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Gynaecology

A COMPARISON OF THE FETAL MEASUREMENTS FOR SONOGRAPHIC ESTIMATION OF GESTATIONAL AGE AT 10 TO 14 COMPLETED WEEKS

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ABSTRACT

Objectives: To compare the correlation of sonographic fetal measurements to the estimated gestational age and foot length at 10-14 completed weeks' gestation

Methods: The fetal measurements in 35 routine Obstetric scans performed at 10-14 completed weeks' gestation in women attending antenatal care were obtained and compared to the estimated gestational age and the foot length.

Results: The crown rump length (CRL), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) showed a linear correlation with the estimated gestational age (GA) and foot length (FT) ($p<0.001$), with the least correlation observed with CRL. A combination of fetal parameters correlated with FT or GA better without CRL ($R2 = 0.881$ and 0.817 respectively) than with ($R2 = 0.685$ and 0.560 respectively).

Conclusion: The fetal BPD, HC, AC and FL correlate better with GA and FT compared with CRL alone or in combination at 10-14 weeks gestation.

KEYWORDS : ultrasonography; fetus; pregnancy; first trimester

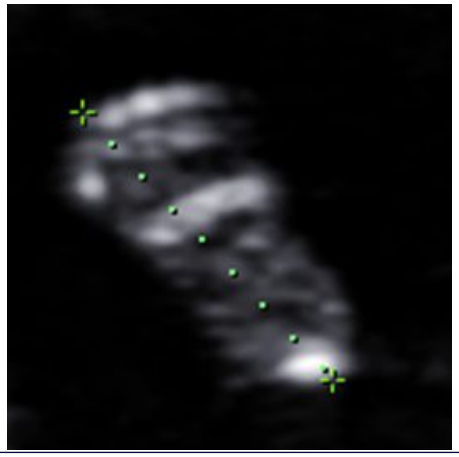
Introduction

Fetal foot length has been reported by Streeter to bear a linear correlation with gestational age histologically in 704 human fetal specimens from as early as 50 days post-conception to term. (Streeter, 1920) A close and linear correlation has been confirmed by later studies in dead (Manjunata, 2012) (Croft, 1999) (Hern, 1984) (Conway, 2013) (Hirst, 2012) and live fetuses (Mercer, 1987) (Platt, 1988) (Goldstein, 1988) (Kustermann, 1992) alike. In Obstetrics, crown rump length has been used traditionally for assessment of fetal gestation at 10-14 weeks gestation. However, it is well known that fetal position has a major effect on crown rump length measurement in this period. In this paper, we would like to compare the performance of various fetal measurements compared to crown rump length in the assessment of the gestational age at 10-14 weeks gestation, using fetal foot length as an alternative estimate for gestational age.

Method and material:

Routine transabdominal Obstetric ultrasound scan was performed from 7th March 2014 to 7th September 2016 in women attending an Obstetric clinic with normal pregnancies at 10-14 completed weeks' gestation (Accuvix V20 Prestige, Medison with 4-8MHz volumetric transducer or EPIQ 7, Philips with X6-1 matrix transducer) for crown rump length (CRL), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and foot length (FT). Cases were excluded if the entire fetal foot could not be clearly visualized. The fetal foot length was measured from the most posterior point of the foot to the tip of the first or the second toe whichever was longer, as outlined in a previous paper (Fig. 1) (Wong, 2017).

Fig. 1: The measurement of fetal foot on ultrasonogaphy



The fetal foot length was measured from the most posterior point of the foot to the tip of the first or the second toe whichever was longer.

Gestational age in weeks (GA) was estimated from the last normal menstrual period (LMP) or from the first trimester dating scan if there was a discrepancy of more than a week. Ethics approval was not sought within the institution as the study involved minimal risk and conformed to the standards established by the NHMRC not requiring ethical review (NHMRC, 2015).

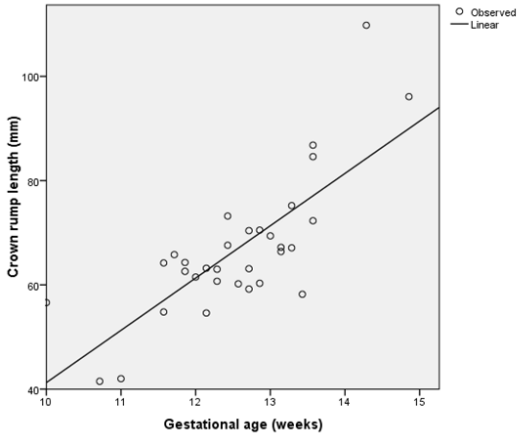
Statistical analysis was performed with Statistical Package for the Social Sciences version 21.0 (SPSS Inc., Chicago, IL, USA). A two-sided probability (p) value of <0.05 was considered statistically significant.

