Sonographic Biometry of Fetal Interorbital Distance as a Predictor of Gestational Age in Enugu, Southeast Nigeria

UI Nwadike[1], KK Agwu[1], CU Eze[1], OC Okpala[2], AO Onu[3]

ABSTRACT

Objective: *The objective of this study was to develop a sonographic technique for the measurement of fetal interorbital distance (IOD) for gestational age (GA) determination and to establish a normogram of IOD for the local population.*

Methods: *The fronto-transverse sonographic technique was established as a feasible and reproducible technique for IOD measurement. Two independent and experienced sonographers tested the technique and had a coefficient of variation of 17.64% and 19.72%, respectively, which is statistically insignificant. The established technique was used to measure the IOD of 320 fetuses from the 13th week to 40th week GA, while standard technique was used to measure biparietal diameter (BPD), head circumference (HC) and femur length (FL) of the fetuses. The data obtained were used to determine the regression equation GA = 6.24 + 4.89 IOD for the prediction of the gestational age.*

Results: *There was good correlation between IOD, BPD, HC and FL. The predicted normogram of IOD was compared with normogram of the Caucasian population. The result showed that there was no statistical difference between them (*$p < 0.05$*).*

Conclusion: *Results from the study suggest that the fronto-transverse technique is a feasible and reproducible technique for IOD measurement and the established normogram of IOD can be a veritable statistic for GA prediction in our locality.*

Keywords: Fetal interorbital distance, fronto-transverse technique, gestational age, normogram, Nigeria

Biometría Sonográfica de la Distancia Interorbital Fetal Como Predictor de la Edad Gestacional en Enugu, Nigeria Suroriental

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RESUMEN

Objetivo: *El objetivo de este estudio fue desarrollar una técnica sonográfica para la medición de la distancia interorbital (DIO) fetal a fin de determinar la edad gestacional (EG) y establecer un normograma de DIO para la población local.*

Métodos: *La técnica sonográfica fronto-transversal fue establecida como una técnica factible y reproducible para la medición de la DIO. Dos ecografistas experimentados e independientes probaron la técnica y obtuvieron un coeficiente de variación (CV) de 17.64% y 19.72%, respectivamente, lo cual es estadísticamente insignificante. Se utilizó la técnica establecida para medir la DIO de 320 fetos desde la semana 13 a la semana 40 (EG), mientras que la técnica estándar fue utilizada para medir el diámetro biparietal (DBP), la circunferencia cefálica (CC), y longitud del fémur (LF) de los fetos. Los datos obtenidos fueron utilizados para determinar la ecuación de regresión EG = 6.24 + 4.89 DIO para la predicción de la edad gestacional.*

Resultados: *Hubo buena correlación entre la DIO, BPD, CC y LF. El normograma pronosticado de DIO se comparó con el normograma de la población caucásica. El resultado mostró que no hubo diferencias estadística entre ellos (*$p < 0.05$*).*

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Conclusión: *Los resultados del estudio sugieren que la técnica fronto-transversal es una técnica factible y reproducible para la medición de DIO, y el normograma establecido de DIO puede ser una estadística real para la predicción de EG en nuestra localidad.*

Palabras claves: Distancia interorbital fetal, técnica fronto-transversal, edad gestacional, normograma, Nigeria

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INTRODUCTION

Gestational age (GA) determination is a major indication in obstetric sonography. Its accurate prediction is vital to proper patient management and child delivery. Uncertain GA has been associated with adverse pregnancy outcomes including low birthweight, prenatal mortality and spontaneous delivery (1).

Ultrasonically, the following fetal parameters are routinely measured for fetal age determination: crown to rump length (CRL), mean gestational sac diameter (MGSD), biparietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC).

The last menstrual period (LMP) has been the earliest method of clinical measurement of GA. However, about 40% of all pregnancies have an uncertain LMP (2). To this end, studies comparing the sonographic estimate of the due date during the first trimester *versus* prediction by means of LMP have shown sonography to be more accurate (2). Thus, studies in sonographic measurement of various fetal body parts for GA determination showed that fetal GA can be predicted with a measure of accuracy. Results from the studies showed that fetal body parts mentioned above can be used for fetal age determination (3).

