

Fetal Foot Length as a Biometric Parameter in Estimation of Gestational Age

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Abstract

Introduction: Sonographic fetal measurements provide information about fetal age and growth. Accurate knowledge of gestational age is important for several reasons. The timing of chorionic villus biopsy in the 1st trimester, genetic amniocentesis in the 2nd trimester, and timing of elective induction/cesarean delivery in the 3rd trimester depends on GA. This study assesses the efficacy of fetal foot length measurement as a biometric parameter in predicting gestational age.

Aim: This study aims to evaluate the role of fetal foot length as a biometric parameter in estimation of gestational age along with conventional parameters biparietal diameter, femur length, and abdominal circumference in normal pregnancy.

Materials and Methods: Pregnant women of gestational age 15–40 weeks attending the antenatal outpatient department and inpatient department during the second and third trimesters in Kilpauk Medical College, Chennai, were assessed clinically and other conventional. USG parameters were measured. After getting approval from the ethical committee, Kilpauk Medical College, the study was done with patient consent. A thorough obstetric examination was made and documented. Under the guidance of expert sonologist, USG estimation of BPD, FL AC, and foot length were done. The role of fetal foot length measurement as a reliable parameter in predicting gestational age and conventional parameters was then analyzed and reported.

Results: Fetal foot length correlates well with the conventional parameters such as biparietal diameter, femur length, and abdominal circumference. The correlation coefficient [R] of fetal foot length is 0.9827, 0.9563, and 0.9791 with BPD, FL, and AC, respectively. The correlation of fetal foot length with conventional parameters is statistically significant with $P < 0.0001$ in all of the above three correlations.

Conclusion: Fetal foot length is a reliable biometric parameter in predicting accurate gestational age on which obstetric decisions can be made with precision for a better perinatal outcome.

Key words: Fetal foot length, Gestational age, Ultrasonographically age estimation

INTRODUCTION

Introduction of sonography to obstetrics by Donald *et al.* in 1958 is now regarded as one of the modern medicine's significant milestones. Recent advances such as color Doppler and high-intensity transducers have made diagnosis more precise. A technologically advanced four-dimensional ultrasound allows the clinician to acquire a single volume that can be reformatted at any orientation. A subsequent meta-analysis published

by Bucher and associates based on four randomized controlled studies with data on 15,935 women found that perinatal mortality rate was much reduced in the group of patients subjected to routine USG.^[1] Accurate knowledge of gestational age is essential for a number of reasons. The diagnosis of preterm labor and the characterization of pregnancy as postdated depend mainly on accurate fetal age calculation. Knowledge of fetal age can be critical in distinguishing normal from pathologic fetal development. Many sonographic parameters have been proposed for estimating GA in the 1st, 2nd, and 3rd trimesters. The American College of Radiology, American Institute of USG in Medicine, and American College of Obstetrics and Gynaecology, parameters recommended for accurate gestational age estimation is biparietal diameter (BPD), abdominal circumference (AC), and femoral length (FL).^[1]

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Crown rump length (CRL) is the best biometric parameter in the first trimester; biparietal diameter closely correlates in mid-trimester abdominal circumference forms an important measure in evaluating appropriate growth; and femur length is the best in the evaluation of skeletal dysplasia. The use of more than 1 predictors is shown to have improved accuracy of estimates. We should take into account various epidemiological factors in assessing growth pattern. Specific growth profile charts are recommended for every different community.

