Ultrasonic measurement of biparietal diameter and femur in foetal age determination

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Summary

Our objective was to verify ultrasonic measurement of biparietal diameter and femur in foetal age determination in the second and third trimester of pregnancy. The prospective cross-sectional study was carried out at the ultrasound department of Aberdeen Maternity Hospital Scotland. The study population consisted of 716 pregnant Scottish (Caucasian) women who were certain of their gestational ages and had their gestational ages confirmed in the first trimester by ultrasound. The findings revealed: (1) Linearity through out pregnancy using the femur length measurements while that of the biparietal diameter demonstrated poor correlation after 32 weeks of gestation. (2) The standard deviation and the correlation coefficient of the femur length measurements were 0.0042 and 0.9920 respectively while the corresponding values for biparietal diameter were 0.0045 and 0.9850 respectively. (3) The standard error for femur length estimate was 0.2251 as against 0.3009 for biparietal diameter estimate.

The results suggest that femur length measurement is a more reliable index of late third trimester gestational age prediction than biparietal diameter.

Keywords: Gestational age, Prediction, Biparietal diameter, Femur length.

Résumé

Notre objectif était de vérifier le diamètre foetal bi-parié
tal et la mesure de la longueur du fémur au moyen de l’ultra
sound dans détermination de l’âge du foetus dans le second et
le troisième trimestre de la grossesse. L’étude prospective
échantillonnée a été effectuée au département de d’ultrason
de la maternité d’Aberdeen en Ecosse (Aberdeen Maternity
Hospital, Scotland). La population étudiée était de 716 femm
es Scottish (Caucasian) enceintes, connaissant l’âge de leur
foetus au premier trimestre de la grossesse et qui a été confrimée par l’ultrason. Les résultats ont révélé: (1) une linéarité
dans les mesures de la longueur du fémur pendant la grosses
se alors qu’il n’y a eu qu’une faible corrélation dans le
cas du diamètre bi-pariétal après 32 semaines de grossesse.
(2) L’écart type et le coefficient de corrélation des mesures
du fémur étaient respectivement de 0.0042 et 0.9920, alors
que dans le cas du diamètre bi-pariétal ces grandeurs avaient
pour valeurs respectives 0.0045 et 0.9850. (3) L’erreur stan
dard pour la longueur du fémur était de 0.2552 contre 0.3009
pour l’estimation du diamètre bi-pariétal.

Les résultats suggèrent que, pour la prédiction de l’âge
du foetus vers la fin du troisième trimestre de grossesse, la
mesure de la longueur du fémur est plus fiable que le diamètre
bi-pariétal.

Introduction

It has been documented by various workers that fetal
biparietal diameter measurement in the determination of fetal
gestational age before 30 weeks can provide accuracy but
the precision decreases there after. It has also been docu
mented that accurate measurement of fetal biparietal diam
eter can be difficult under certain conditions such as deeply
engaged fetal head, direct occipito-anterior or occipito-pos
terior position, and breech presentation.

The measurement of fetal femur length is however easily
done with the use of improved real time Ultrasound scanners
under the conditions in which biparietal diameter is difficult
to measure.

This study examined the accuracy of gestational age
assessment based on biparietal diameter and femur length
measurements from 14 - 40 weeks gestation.

Materials and methods

The study population consisted of pregnant women who
had ultrasound done at the ultrasound scan unit of Aber
deen Maternity Hospital, United Kingdom. All the patients
included were certain of their date and had their gestational
ages confirmed in the first trimester by ultrasonic measure
ment of crown rump length.

The ultrasound machine used for this study was ultra
mark 4 real time ultrasound equipped with 5MHz linear trans
ducer. All the scans were performed by the first author. The
biparietal diameter measurements were obtained at the level
of the thalamus according to the standard technique Patricia
et al. The femur length was measured electronically with calipers
along the axis of the calcified points at both ends of the
femur. The largest measurement was used for this study
as recommended by Mahoney and Hobbins, and Mongellis
and Gardosi. An average of three different measurements
of both biparietal diameter and femur lengths were obtained.