Results:

Thirty-five women from 10-14 completed weeks of pregnancy were recruited. The mean and standard deviation of their age, gravidity and parity were 32.0 ± 4.6 years, 2.3 ± 1.5 and 0.7 ± 0.7 respectively.

The graphs of fetal measurements CRL, BPD, HC, AC, FL and FT (mm) against estimated gestational age are shown in Fig. 2-7, and CRL, BPD, HC, AC, FL against FT are shown in Fig. 8-12. A linear correlation was observed for all these parameters ($p<0.001$).

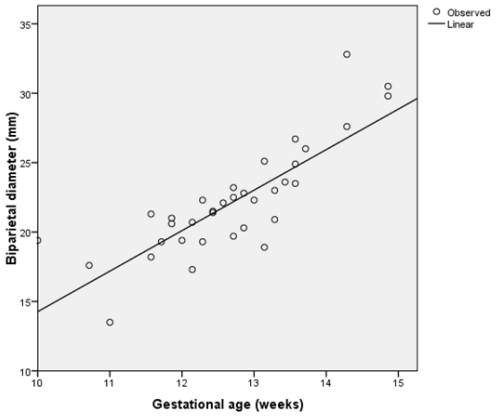
Fig. 2: The graph of crown rump length against the estimated gestational age at 10-14 completed weeks' gestation



Equation: CRL = 10.464 x GA – 64.682
R = 0.78

CRL, crown rump length in mm; GA, estimated gestational age in weeks

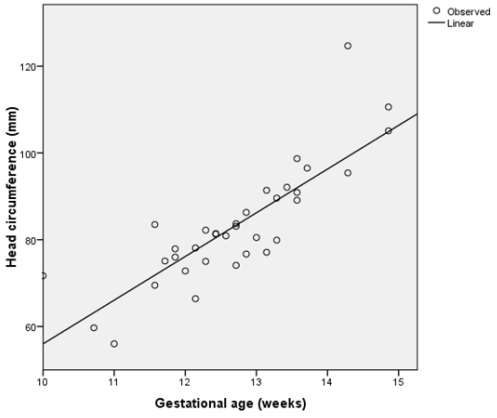
Fig. 3: The graph of biparietal diameter against the gestational age at 10-14 completed weeks' gestation



Equation: BPD = 3.01 x GA -15.967
R = 0.83

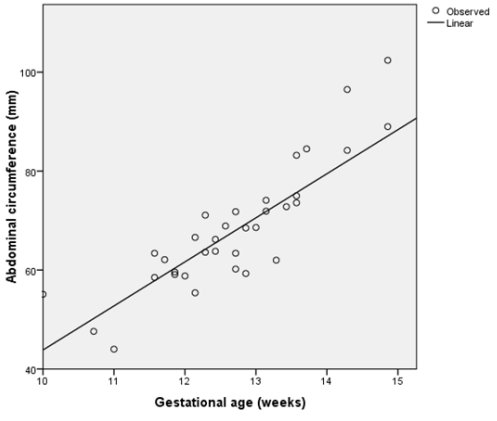
BPD, biparietal diameter in mm; GA, gestational age in weeks

Fig. 4: The graph of head circumference against the gestational age at 10-14 completed weeks' gestation



Equation: HC = 10.488 x GA – 49.951
R = 0.84
HC, head circumference in mm; GA, gestational age in weeks

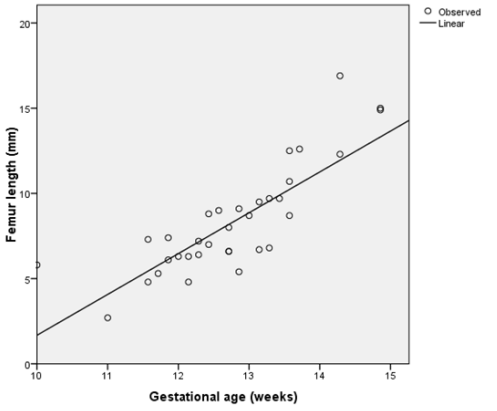
Fig. 5: The graph of abdominal circumference against the gestational age at 10-14 completed weeks' gestation



Equation: AC = 10.16 x GA – 60.453
R = 0.88

AC, abdominal circumference in mm; GA, gestational age in weeks

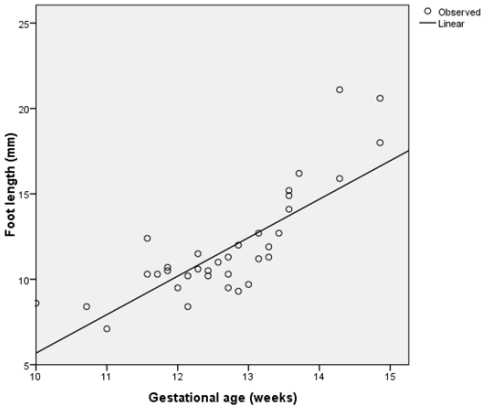
Fig. 6: The graph of femur length against the gestatonal age at 10-14 completed weeks' gestation