In the second trimester, the biparietal diameter, head circumference, transcerebellar diameter, abdominal circumference, femur length, and other long bones are also useful. In 1987, MERCER *et al.* did the study of fetal foot length measurement to predict accurate fetal age. They concluded that fetal foot length was a reliable parameter for determining gestational age and was particularly useful in hydrocephalus conditions anencephaly, skeletal dysplasia, or short limb dwarfism.^[2] In normal scenarios, we depend on MSD, CRL, BPD, HC, and FL for a conclusion. However, in exceptional situations such as macrocephaly/microcephaly, limb dysplasia,^[2] engaged head in late pregnancy, in cases of fetal growth retardation difficulty, may arise and hence we need alternative reliable parameters like fetal foot length which is a relatively simple technique, performed easily in everyday practice with good reliability. In 1920, Streeter *et al.* proposed that fetal foot could be used to estimate fetal age.^[3] Shalev *et al.* proposed the same agreement between fetal foot length and prediction of gestation.^[4] Our study assesses the validity of fetal foot length in the accurate estimation of fetal gestational age.

Aim

This study aims to evaluate the role of fetal foot length as a biometric parameter in estimation of gestational age along with conventional parameters biparietal diameter, femur length, and abdominal circumference in normal pregnancy.

MATERIALS AND METHODS

This prospective study was conducted in pregnant women of gestational age 15–40 weeks as assessed clinically and measuring other conventional USG parameters attending the antenatal outpatient department and inpatient department during the second and third trimesters in our Kilpauk Medical College, Chennai. Patients with structural anomalies, oligohydramnios, and multiple pregnancies were excluded from the study. After getting approval from ethical committee, Kilpauk Medical College, the study was done with patient consent, detailed menstrual (whether the patient is sure of her menstrual dates or not, LMP), previous obstetric, and past medical and surgical history were taken. Patients general condition was examined. Vitals

such as pulse rate, blood pressure, and the temperature were checked. Cardiovascular and respiratory systems were examined. A thorough obstetric examination was made. All routine investigations were done as a part of the antenatal examination. Obstetric ultrasound examination was done in patients included in study USG estimation of BPD, FL, AC, and foot length done and documented.

RESULTS

This scatter diagram shows that foot length in mm taken along Y-axis and biparietal diameter taken along X-axis showed a significant correlation of 0.9827 with a significant $P < 0.0001$ [Figure 1].

This scatter diagram shows foot length in millimeters plotted in Y-axis and femur length in millimeters plotted in X-axis showing a positive coefficient of correlation of 0.9563 which is a significant thing with $P < 0.0001$ this further helps to consider fetal foot length measurement as a reliable biometric parameter in assigning fetal age [Figure 2].

This scatter diagram depicting foot length in Y-axis and abdominal circumference in X-axis also had good correlation of 0.9761 with a significant $P < 0.0001$ [Figure 3].

This scatter diagram studying the linear correlation coefficient of 0.9955 comparing lower limit of foot length with standard biparietal diameter [Figures 4 and 5].

The previous two scatter diagrams measuring correlation between foot length and femur length which already showed a significant linear relationship the upper and lower range limits of both parameters when compared also shows good measurement of agreement with a statistically significant, $P < 0.001$, the 95% confidence interval being not very wide [Figure 6].

This scatter diagram depicting foot length in mm lower range is analyzed for its correlation with upper and lower limit of abdominal circumference and found to have significant correlation with a correlation coefficient of 0.9855 with $P < 0.0001$ which is statistically significant [Figures 7 and 8].

DISCUSSION

Fetal foot length can be a reliable measurement in fetal age prediction in the case where conventional parameters are of less reliability. Biparietal diameter cannot be accurate in places of abnormal head shapes like microcephaly or macrocephaly. Head circumference cannot be used in assessing gestational age in cases of dolichocephaly.^[5]

