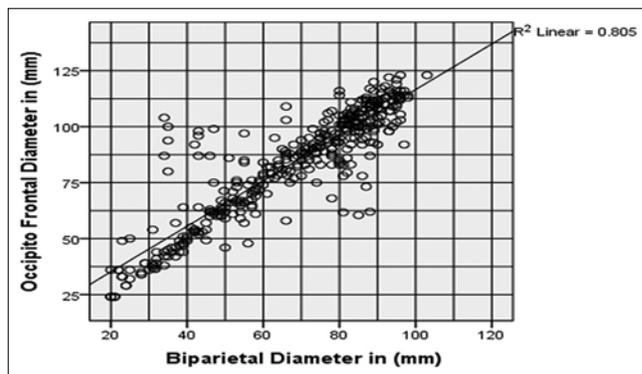


Figure 4: Linear correlation of OFD with BPD

Table 1: Correlation of fetal occipito-frontal diameter with maternal characteristics

Variables	Person correlation	P
Maternal age	0.077	0.133
Weight	0.023	0.650
Height	0.083	0.105
BMI	0.058	0.261
Parity	0.020	0.694
Occupation	0.042	0.416

Table 2: Regression models of relationship between GA with parameters OFD, BPD and FL

Fetal biometrics	Equations	Correlation coefficient R	Adjusted R ²	SE
OFD	GA=3.663+0.286×OFD	0.924	0.853	2.882
FL	GA=8.530+0.374×FL	0.930	0.864	2.771
BPD	GA=5.642+0.325×BPD	0.923	0.853	2.879
BPD, FL and OFD	GA=4.474+0.100×BPD+0.128FL+0.118×OFD	0.953	0.909	2.270

OFD - Occipitofrontal diameter, FL - Femoral length, BPD - Biparietal diameter, GA - Gestational age

Table 3: Estimation of gestational age with occipital-frontal diameter at 12-40 weeksæ

Weeks of gestation (LMP)	OFD mean±SD (mm)
12	31.67±2.160
13	36.40±1.503
14	36.60±1.506
15	40.33±1.406
16	44.87±1.356
17	49.67±1.371
18	53.93±0.917
19	58.33±1.211
20	63.00±1.414
21	66.10±1.197
22	66.70±1.059
23	74.50±0.707
24	79.33±2.526
25	85.01±1.662
26	87.67±0.492
27	89.42±0.515
28	90.55±0.522
29	92.53±0.990
30	96.50±0.707
31	97.61±0.530
32	98.47±0.772
33	102.53±2.478
34	105.64±0.497
35	106.00±0.864
36	107.50±0.707
37	109.40±0.843
38	111.91±1.446
39	113.50±0.548
40	118.70±3.561
Total	85.43±23.786

LMP - Last menstrual period, OFD - Occipitofrontal diameter

et al.^[15] These findings supported our results. We found a direct proportionality linear relationship between OFD and GA estimated by LMP, BPD, and FL.

In the current study, the fetal biometric parameters (BPD, FL, and OFD) were measured in 384 normal pregnancy cases. We observed that OFD has a strong linear correlation with BPD and FL. We also noticed that by FL alone the GA was estimated with SE of 2.770 days and the SE of OFD was 2.882. However, the difference between FL and OFD is not high. This supported the accuracy of OFD which is approximately close to FL. In a previous study, the OFD was used in combination

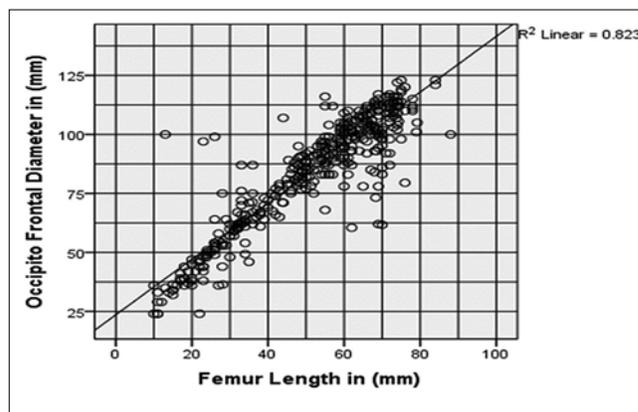


Figure 5: Linear correlation of OFD with FL

with BPD, FL, and mean abdominal diameter (AD). It provided an accuracy of estimated GA with an SD of 2.2 days.^[14,16] This supported our findings.

In the study, we found a strong linear correlation between the mean of LMP with BPD, FL, and OFD. The highest correlation coefficient was observed between LMP and femur length ($r = 0.953$). This result is consistent with Peter *et al.* who reported a strong correlation of LMP with FL ($r = 0.946$).^[17] Moreover, it was found that there is a direct proportionality linear relationship between GA and OFD with linear correlation of .924. When OFD was used for calculating the GA alone, the model regression equation was $GA = 3.663 + .286 \times OFD$ with standard error (SE) = 2.882. It revealed a strong linear correlation. This finding agreed with Blaas *et al.* who reported a significant linear correlation of OFD with LMP.^[18] When all the three parameters (FL, BPD, OFD) were incorporated the accuracy was improved (SE = 2.271), and the linear correlation increased ($r = 0.90$). Therefore, the combination of OFD with BPD and FL provided a better accurate estimation of GA in second and third trimesters. This finding agreed with Abuzeed *et al.*^[19] who estimated the GA from OFD.

Moreover, using the equation: $GA = 4.474 + .100 \times BPD + .128FL + .118 \times OFD$. With SE of 2.270 to estimate the GA provides a considerable improvement of estimation. However, according to these findings, the high accuracy of estimating GA can be obtained by the combination of FL, BPD, and OFD. Therefore, the addition of OFD to FL and BPD provides better accuracy for the determination of GA.

Our results took into account the inaccuracy of GA estimation at the end of the third trimester due to biological variability of fetal growth and maternal ethnicity that may lead to errors of fetal measurements with advancing GA.^[20,21]

Conclusion

OFD is an important accurate fetal biometric parameter. There was a linear relationship and strong correlation of OFD with FL, BPD, and GA. The regression models of OFD with a combination of BPD and FL provides an accurate prediction of GA more than using BPD and FL alone. We constructed a nomogram for OFD at second and third trimesters of pregnancy for the local Sudanese population. This nomogram may be useful to assess GA when dates of the pregnancy are unknown.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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