Altogether there were 716 measurements recorded. It
was a cross sectional study and each patient was measured
once at a particular gestation after the first trimester. The
data was analysed by SPSS-PC (Release 5.0, SPSS Inc, Chi
cago, IL, USA) using a method of least square linear regres
sion. The predicted gestational ages for both biparietal di
ameter (BPD) and femur length measurements (FL) were
determined from the regression results using the following equa
tions respectively.

\[ GX_1 = BDP (b_1) + b_2 \]
\[ GX_2 = FL (b_3) + b_4 \]
\[ GX_1 = \text{Predicted gestational age for BPD measurements} \]
\[ BPD = \text{Mean of biparietal diameter at a particular gestation} \]
\[ b_1 = \text{Regression coefficient (slope) of BPD} \]
\[ b_2 = \text{Regression constant or intercept of BPD} \]
\[ GX_2 = \text{Predicted gestational age for femur length measurements} \]
\[ FL = \text{Mean of femur length at a particular gestation} \]
\[ b_3 = \text{Regression coefficient of femur length (slope)} \]
Regression constant or intercept of femur length.

Results

Table 1 shows clearly that the predicted gestational age using femur length measurements were closer to that of the menstrual age in both the second and third trimester. The predicted gestational ages using biparietal diameter, however, varied from that of the menstrual age after 32 weeks of gestation.

Table 1 Comparison between femur length and biparietal diameter (BPD) estimates for predicted gestational ages and the menstrual ages.

<table>
<thead>
<tr>
<th>Femur length (mm)</th>
<th>Menstrual age (wks)</th>
<th>Predicted gestational age (wks)</th>
<th>BPD (mm)</th>
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<th>Predicted gestational age (wks)</th>
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Table 2 Parameters estimates for least squares regression line for relationship between gestational age biparietal diameter and femur length

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
<th>Value</th>
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<tr>
<td>Gestational age versus Bipariet</td>
<td>0.3493 (B1)</td>
<td>0.4129 (B3)</td>
</tr>
<tr>
<td>Gestational age versus Femur</td>
<td>1.6033 (B2)</td>
<td>6.5398 (B4)</td>
</tr>
<tr>
<td>Regression coefficient</td>
<td>0.0045</td>
<td>0.0042</td>
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<tr>
<td>Standard deviation</td>
<td>0.3009</td>
<td>0.2251</td>
</tr>
<tr>
<td>Correlation coefficient</td>
<td>0.9850</td>
<td>0.9920</td>
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</table>

Discussion

The prediction of gestational age by biparietal diameter measurements before 30 weeks gestation can provide accuracy but its precision declines thereafter.\textsuperscript{3,11} It has been documented that proper measurement of biparietal diameter can often be difficult under the following conditions: deeply engaged fetal head, direct occipito-anterior and occipito-posterior positions and in breech presentation.\textsuperscript{1} Furthermore, with the aid of real time ultrasound, the femur length can easily be measured under the conditions in which biparietal diameter measurement is difficult.\textsuperscript{12}

This study was designed to compare the accuracy of predicting gestational age by the measurements of biparietal diameter and femur length in the second and third trimester.

The results demonstrate a linear relationship between the predicted and the menstrual ages throughout the second and third trimester using the femur length measurements, whereas there was a considerable variation with that of biparietal diameter measurement after thirty-two weeks of gestation. This study reaffirms the findings of previous workers.\textsuperscript{1,5} These findings also reaffirm the fact that the growth rates of Biparietal diameter and femur length follow a characteristic pattern with maximal growth rate at different gestation.\textsuperscript{4}

Although the measurement of femur length by ultrasound is not intended to replace biparietal diameter measurements of fetal age determination, it nevertheless would add to the reliability of fetal age determination in late third trimester.

Figure 1 also demonstrates stronger linearity in femur length measurements as compared to biparietal diameter in late third trimester. Table 2 shows that the standard deviation and the standard error for femur length 0.0042 and 0.2251 respectively were smaller than that of the biparietal diameter which were 0.0045 and 0.3009 respectively. There was also a stronger significant coefficient of correlation between femur length measurement and gestational age $r = 0.9920$ than that of biparietal diameter $r = 0.9850$. 

![Figure 1 Comparison between femur length and biparietal diameter (BPD) estimates for predicted gestational age and menstrual age.](image-url)
References