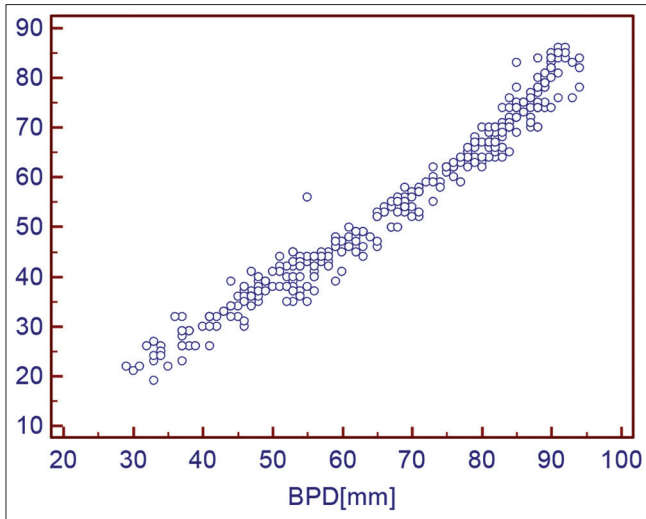


Figure 1: Correlation of foot length with BPD in estimation of GA

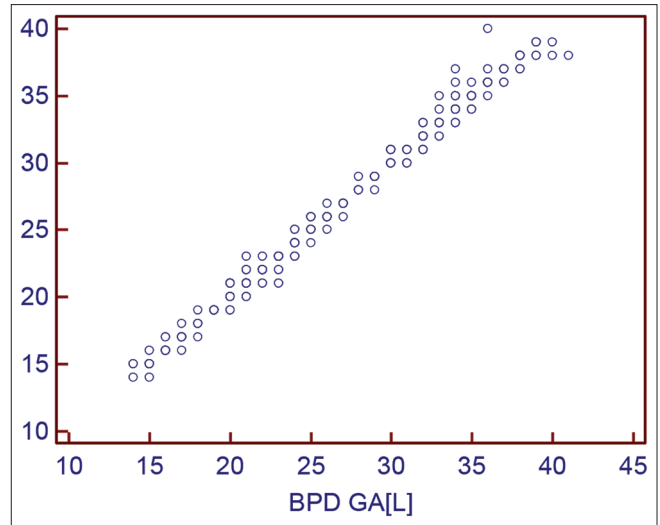


Figure 4: Correlation of foot length [L] with BPD [L] in estimation

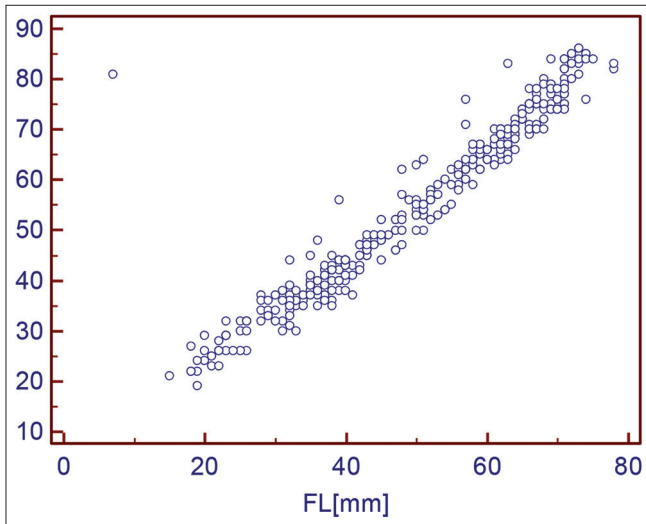


Figure 2: Correlation of foot length with FL in estimation of GA

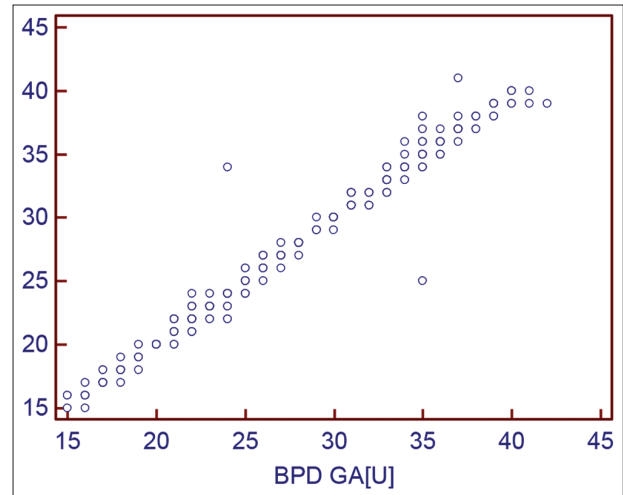


