Original Article

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# Accuracy Evaluation of Fetal Foot Length and Correlation with Biparietal Diameter for Ultrasonographic Fetal Age Estimation in Uncomplicated Pregnant Women of Chattogram, Bangladesh

Shehrin Islam[1*] Md. Ashrafuzzaman[2] Tamanna Zahur[3] Sunanda Sen[4] Md. Mohiuddin Juwel[5]

**ABSTRACT**

***Background:*** *Prediction and visual representation of developmental milestones of a growing fetus is most accurately done by ultrasonography.The present study was aimed to evaluate the correlation and accuracy of fetal foot length with fetal biparietal diameter to estimate fetal gestational age in Bangladeshi uncomplicated pregnant women of Chattogram district.*

***Materials and methods:*** *This cross-sectional observational study was conducted on 200 uncomplicated pregnant women of 15th to 28th weeks of gestation during the period from October 2021 to September 2022 in the Department of Anatomy, Chittagong Medical College, Chattogram. Fetal biometric parameters such as fetal foot length and biparietal diameter were measured by ultrasonography. For statistical analysis, Pearson's correlation test and correlation-regression analysis was done and p-value was considered significant if itwas <0.05 at 95% level of confidence.*

*Results: Pearson's correlation test showed that gestational age had strong positive and highly significant (p=0.000) correlation with both fetal foot length and biparietal diameter. The relation between gestational age and fetal foot length(r=0.986) is less strong than the relation between gestational age and biparietal diameter(r=0.988).*

*Conclusion: This study revealed relationship between fetal foot length and gestational age regarding accuracy. Ultrasonographic measurement of fetal foot length can be practiced alongside traditional biometric parameters for pregnancy dating in modern medical science.*

**Key words:** Biparietal diameter; Fetal biometric parameter; Fetal foot length; Gestational age; Ultrasonography.

## Introduction

Pregnancy is the time of joy, hope, anticipation and the creation of a new life. Healthy pregnancy and birth of a healthy baby are universal desires for any mother. To prevent preterm birth, post-term births and related morbidities, proper antenatal care is a must.It is very important to know appropriate gestational age of the fetus for pregnancy planning, scheduling, counseling, managing complications and preventing adverse outcomes.[1]

Gestational age can the calculated by Naegele's formula or ultrasonography.[2] Gestational age estimation by first day of Last Normal Period (LNMP) may have contradiction in irregular menstrual cycle or unawareness of mother regarding dating.[3] Therefore, ultrasonography being a painless, non-invasive, non-injurious, reusable, cost effective test provides the most reliable estimation of gestational age.[4] Every part of the fetal anatomy can clearly be seen by ultrasonography which helps to detect fetal anomalies and pregnancy complications. Doctors of many countries suggest at least one mid-trimester ultrasonography for taking decisions timely during pregnancy.[5] Particularly between 18 and 22 weeks of gestation, sonologists perform anomaly scan and refer for further investigations and intervention including termination if needed.[6]

Fetal Biparietal Diameter (BPD), Femur Length (FL) and Abdominal Circumference (AC) are long established anatomical parameters for assessment of Gestational Age (GA) in second trimester.[7] But these conventional parameters might not always be appropriate for each case. For example, fetal BPD would vary if fetal head is unusually rounded (Brachycephalic) or elongated (Dolichocephalic),

1. Assistant Professor of Anatomy
City Medical College, Gazipur, Dhaka.
2. Professor of Anatomy
Chittagong Medical College, Chattogram.
3. Assistant Professor of Dental Public Health
Chittagong Medical College, Chattogram.
4. Assistant Professor of Radiology and Imaging
Chittagong Medical College, Chattogram.
5. Resident, MS (Orthopedic Surgery)
Combined Military Hospital, Dhaka.

