Original Article

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Fidelity of Fetal Foot Length in Association with Femur Length to Determine Ultrasonographic Fetal Gestational Age in Uncomplicated Pregnant Women of Chattogram, Bangladesh

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ABSTRACT

Background: *Ultrasonography is the most admissible method for gestational age estimation worldwide. The current study was aimed to determine the accuracy of fetal foot length and its correlation with femur length for fetal gestational age prediction in among Bangladeshi uncomplicated pregnant women of Chattogram district.*

Materials and methods: *This cross-sectional observational study, conducted in Chittagong Medical College, Chattogram, included 200 uncomplicated pregnant women of 15th to 28th weeks of gestation. Fetal biometric parameters such as fetal foot length and femur length were measured by 2D ultrasonography. For statistical analysis Pearson's correlation test and correlation-regression analysis was done and p-value was considered significant if it was <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 femur length. The relation between gestational age and fetal foot length (r=0.984) was stronger than the relation between gestational age and femur length (r=0.979).*

Conclusion: *This study revealed definiteness of fetal foot length measurement for ultrasonographic fetal gestational age appraisal. Fetal foot length might be considered as a new parameter apace with classical biometric parameters for meticulous pregnancy dating.*

Key words: Femur length; Fetal biometric parameter; Fetal foot length; Gestational age; Ultrasonography.

Introduction

Pregnancy is the period where happiness and risks lie parallelly. Some common pregnancy risks include preterm birth, Low Birth Weight (LBW), Intrauterine Growth Retardation (IUGR), congenital anomalies affecting both maternal and fetal health.[1] Bangladesh made a significant progress in declining maternal and neonatal mortality rate but burden of congenital anomalies is still an existing challenge. Regular antenatal visits, health assessment, required investigations, estimating accurate gestational age can reduce these risks.

Gestational age is a fundamental factor in managing pregnancy, guiding decision making and thus ensuring well-being of both mother and fetus.[2] Ultrasonography is the blessing in the advancement of modern medical science as it can track the development of fetus throughout the pregnancy. Fetal anomaly scan by ultrasonography is done in mid-trimester particularly in between 18th to 22nd weeks of pregnancy to identify structural abnormalities, determine gestational age and provide information for planning the rest of the pregnancy period.[3]

Various anatomical measurements by ultrasonography are established for estimation of gestational age and monitoring fetal development.[4] One of the well- known parameters is Femur Length (FL). But babies born with IUGR, LBW or Small for Gestational Age (SGA) are more vulnerable of having certain anatomical structural defects such as limb shortening, neural tube defects[5].In these circumstances where gestational age prediction is doubtful, Fetal Foot Length (FTL) can be considered as another biometric parameter as foot is usually not involved in skeletal dysplasia.[6]

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In the developing limb bud, foot has one of the most characteristic normal growth patterns as the pregnancy advances.[7] It was also observed that fetal foot length had linear relationship and good correlation with gestational age proving that estimation of gestational age might be done by fetal foot length.[5,8,9]

So, this study was conducted to assess the correlation and accuracy of femur length with fetal foot length measurement by ultrasonography regarding gestational age determination.

Materials and methods

This cross-sectional study was conducted during the period from October 2021 to September 2022 among 200 respondents with uncomplicated singleton pregnancies between 15th to 28th weeks of gestation.[10] After getting approval from the Ethical Review Committee of Chittagong Medical College, fetal biometric parameters were measured with the image analysis software from the 2D images of fetus being reported as normal ultrasound scan by sonologist of department of Radiology and imaging, Chittagong Medical College Hospital (CMCH), Epic Health Care, Chattogram. 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, 10-240 VAC, 50- 60 Hz frequency curvilinear probes and 2D optimization signal processing unit.

Once the entire foot was clearly visible, single fetal foot length was measured from the heel (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 (Figure 1).[9,11] The measurement was taken more than once or on both feet if practical, to assure accuracy and an average was commonly noted.