Figure 5: Correlation of foot length [U] with BPD [U] in estimation of GA

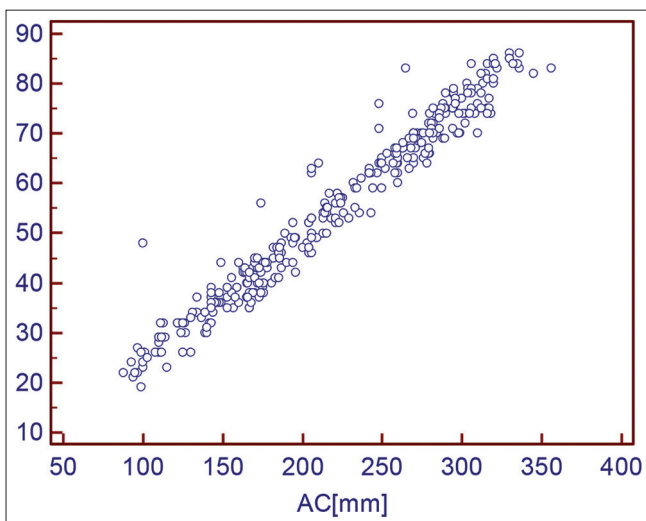


Figure 3: Correlation of foot length with AC in estimation of GA

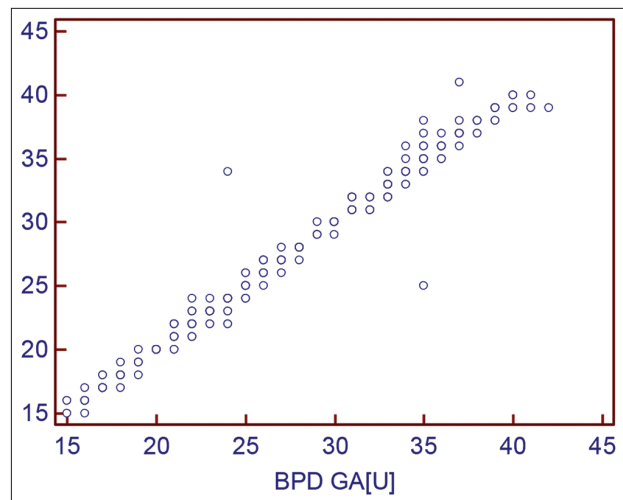


Figure 6: Correlation of foot length [L] with FL [L] in estimation GA

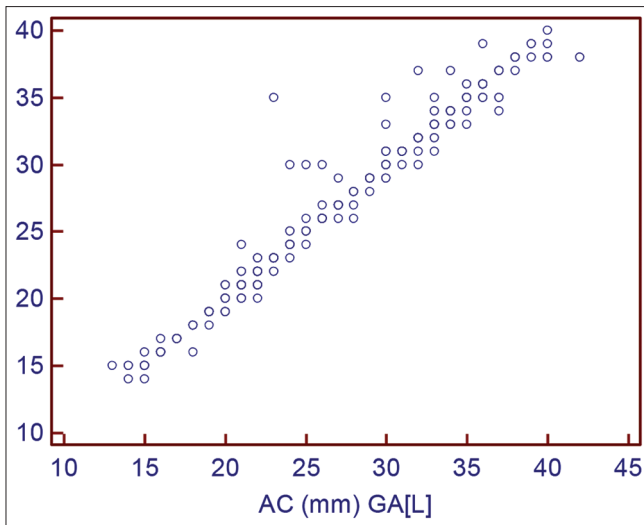


Figure 7: Gestation age: Foot length [L] correlation with AC [L] in estimation GA