*Correspondence : **Dr. Shehrin Islam**
Cell : +88 01705 23 53 61
Email : dr.shehrinislam@gmail.com

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hydrocephalus or anencephaly.[8] In this crucial dilemma, Fetal Foot Length (FTL) can be applied as an alternative new parameter for gestational age estimation.[7,9-11] Fetal foot length has no relation with fetal gender, fetal or maternal health issues.[12] Moreover, it was observed that FTL increased 1 cm (10mm) for increasement of 4.11 gestational weeks.[13] Keeping the above background and knowledge in mind, this study was aimed to evaluate the accuracy of fetal foot length measurement for gestational age determination alongside fetal biparietal diameter by ultrasonography.

**Materials and methods**

This cross-sectional observational study with some analytical component was conducted in the Department of Anatomy of Chittagong Medical College. Data collections were done in the Department of Radiology and Imaging, Chittagong Medical College Hospital (CMCH) and Epic Health Care, Chattogram during the period from October 2021 to September 2022 where 200 respondents of uncomplicated singleton pregnancies between 15$^{th}$ to 28$^{th}$ weeks of gestation were studied.[14] Age was recorded according to NID/Birth certificate. All demographic data were taken and some biometric data were measured by ultrasound examinations performed by using Philips Affinity 30 multipurpose midranges ultrasound machine with 4 active transducer ports, 21.5" high resolution LCD monitor, 100-240 VAC, 50-60 Hz frequency curvilinear probes and 2d optimization signal processing unit.After getting approval from the ethical review committee of Chittagong Medical College, the 2d images of fetus being reported by sonologist of Radiology and Imaging Department of CMCH as normal ultrasound scan, fetal biometric parameters were measured with the image analysis software.

Single fetal foot length was measured from the skin edge covering the calcaneus to the distal end of the longest toe, the first or second toe whichever is longest on either right or left foot.[8,15]


**Figure 1** Measurement of fetal foot length by 2d ultrasonography

BPD measurement was taken from transaxial sonogram of the fetal head at the level of the paired thalami and cavum septi pellucidi. The image demonstrated the head as oval with symmetry of the thalami and cerebral hemispheres. BPD was measured from the outer edge of the cranium nearest the transducer to the inner edge of the cranium farthest from the transducer.[16]


**Figure 2** Measurement of fetal BPD by 2d ulrasonography

Then the Gestational Age (GA) in weeks were confirmed by trans-abdominal ultrasonographic measurement of fetal biparietal diameter.[17]

All data were fed into Statistical Package for Social Sciences (SPSS-26) software for statistical analysis. Data were presented as number, percentage, or mean ± standard deviation. Pearson's correlation test was run to search any correlation between FTL, BPD with gestational age and also for accuracy evaluation of FTL.

**Results**

The mean age of the 200 respondents was 24.20±2.78 years (range: 17-37 years). Their gestational age ranged from 15 to 28 weeks where majority of respondents (43%) were within 20 to 24 weeks of gestation (Figure: 3).

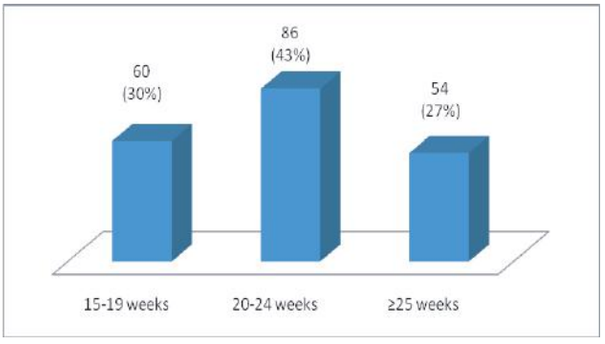


**Figure 3** Distribution of respondents according to gestational age (n=200)

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Ultrasonographically fetal foot length and biparietal diameter were measured in millimeter (mm) from 15 to 28 weeks of gestation. The mean foot length was 12.30±1.41mm during 15th week of gestation and 55.33±1.49mm during 28th week of gestation. The fetal foot length showed gradual increase with gestational age. Mean biparietal diameter was 25.81±3.14mm during 15th week of gestation and it increased gradually to 72.61±1.32mm during 28th week of gestation (TableI).