Equation: FL = 2.56 x GA -24.255
R = 0.84

FL, femur length in mm; GA, gestational age in weeks

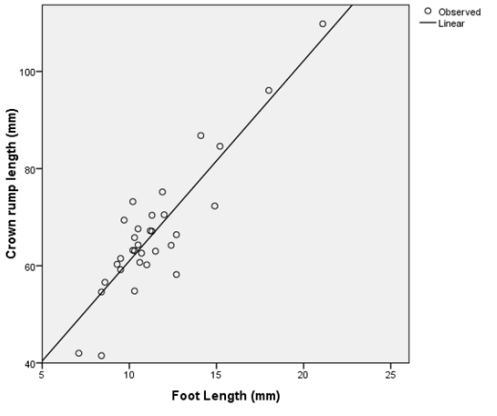
Fig. 7: The graph of foot length against the gestational age at 10-14 completed weeks' gestation



Equation: FT = 2.472 x GA – 19.44
R = 0.82

FT, foot length in mm; GA, gestational age in weeks

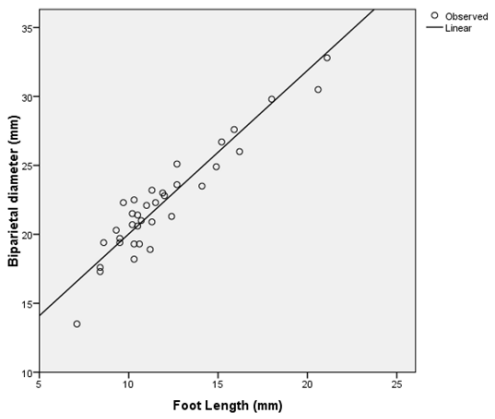
Fig. 8: The graph of crown rump length against the foot length at 10-14 completed weeks' gestation



Equation: CRL = 4.291 x FT + 17.635
R = 0.90

CRL, crown rump length in mm; FT, foot length in mm

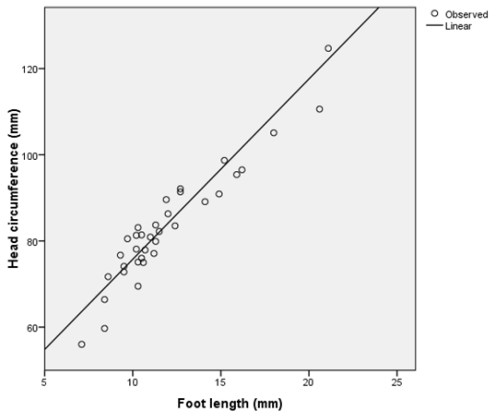
Fig. 9: The graph of biparietal diameter against the foot length at 10-14 completed weeks' gestation



Equation: BPD = 1.131 x FT + 8.748
R = 0.94

BPD, biparietal diameter in mm; FT, foot length in mm

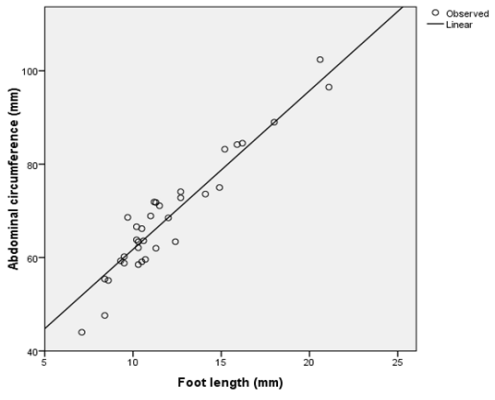
Fig. 10: The graph of head circumference against the foot length at 10-14 completed weeks' gestation



Equation: HC = 3.932 x FT + 36.257
R = 0.95

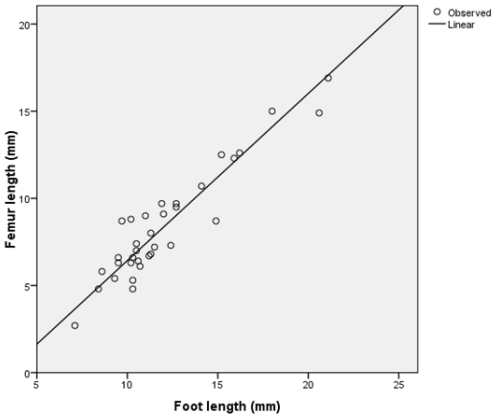
HC, head circumference in mm; FT, foot length in mm

Fig. 11: The graph of abdominal circumference against the foot length at 10-14 completed weeks' gestation



Equation: AC = 3.639 x FT + 24.905
R = 0.95
AC, abdominal circumference in mm; FT, foot length in mm

Fig. 12: The graph of femur length against the foot length at 10-14 completed weeks' gestation



Equation: FL = 0.922 x FT - 2.707
R = 0.94

FL, femur length in mm; FT, foot length in mm

The correlation of fetal parameters to the estimated gestation age and to the foot length (FT) (mm) are shown in Table 1.