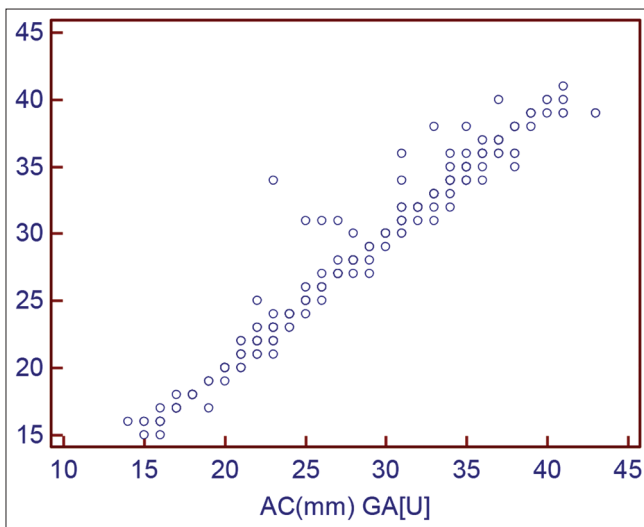


Figure 8: Correlation of foot length [U] with AC [U] in estimation of GA

The long bones length measurement studied in fewer studies, failed to predict gestational age of growing fetus accurately because the skeletal limb dysplasia is virtually affecting most of the bones.^[6] It cannot be depended even in conditions like short limb dwarfism. In case of anencephaly, a neural tube defect occurs due to deficiency of folate and other antiepileptic therapy; there is the absence of skull calvaria, then it is difficult to ascertain gestational age by conventional methods such as biparietal diameter or head circumference or transcerebellar diameter/occipitofrontal diameter. In such situations, along with other traditional parameters, femur length and abdominal circumference fetal foot length can be a good reliable parameter.^[6,7]

When choosing a single best fetal parameter to assess the period of gestation, there is little biologic variation. Each

study claims one parameter to be more reliable than other conventional parameters. Using multiple biometric parameters as in my study, the accuracy of fetal age estimation can be greatly improved which helps in a very great way to make appropriate clinical decisions regarding timing of termination of pregnancy, and induction of labor to minimize maternal morbidity, mortality, and improved perinatal outcomes which is our ultimate goal.^[8] The use of multiple parameters also reduces the effects due to biologic phenomenon or a technical error that occurs in a single measurement. It is also known from various studies to ascertain gestational age that random errors get reduced with multiple parameter measurement rather than a single parameter in the estimation.^[9]

About 20% of antenatal women do not have reliable dates,^[4] may cycle irregular due to various reasons, it is our duty to estimate gestational age in those individuals also to decide on the timing of delivery the mode of induction and to decide risk–benefit ratio in certain high-risk pregnancies such as preeclampsia, overt diabetes, heart diseases, Rh isoimmunization, and so on. Among my study group, there were 43 patients with irregular cycles whose biometric parameters were analyzed to find whether fetal foot length measurements can predict accurate gestational ages. The analysis showed that it reliably predicts fetal age with a correlation coefficient of 0.98 and a significant $P < 0.0001$. From this study, it is evident that fetal foot length reliably helps in the accurate estimation of gestation even in patients with irregular cycles.

CONCLUSION

Fetal foot length measurement is a reliable parameter in predicting gestational age along with conventional parameters biparietal diameter, femur length, and abdominal circumference. Fetal foot length measurement reliably predicts gestational age in antenatal women with irregular menstrual cycles. Fetal foot length can be influenced by fetal growth abnormalities. This study implies that the fetal foot length measurement has a limited role in growth abnormalities. Foot length is more accurate in ascertaining period of gestation in the second trimester than the third trimester. Further studies are required in the cohort of IUGR to establish the role of foot length in gestational age prediction. To conclude, fetal foot length is a reliable biometric parameter in predicting accurate gestation age on which obstetric decisions can be made with precision for a better perinatal outcome.

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Thennarasi and Nagasutha: Fetal Foot Length as a Biometric Parameter in Estimation of Gestational Age

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