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Ultrasonic foetal abdominal circumference as a means of assessing gestational age in Nigerians

B. O. OSINUSI* AND O. OGUNSEYINDE

*Departments of *Obstetrics & Gynaecology and Radiology, University College Hospital, Ibadan, Nigeria*

Summary

Foetal abdominal circumference values have been established amongst pregnant Nigerian women between 16 weeks and 40 weeks of gestation, using standard ultrasound methods.

A linear mathematical model was found to be adequate in describing the relationship between gestational age and abdominal circumference, and by using the regression equation from the data it was possible to predict the gestational age from knowledge of the abdominal circumference and vice versa. The value of this parameter in assessing foetal age and monitoring high risk pregnancies is discussed.

Résumé

Les valeurs pour la circonférence abdominal des foetus ont été établi parmi les Nigérianes enceintes entre la 16e et la 40e semaine de gestation utilisant les méthodes ultrasons normales.

Nous avons trouvé un model mathématique linéaire adéquat pour décrire le rapport entre l'âge de gestation et la circonférence abdominale, et utilisant en plus l'équation de régression tirée de ces données, il a été possible de prédire l'âge de gestation à partir d'une connaissance de la circonférence abdominale et vice versa. Nous discutons finalement la valeur de ce paramètre pour estimer l'âge foetal et pour contrôler les grossesses aux risques élevés.

Introduction

Foetal abdominal circumference measurement was first described by Campbell and Wilkin [1] as a means of estimating foetal weight. In a later publication Campbell and Thoms [2] described the value of the head:abdomen circumference ratio in the identification and management of intra-uterine growth retardation. Several authors have since reported the value of the foetal abdominal circumference measurement in estimating gestational age [3–5], especially in situations where the biparietal diameter (BPD) measurement may be inaccurate, such as in a breech presentation, or in occipito-anterior position of the foetal head.

It was the aim of this study to establish the normal abdominal circumference values amongst pregnant Nigerian women at different gestational ages, and also to test the reliability of the parameter by using mathematical models to predict gestational age.

Subjects and methods

The subjects (242) were all pregnant women attending antenatal clinics at the University College Hospital, Ibadan. To qualify for recruitment, the subjects had to be certain of the dates of their last menstrual periods, be carrying uncomplicated singleton pregnancies, and have been shown to have no obvious disparity between the given date and the uterine size on clinical examination.

All the scans and measurements were performed by one of us (B.O.O.) with a Philips SDR 1000 ultrasound machine equipped with a 2.5 MHz linear array transducer and an electronic Caliper system calibrated at a sound speed of 1540 m/sec.

The abdominal circumference was obtained by taking a transverse section through the upper abdomen, showing the umbilical vein at the level of the foetal liver as described by Campbell and Wilkin [1]. It was always ensured

*To whom correspondence should be addressed.

that the section was as round as possible to avoid an oblique section through the abdomen.

Where the foetal spine was directly anterior, thus obscuring the umbilical vein, the foetal stomach was used as a reference point instead. This section was then measured along the antero-posterior (AP) and transverse diameters (TD).

Two separate measurements of each diameter were taken from every foetus and the mean value of each pair was used to compute the abdominal circumference (AC) using the formula:

$$AC = (AP + TD) \times 1.57 \quad [6].$$

Altogether, 285 AC measurements were taken from 242 subjects at 2-weekly intervals between 16 weeks and 40 weeks. The majority of the subjects were scanned only once, while a few were scanned two or three times.

The mean AC values ± two standard deviations (2SD) were calculated using standard methods, while a linear mathematical model was used to describe the relationship between gestational age and foetal AC. The optimal coefficient estimates were obtained by the least squares method, and the adequacy of the function was evaluated by measurement of the coefficient of correlation, (r).

Results

Table 1 shows the mean AC values ± 2SD at 2-weekly intervals between 16 weeks and 40 weeks, and the same data is presented graphically in Fig. 1. Table 2 shows the predicted gestational ages against the actual menstrual age at various AC measurements, using the regression equation GA = 6.72 + 0.96AC. The linear mathematical model gave a highly significant relationship between gestational age and foetal AC ($r = 0.998$; $P < 0.0001$). The equation is therefore reliable for predicting gestational age from AC values.

The residuals were very small and no significant patterns emerged. Table 3 compares the values obtained in this study with previous studies.