Figure 1 Measurement of fetal foot length by 2D ultrasonography

Femur Length (FL) was measured from an image of the full femoral shaft in a plane close to 90 degrees to the ultrasound beam (Figure 2). The distal femoral epiphysis was excluded.[12]

Figure 2 Measurement of fetal Femur Length (FL)by 2D ultrasonography

Participant's gestational age in weeks were determined by the FL. Statistical analysis was done by Statistical Package for Social Sciences (SPSS-26) software. Data were expressed in number, percentage, or mean ± standard deviation. In order to look for any link between FTL, FL and gestational age as well as to assess the accuracy of FTL, Pearson's correlation test was used.

Results

The age of the respondents ranged from 17-37 years with the mean age of 24.20±2.78 years. Their mean weight was 49.14±1.95 kg (Range: 41-55 kg). Regarding the gestational age of the respondents, 30% were between 15 and 19 weeks of gestation, 43% between 20 and 24 weeks and 27% between 25 and 28 weeks.

Fetal foot length and femur length were measured ultrasonographically in millimeter(mm) between 15 to 28 weeks of gestation. The mean foot length was 12.30±1.41mm during 15th week of gestation and increased to 55.33±1.49mm by 28th week of gestation showing gradual increase with advancing gestational age. Likewise, mean femur length increased gradually from 16.10±1.75mm (15th week) to 59.25±3.47 mm(28th week)(Table I).

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Table I Measurement of the fetal foot length (FTL), Femur Length (FL) in relation to Gestational Age (GA) (n=200)

GA in weeks	No. of participants	FTL (mm) Mean ± SD	FL (mm) Mean ± SD
15	9	12.30±1.41	16.10±1.75
16	12	16.61±1.51	18.78±1.21
17	12	22.34±0.67	23.78±1.28
18	11	24.67±2.61	27.83±1.54
19	16	26.58±2.17	29.68±1.59
20	15	30.84±0.92	33.77±1.87
21	18	34.44±1.81	37.72±2.47
22	16	37.48±1.24	41.56±2.76
23	14	38.38±1.30	45.41±1.37
24	23	41.97±0.61	46.27±1.12
25	7	43.40±0.33	48.23±0.34
26	11	45.91±0.55	50.15±0.66
27	21	48.36±1.69	51.91±1.84
28	15	55.33±1.49	59.25±3.47

As data were normally distributed and had a linear relationship, Pearson's correlation coefficient test was done to see correlations. 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=0.000) and also of Femur Length (FL) with Gestational Age (GA) (r=0.979, r^2=0.958, p=0.000) (Figure 3 and 4). The relation between gestational age and fetal foot length (r=0.984) is stronger than the relation between gestational age and femur length (r=0.979).

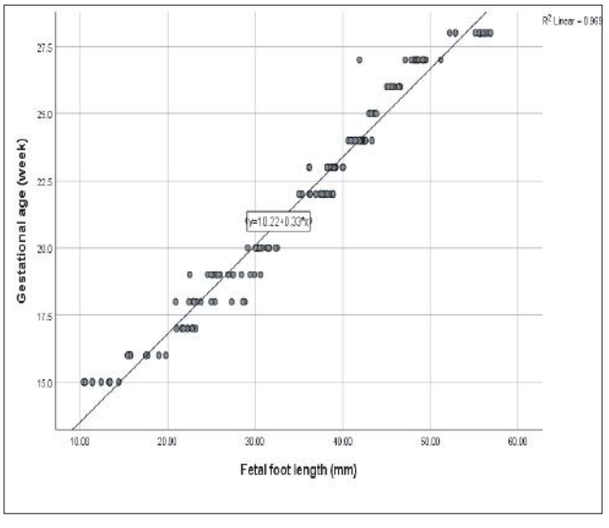

Figure 3 Correlation of Fetal Foot Length (FTL) with Gestational Age (GA)