The fetal CRL and MGSD are used to determine the GA in the first trimester; the former is accurate to GA estimation by ± 4 days, while the latter is accurate to GA by ± 10 days. In the second and third trimesters, the BPD, HC, FL and AC are the parameters for GA determination. However, as the pregnancy progresses, the accuracy of these parameters vary. For instance, BPD in the second trimester is accurate to GA by ± 10 days and ± 21 days in the third trimester. Similarly, the FL is accurate to GA by ± 6 days in the 2nd trimester, while in the third trimester, it is accurate to GA by ± 14 days (4, 5). However, from 20 weeks of gestation, it is more reliable to use the mean values of BPD, FL, HC and AC because the use of a single parameter such as BPD becomes relatively unreliable. A combination of the use of these fetal parameters is known as multiple fetal growth parameters (2, 4).

The fetal interorbital distance (IOD) is the measured distance between the outer canthus of both orbits, as shown in Figs. 3 and 4. Mayden *et al* established the orbits as a parameter for gestational age determination (3). Using a single orbital diameter, Turner and Twining determined the fetal gestational age of equines (6). The fetal orbital distance is used to diagnose some intrauterine facial malformations such as hypertelorism, hypotelorism, cyclopia and cataract (7).

It has been established by various studies that there are racial variations in the size and shape of the skull. The Caucasian skull tends to be larger than that of the blacks (8, 9). Moreover, there is paucity of data on fetal IOD from the local population as a predictor of GA. Therefore, the present study aims to establish a standard and reproducible technique for IOD measurement and a normogram for the local population.

OBJECTIVE

To establish a technique for measuring the fetal IOD and to correlate values measured with other established fetal parameters age such as BPD, HC and FL for the estimation of gestational age. The values obtained will be used to develop a normogram for the local population.

SUBJECTS AND METHODS

The study was carried out at University of Nigeria Medical Centre, Nsukka, in the southeast geopolitical zone of Nigeria. The study took place between January and June 2012. Ethical clearance was obtained from University of Nigeria Medical Centre. Informed consent of all the patients scanned was obtained before the investigation was done.

Patient selection

The fetal IOD of 320 pregnant women referred for obstetric scan in the ultrasound department of the hospital was scanned. Those scanned were the women whose fetuses met the inclusion criteria; this included all fetuses with no cranial abnormality or intrauterine growth restriction. The fetuses that were scanned for IOD were from the 13th week to 40th week GA. At the 13th week of GA, the fetal skull is developed.

Scanning technique

All the subjects underwent real-time ultrasound scans using 3.5 MHz transducer with a Medison Sonoace 3200 and Philips SDR 1550 Ultrasound Machine. The patients were scanned in longitudinal and transverse positions to determine the fetal presentation and lie, and the fetal well-being was ascertained by observing the fetal heart beat and biophysical profile. Then the fetal skull was carefully scanned to determine the facial position of the fetus. The transducer was then placed sagittally across the fetal skull as shown in Fig. 1. From this position, the transducer was rotated through 90° into the transverse position as shown in Fig 2. From this position, the transducer is gradually swept down through the frontal bone to the glabella and then the nasion. The sonographic image that will

be obtained is shown in Figs. 3 and 4. The two orbits are seen as two echolucent circular structures lateral to the nasal bridge in the midline, as shown in Fig. 4. The value is read off from the screen.

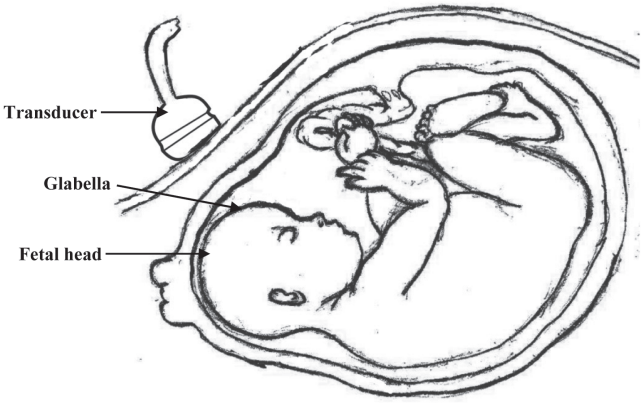

Fig. 1: The transducer in sagittal plane.

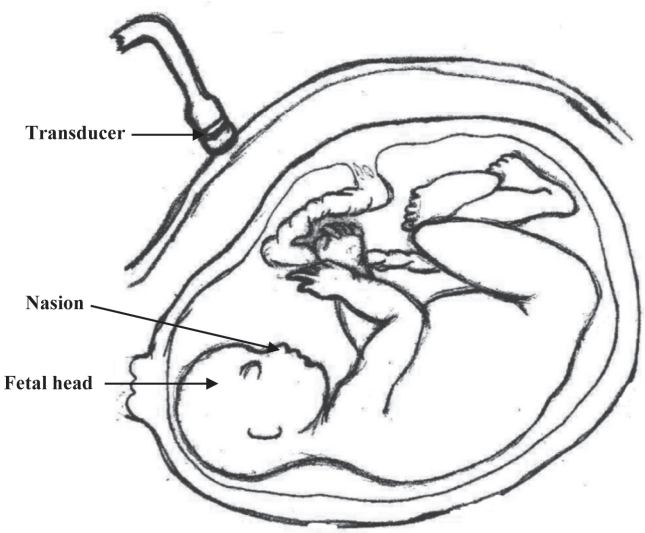

Fig. 2: The transducer in transverse plane.