**Table I** Measurement of the Fetal Foot Length (FTL) Biparietal Diameter (BPD) in relation to Gestational Age (GA) (n=200)

| GA in weeks | No. of participants | FTL (mm) Mean ± SD | BPD (mm) Mean ± SD |
|---|---|---|---|
| 15 | 9 | 12.30±1.41 | 25.81±3.14 |
| 16 | 12 | 16.61±1.51 | 34.01±1.11 |
| 17 | 12 | 22.34±0.67 | 34.79±0.48 |
| 18 | 11 | 24.67±2.61 | 39.28±0.81 |
| 19 | 16 | 26.58±2.17 | 43.93±1.29 |
| 20 | 15 | 30.84±0.92 | 45.71±0.49 |
| 21 | 18 | 34.44±1.81 | 48.19±1.74 |
| 22 | 16 | 37.48±1.24 | 52.55±1.82 |
| 23 | 14 | 38.38±1.30 | 55.23±1.03 |
| 24 | 23 | 41.97±0.61 | 61.63±2.19 |
| 25 | 7 | 43.40±0.33 | 66.40±0.31 |
| 26 | 11 | 45.91±0.55 | 68.18±0.93 |
| 27 | 21 | 48.36±1.69 | 68.66±1.71 |
| 28 | 15 | 55.33±1.49 | 72.61±1.32 |

Pearson's correlation coefficient test was done to see correlations, as data was normally distributed. There was very highly significant positive linear correlation of Fetal Foot Length (FTL) with Gestational Age (GA) (r=0.984, $r^2$=0.969, p.000) and also of Biparietal Diameter (BPD) with Gestational Age (GA) (r=0.988, $r^2$=0.976; p.000) (Figure 4 & 5). The relation between gestational age and biparietal diameter (r=0.988) is stronger than the relation between gestational age and fetal foot length (r=0.984).

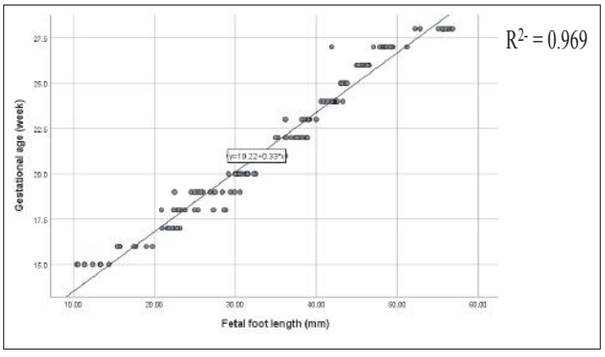


**Figure 4** Correlation of Fetal Foot Length (FTL) with Gestational Age (GA)

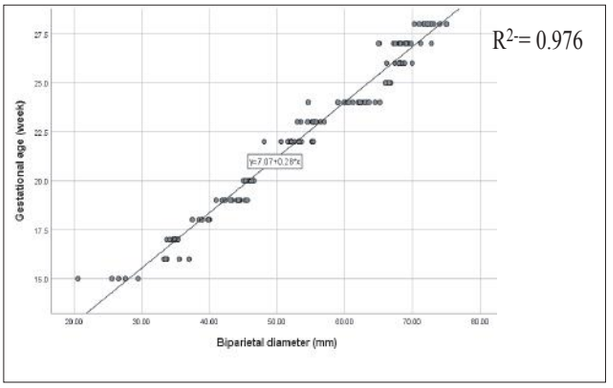


**Figure 5** Correlation of Biparietal Diameter (BPD) with Gestational Age (GA)

**Discussion**

Ultrasonographic fetal measurements provide information about fetal age, growth as well as wellbeing'. To determine the gestational age, Biparietal Diameter (BPD) is commonly used as reliable fetal biometric parameter.[16] Studies of different countries reflected that Fetal Foot Length (FTL) can be a reliable fetal biometric parameter particularly which can be used where other traditional biometrics are not reliable such as in cases of pathologic developments like macrocephaly, microcephaly, anencephaly, fetal growth retardation.[7,8,18]