Discussion

The most frequently used, and perhaps the easiest to determine of all foetal biometric parameters available for estimating gestational age, is the BPD. However, it is known to be less reliable after 26 weeks, with a variability of 7–10 days at a 95% confidence level [7]. Also, BPD may be difficult to obtain in some cases, either because the head is engaged or because it is malrotated. In each of these situations the AC would be an alternative parameter to measure.

Table 1. Mean abdominal circumference values ± 2SD at 2-weekly intervals between 16 and 40 weeks

Gestational age (weeks)	Mean abdominal circumference ± 2SD (cm)	n
16	9.3 ± 1.3	12
18	11.86 ± 1.6	10
20	13.83 ± 2.0	16
22	16.3 ± 2.4	21
24	18.24 ± 2.6	24
26	20.6 ± 2.0	19
28	23.96 ± 2.3	18
30	26.25 ± 2.5	24
32	29.0 ± 1.8	26
34	31.2 ± 2.2	32
36	33.3 ± 2.2	25
38	34.9 ± 2.6	30
40	35.8 ± 2.7	28

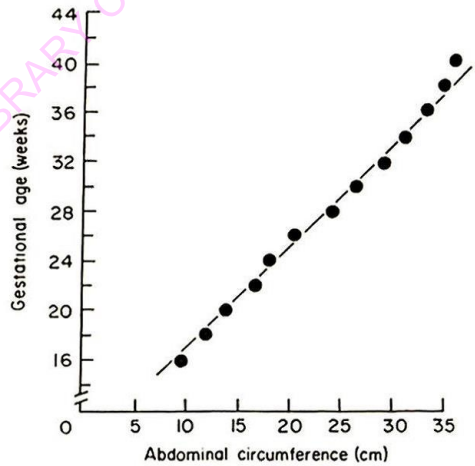

Fig. 1. Relationship between abdominal circumference and gestational age.

Table 2. The predicted and the actual gestational age at different abdominal circumferences*

Mean abdominal circumference (cm)	Actual gestational age (weeks)	Predicted gestational age (weeks)
9.3	16	15.6
11.86	18	17.5
13.83	20	20.0
16.3	22	22.3
18.24	24	24.2
20.6	26	26.6
23.96	28	27.9
26.25	30	30.1
29.0	32	32.3
31.2	34	34.5
33.3	36	36.0
34.9	38	38.1
35.8	40	38.9

*The relationship between the predicted and actual gestational age was significant: $r = 0.998$; $P < 0.0001$.

However, it must be stressed that foetal AC measurement is not a better predictor of gestational age than BPD, except in the situations mentioned above, and after 36 weeks of gestation [4].

The various causes of non-reliability include biological variability, inaccuracies in the measurement such as taking an oblique section which could elevate the circumference, and occasional late flattening of the foetal abdomen [4].

Its value in assessing foetal growth is, however, generally enhanced when it is used in conjunction with other biometric parameters.

The data presented in this study have been obtained by measuring the circumference at the level of the liver as described by Campbell and Wilkin [1]. Some other workers [8] have advocated measurement at the level of the bifurcation of the main portal vein into its left and right branches, as the vein is not situated in an exactly transverse plane. However, Defoort *et al.* [9] in a randomized study have shown no statistically significant differences in the values obtained by the two methods. Most authors prefer to use the former method as it is more reproducible.

The data obtained in this study compare favourably with similar data obtained amongst Caucasians, and it is hoped that the experience gained in the study will form the basis for further work aimed at determining foetal weights *in utero* using abdominal circumference in conjunction with other parameters in various statistical models.

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Table 3. Comparison of data from this study with previous studies

Gestational age (weeks)	Campbell (1976) [10]	Hadlock *et al.* (1982) [4]	Tamura *et al.* (1980) [5]	Present study
18	12.8	12.9	13.1	11.86
20	14.8	15.2	15.4	13.83
22	17.0	17.5	18.0	16.3
24	19.5	19.7	20.5	18.24
26	21.3	21.9	22.1	20.6
28	23.3	24.0	25.3	23.96
30	25.3	26.0	27.4	26.25
32	27.7	28.0	28.7	29.0
34	29.7	30.0	30.1	31.2
36	32.0	31.8	33.3	33.3
38	33.5	33.6	35.7	34.9
40	35.3	35.4	36.1	35.8

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