Using standard techniques, the BPD, FL and HC measurements were obtained of the fetus. The results of these measurements obtained were correlated with IOD.

This new fronto-transverse technique was verified by two independent sonographers. Their results were statistically tested using coefficient of variation, which is expressed as the percentage of the standard deviation over the mean. The results obtained from the two observers were 17.6% and 19.7% and this variation is insignificant (10). The fronto-transverse technique was used to measure 320 fetal interorbital distances. Each fetus was measured three times by the researchers to minimize intra-observer error of measurement.

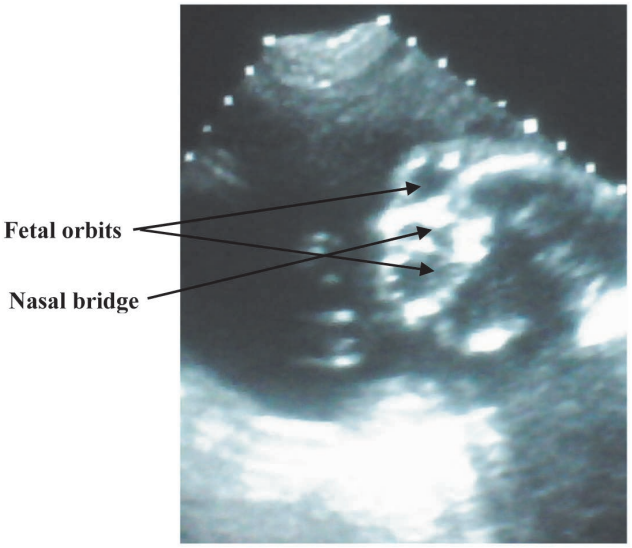

Fig. 3: Sonogram of the fetal orbits at 24 weeks gestational age.

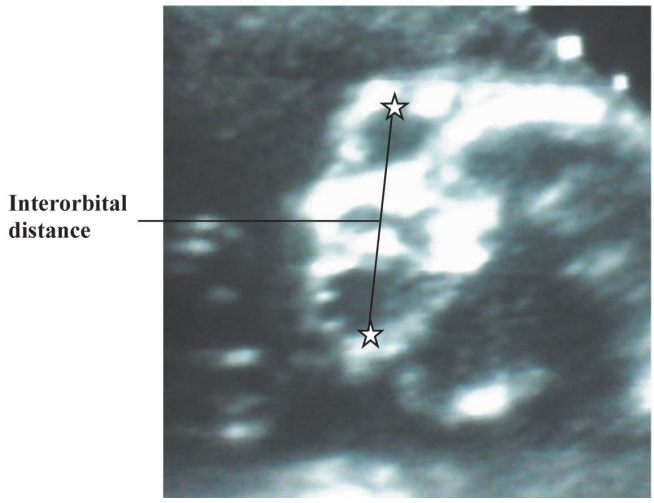

Fig. 4: Sonogram of the fetal orbits showing the cursor positions for interorbital distance. The cursor is then placed on the outer canthus of the orbits and the distance read off from the screen.

Statistical analysis

Results are reported as mean ± standard deviation (SD). Descriptive statistics were used in calculating the mean IOD and BPD. The correlation and regression analysis for establishing the relationship between IOD and BPD were done using Microsoft Statistical Packages for the Social Sciences (SPSS) version 11.0 and the ordinary least square (OLS).

RESULTS

Table 1 shows the distribution of mean values of IOD and BPD matched against the gestational age. At 12 weeks, the BPD measured 2.1 cm and IOD 1.5 cm. There is a linear increase of both parameters from the 13th week to the 40th week of gestation. The table also showed that as the pregnancy neared

term, the growth rate slowed down. The maximum value of the BPD is 9.7 cm, while the value for IOD is 6.0 cm at 40 weeks GA.

The mean IOD and the standard deviation are shown in Table 2. The minimum value of standard deviation is at 27 weeks GA with a value of 0.05 and the maximum value of 0.47 is at 37 weeks GA ($p < 0.05$).