In the present study among the 200 uncomplicated singleton pregnant women, 30% belonged to the gestational age of 15th to 19th weeks, 43% belonged to the gestational age of 20th to 24th weeks and the rest 27% belonged to the gestational age of 25th weeks to 28th weeks of gestation (Figure 3). In this study, the mean foot length increased gradually from 12.30±1.41mm during 15th week of gestation to 55.33±1.49 mm during 28th week of gestation (Table I). In a study on 150 pregnant women with singleton pregnancies in Rajasthan, mean fetal foot length at 16th week was 21.50± 2.59 mm and at 28th week the mean fetal foot length was 52.86±2.12mm where Fetal Foot Length (FTL) was seen to increase with gestational age.[19] This observation was nearly similar with the findings of present study. But in another study conducted in 2015, the mean FTL was 17.5± 1.29 mm in 15th week of gestation. They also found that at 28th week of gestation the mean FTL was 37.33±1.21mm.[8] The findings of this study are not similar to the current study. This dissimilarity may be due to variation of sample size.

Ultrasonographically BPD was measured and the mean biparietal diameter was 25.81±3.14 mm during 15th week of gestation which increased gradually to 72.61±1.32 mm during 28th week of gestation (Table I).

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Pandey VD et al. found the mean BPD 30.00± 1.14 mm at 15th week and 71.66±3.07 mm at 28th week.[8] The observation is nearly similar to the findings of present study. In a study in California it was observed that at 14th week BPD was 28mm.[20] This result shows some degree of inconsistency with the present study and this inconsistency may be due to ethnic variations.

In the present study, Fetal Foot Length (FTL) showed significant positive correlation with gestational age (GA) (r=0.984, p0.000). According to Sharma V et al. fetal foot length showed significant positive linear relationship with gestational age (r=0.985 and p< 0.01).[19] In the study by Pandey VD et al. fetal foot length showed good correlation with gestational age (r = 0.960 with p< 0.01).[8] Also, another study in Sudan revealed a significant positive linear relationship between fetal foot length and gestational age (r=0.940, p=0.000).[21] The findings of all the studies mentioned are similar with the current study.

In the current study, Biparietal Diameter (BPD) showed significant positive correlation with Gestational Age (GA) (r=0.988, p=0.000). George et al. in Egypt revealed significant positive linear relationship between BPD and GA (r =0.996, p<0.001).[22] In another study in Khartoum on pregnant women of 2nd and 3rd trimester unveiled strong positive correlation between BPD and GA(r=0.970, p=0.000).[21] In another study carried out in Turkey showed significant positive linear relationship between BPD and GA (r=0.934, p<0.00).[23] The findings of all the mentioned studies are similar with the finding of the present study.

In the present study, gestational age has shown positive and statistically highly significant (p=0.000) correlation with both fetal foot length and biparietal diameter. The relation between gestational age and fetal foot length is less strong than the relation between gestational age and biparietal diameter. The study carried out by Pandey VD et al. revealed the relation between BPD and GA was less strong than relation between FTL and GA. The findings of this study are dissimilar with the present study, may be due to variation in the sample size and ethnic variation.[8]

**Limitations**

Sample was obtained only from a particular zone.So the present study may not be truly representative for Bangladeshi population as a whole.

**Conclusion**

In the present study a strong significant positive linear relationship was observed between fetal foot length and gestational age (r=0.984, p<0.001) which indicates that fetal foot length can be a reliable and alternative ultrasonographic fetal biometric for the assessment of gestational age more accurately. From the observations of the current study, it can also be stated that FTL can be used as an alternative biometric where fetal BPD is not confirmatory in some conditions such as fetal anomalies or Intrauterine Growth Retardation (IUGR).

**Recommendation**

Considering the experience gained from the present study, the following suggestions can be made regarding further studies:

- Relativelylarger sample size can be taken for accuracy evaluation.
- Multicenter based study can be performed in different regions.
- Further study can be performed in uncomplicated or complicated pregnancies with congenital anomalies of fetus to estimate accurate gestational age specially where other traditionally practiced fetal biometrics might be difficult to estimate proper gestational age.

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**Disclosure**

All the authors declared no competing interests.

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