Table 1: Correlation of fetal sonographic parameters (mm) to estimated gestational age (weeks) and fetal foot length (mm)

Sonographic fetal parameters	Correlation coefficients in relation to			
	Gestational age	p†	Fetal foot length	p†
CRL	0.78	<0.001*	0.90	<0.001*
BPD	0.83	<0.001*	0.94	<0.001*
HC	0.84	<0.001*	0.95	<0.001*
AC	0.88	<0.001*	0.95	<0.001*
FL	0.84	<0.001*	0.94	<0.001*
FT	0.82	<0.001*	-	

CRL, crown rump length; BPD, biparietal diameter; HC, head circumference; AC, abdominal circumference; FL, femur length; FT, foot length; †, ANOVA; p, probability; *, statistically significant When a combination of all these fetal parameters was used to correlate with the estimated gestational age, the R^2 for this model was 0.56 ($p < 0.001$, ANOVA). With the exclusion of CRL from the cluster of fetal parameters, the R^2 became 0.685 ($p<0.001$, ANOVA). The R^2 for the combination of CRL, BPD, HC, AC, FL against the gestational age was 0.817 ($p<0.001$, ANOVA), and became 0.881 when CRL was removed ($p<0.001$, ANOVA) (Table 2). Of note, the R^2 for CRL against the estimated gestational age and FT were 0.61 and 0.81 respectively.

Table 2: The comparison of models using combinations of sonographic fetal parameters in the estimation of gestational age at 10-14 completed weeks' gestation

Combination of fetal parameters	Correlation to estimated gestational age or foot length	
	R2	p†
CRL, BPD, HC, AC, FL, FT	0.56	<0.001*
BPD, HC, AC, FL, FT	0.685	<0.001*
CRL, BPD, HC, AC, FL	0.817	<0.001*
BPD, HC, AC, FL	0.881	<0.001*

CRL, crown rump length; BPD, biparietal diameter; HC, head circumference; AC, abdominal circumference; FL, femur length; FT, foot length; †, ANOVA; p, probability; *, statistically significant.

The Pearson coefficient was 0.992 for intra-observer correlation ($p < 0.001$) and 0.990 for inter-observer correlation ($p < 0.001$) in the measurement of fetal foot length.

Discussion:

Accuracy in assessment of gestational age in the first trimester is important for comparison of fetal growth (Reece, 1989), assignment of risk scores (Bindra, 2002) and prediction of abnormality in singleton (Bernard, 2013) and twin pregnancies (El Kateb, 2007) (D'Antonio, 2013), and for the estimation of due date (Committee opinion no. 611) and the subsequent management of post-term pregnancies (Whitworth, 2015) (Butt, 2014). CRL has been used for assessment of fetal gestational age in early pregnancy for decades (Robinson, 1975), and new charts have been derived over the time (McLennan, 2008) (Verburg, 2008) (Sahota 2009) (Pexters, 2010) (Papageorghiou, 2014). It has been noticed that there could be some variation (in terms of a few days) in the estimation of fetal gestational age using CRL among these studies (Napolitano 2014). In a previous paper (Wong, 2017), it has been shown that fetal foot length is an accurate estimate of the gestational age in early pregnancy. In this study, we explore the value of the use of other fetal parameters alone or in combination, in comparison to CRL in the estimation of gestational age, using fetal foot length as a surrogate for gestational age rather than estimate based on the last menstrual period.

In this study, the correlation of fetal parameters with the foot length is higher than with the estimated gestational age by date or early scan at a gestation of 10-14 completed weeks. Of note, the correlation between CRL and estimated gestational age or foot length is lower compared with the other parameters (Table 1). This is likely to be related with the effect of fetal posture on the CRL measurements. Thus CRL may not be the best parameter for estimation of fetal gestational age at 10-14 completed weeks. A combination of BPD, HC, AC and FL (± FT) gives a better estimate for gestational age. Moreover, in situation when fetal abnormality is suspected, the use of a combination of fetal measurements may take care of the potential erroneous estimation of fetal gestational age based on a single fetal parameter alone.

The main limitation for this study is the small sample size and its retrospective nature. However, data were collected prospectively and the results are highly statistically significant.

Conclusion:

At 10-14 completed weeks' gestation, the correlation of CRL to the gestational age or foot length is lower compared with the other fetal parameters, namely BPD, HC, AC and FL. The use of a combination of fetal parameters with or without CRL gives a better estimation of gestational age compared to CRL alone.

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