Table 1: Mean values of interorbital distance, biparietal diameter, and corresponding gestational age

GA	IOD	BPD	No. of measurements
12	1.5	2.1	10
13	1.8	2.5	7
14	2.1	2.8	14
15	2.3	3.2	10
16	2.5	3.4	11
17	2.7	3.7	10
18	3.1	4.2	13
19	3.3	4.4	9
20	3.5	4.7	10
21	3.7	5.1	11
22	3.9	5.4	12
23	4.0	5.6	11
24	4.1	5.9	12
25	4.2	6.3	11
26	4.3	6.5	13
27	4.5	6.8	12
28	4.7	7.0	12
29	4.9	7.3	11
30	5.0	7.5	9
31	5.1	7.7	10
32	5.3	7.9	9
33	5.4	8.2	13
34	5.5	8.4	16
35	5.6	8.7	15
36	5.7	8.9	10
37	5.8	9.0	10
38	5.8	9.3	13
39	5.9	9.6	7
40	6.0	9.7	9

Total = 320

Table 2: Distribution of mean values of interorbital distance matched against gestational age and the standard deviation

	IOD	SD
12	1.5	0.22
13	1.8	0.31
14	2.1	0.1
15	2.3	0.14
16	2.5	0.09
17	2.7	0.07
18	3.1	0.22
19	3.3	0.078
20	3.5	0.38
21	3.7	0.26
22	3.9	0.22
23	4.0	0.25
24	4.1	0.18
25	4.2	0.34
26	4.3	0.41
27	4.5	0.05
28	4.7	0.13
29	4.9	0.27
30	5.0	0.24
31	5.1	0.35
32	5.3	0.19
33	5.4	0.34
34	5.5	0.39
35	5.6	0.43
36	5.7	0.42
37	5.8	0.47
38	5.8	0.32
39	5.9	0.31
40	6.0	0.25

Table 3: Correlation and regression model for interorbital distance against biparietal diameter using the formula Y = a + bx

Y	*X*	*A*	*B*	*R*
IOD	BPD	0.53	0.58	0.99
IOD	FL	1.24	0.63	0.73
IOD	HC	20.878	0.60	0.99

IOD: interorbital distance; BPD: biparietal diameter; FL: femur length; HC: head circumference

The measured values of HC, FL, BPD and IOD were correlated and the result shows a high correlation value between BPD, FL, HC and IOD, as shown in Table 3. More so, the regression equation for the mean value of IOD is thus expressed as IOD = 0.53 + 0.58 BPD.

The formula for GA prediction was determined as shown in Table 4 which is expressed as GA = 6.24 + 4.89 IOD. With the above equation, the gestational age for IOD measurement was predicted and the result is shown in Table 5. It shows that for a measured value of 1.3 cm, the gestational age is 12.59 weeks, and for a value of 6.9 cm, the GA is 39.98 weeks.

The normogram of the present study was compared with that of Mayden *et al* (3) and Sanders and Smith (11) as shown in Table 6. The tables show that for a measured value of 1.5 cm in the present study, the GA is 13.5 weeks, while it is 12.1 weeks for the study done by Mayden *et al* (3) and Sanders and Smith (11).

The two normograms were tested hypothetically, as the null hypothesis states that there is no difference in the mean IOD of the Blacks from that of the Caucasians. The result, as seen in Table 7, shows that the null hypothesis is accepted.

Table 4: Regression equation for gestational age prediction using $y = a + bx$

	Y	a	b	x
	GA	6.24	4.89	IOD

ie GA = 6.24 + 4.89
GA: gestational age; IOD: interorbital distance

Table 5: Predicted gestational age from the linear regression equation

GA weeks	IOD (cm)
12.59	1.3
13.08	1.4
13.57	1.5
14.06	1.6
14.55	1.7
15.53	1.9
16.02	2.0
16.50	2.1
17.48	2.3
18.46	2.5
19.4	2.7
19.93	2.8
20.42	2.9
20.91	3.0
21.39	3.1
22.37	3.3
23.35	3.5
24.33	3.7
25.31	3.9
25.8	4.0
26.28	4.1
26.77	4.2
27.26	4.3
28.24	4.5
29.22	4.7
30.20	4.9
31.17	5.1
31.66	5.2
32.15	5.3
33.13	5.5
34.11	5.7
34.6	5.8
35.09	5.9
35.58	6.0
36.06	6.1
37.04	6.3
38.02	6.5
39.02	6.7
39.98	6.9

GA: gestational age; IOD: interorbital distance

Table 6: Comparison of Mayden normogram and Nigerian normogram from present study

Caucasians		Blacks	
GA	**IOD**	**GA**	**IOD**
11.6	1.3	12.5	1.3
12.1	1.5	13.0	1.4
12.6	1.7	13.5	1.5
13.1	1.7	14.0	1.6
13.6	1.9	14.5	1.7
14.1	2.0	15.5	1.9
15.0	2.2	16.0	2.0
16.0	2.5	16.5	2.3
16.5	2.6	17.4	2.5
17.0	2.7	18.4	2.7
18.4	3.0	19.4	2.8
19.4	3.2	19.9	2.9
20.4	3.4	20.4	3.0
21.3	3.6	20.9	3.1
21.8	3.7	21.3	3.2
22.3	3.8	21.8	3.3
23.3	4.0	22.3	3.5
24.3	4.1	23.3	3.7
25.2	4.3	24.3	3.7
25.7	4.3	25.3	4.0
26.2	4.4	25.8	4.1
27.2	4.5	26.2	4.2
27.6	4.6	26.7	4.3
28.1	4.7	27.2	4.5
29.1	4.8	28.2	4.7
30.0	5.0	29.2	4.9
31.0	5.1	30.2	5.0
32.0	5.2	30.6	5.1
33.0	5.4	31.1	5.2
34.0	5.4	31.6	5.3
35.0	5.5	32.2	5.4
36.4	5.6	33.1	5.5
37.3	5.7	34.1	5.7
38.3	5.8	34.6	5.8
39.3	5.9	35.0	5.9
39.8	5.9	35.5	6.0
		36.0	6.1
		37.0	6.3
		38.0	6.5
		39.0	6.7
		40.0	6.9

GA: gestational age; IOD: interorbital distance

Table 7: Result of test hypothesis

$$Z = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S^2_1}{N_1} + \frac{S^2_2}{N_2}}}$$

$\overline{X_1}$	$\overline{X_2}$	S_1	S_2	N_1	N_2
4.10	3.53	1.64	1.56	42	46

$Z = 1.38$

DISCUSSION

The sonographic technique used to obtain the two orbits in the same sonotomographic plane is important for ease and reproducibility. The technique used in this study is the fronto-transverse technique; this technique varies from the cranio-transverse technique employed by Mayden *et al* (3) and the coronal and axial planes used by Goldstein and Zeer Weiner (12). The result obtained with this technique demonstrates the orbits in the same sonotomographic plane as shown in Figs. 3 and 4. The technique was assessed for reproducibility by two independent sonographers. The coefficient of variation obtained is not statistically significant ($p > 0.05$).

Gold standard parameters for fetal age determination include BPD, FL and HC. In the present study, we correlated the values of IOD obtained from our results with these established parameters. Interorbital distance correlated highly with measured values of BPD, FL and HC. This now implies that IOD is a parameter for GA determination. This agrees with studies done by Jeanty *et al* (13) and Mayden *et al* (3).

The orbits are visualized sonographically from the onset of the second trimester. They appear as two echolucent circles in the face of the fetus lateral to the nose in the midline. The IOD increases linearly as the fetus grows. This finding is in keeping with other studies by Turner and Twining where a single orbit of fetal equine is used as a marker for GA prediction (6). Earlier studies by Mayden *et al* (3) and Jeanty *et al* (13) show that orbital diameter increases as the fetus grows.

The measured values of BPD, FL and HC were correlated with IOD, and the results as follows were BPD (r = 0.99), HC (r = 0.99) and FL (r = 0.75), respectively. This agrees with the studies done by Jeanty *et al* (13), Mayden *et al* (3) and Denis *et al* (7), and implies that IOD distance can be used as a parameter for GA estimation.

The regression equation derived from the data shows that IOD = 0.53 + 0.58 BPD. The equation was used to determine the IOD. Using the least mean squares approach, the resultant linear regression equation for GA was derived as GA = 6.24 + 4.89 IOD. The present normogram was compared with normogram of the Caucasian population by Mayden *et al* (3). The result indicates no statistical difference ($p > 0.05$). Slight variation observed is that at 35 weeks GA, the value of IOD for the present study is 5.9 cm, while this is the value for the Caucasian population at 40 week GA.

CONCLUSION

From our study, the fronto-transverse technique used in the present study to obtain the values of fetal IOD is reproducible and feasible. The normogram of IOD thus predicted is recommended for GA prediction in our locality and for statistical comparisons with other racial normograms.

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