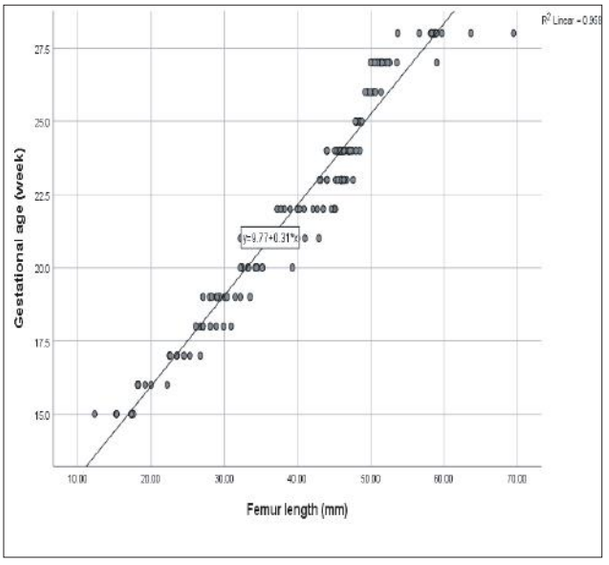

Figure 4 Correlation of Femur Length (FTL) with Gestational Age (GA)

Discussion

Before birth of a baby, ultrasonography is the safest and commonest method for reality check of a fetus such as fetal weight, fetal heart rate and estimated date of delivery. Gestational age can be predicted by fetal femur length.[13] In search of an alternative or parallel biometric parameter, many studies concluded that fetal foot length (FTL) can be used where other traditional biometrics are not reliable in congenital anomalies such as intrauterine growth retardation, skeletal dysplasias, congenital shortening of developing femur.[5,9,14]

In the current study, a total of 200 uncomplicated singletons pregnant women, age ranging from 17-37 years, were selected to assess the reliability of fetal foot length in association with femur length to estimate gestational age. The gestational age of the respondents ranged from 15th to 28th weeks. In this study, the mean foot length increased from 12.30±1.41mm (15thweek)to 55.33±1.49 mm (28thweek). This observation suggests that fetal foot length increases gradually as gestational age advances. This result aligns with the findings from Rajasthan, India that included 150 pregnant women with singleton pregnancies having 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 and where fetal foot length (FTL) was seen to increase with gestational age.[15] The observation of this study was nearly similar with the findings of present study. But in another study, the mean FTL was 17.5± 1.29 mm in 15th week of gestation.[9] They also found that at 28th week of gestation the mean FTL was 37.33±1.21mm. The findings of this study are not similar to the current study. This dissimilarity may be due to variation of sample size.

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In this study, fetal femur length increased gradually from 16.10±1.75 mm in 15th week to 59.25±3.47 mm in 28th week of gestation. Chaithra BR et al. in their study in Karnataka, India on 152 antenatal women from 15th week of gestation, found that mean femur length at 15th week was 17.3mm and mean femur length at 28th week was 52.2 mm.[16] In another study in North India on 100 pregnant women from 15th weeks they found mean FL at 15th week was 15.75 ± 1.70 mm and at 28th weeks of gestation mean FL was 54.00± 2.52mm.[9] The findings of these studies are nearly similar with the present study. But in a further study in India on 103 singleton pregnant women from 16th to 37th weeks of gestation and found FL at 16th week was 20 mm.[17] The observation of this study is slightly dissimilar with the current study and may be due to variation in the sample size and environmental factors.

In the present study, scatter diagram with regression line showing significant positive linear correlation of Fetal Foot Length (FTL) with Gestational Age (GA) (r=0.984, r2 =0.969, p=0.000) (Figure 3). Likewise, a significant positive linear relationship between fetal foot length and gestational age (r=0.985 and p<0.01) was reported from Rajasthan, India.[15]

Another regression analysis, observed by Pandey VD et al. indicated strong correlation of fetal foot length with gestational age (r = 0.960, p<0.01).[9]

Besides, a study in Sudan revealed a significant positive linear relationship between fetal foot length and gestational age (r=0.940 and p=0.000).[18] The findings of all the studies mentioned above are similar with the current study.

In the present study, as evidence by scatter diagram with regression line, significant positive linear correlation of Femur Length (FL) with Gestational Age (GA) (r=0.979, r^2=0.958, p=0.000) (Figure 4) is demonstrated. Patil SM conducted a study on 150 normal antenatal women starting from 18th weeks of gestation, yielding a strong significant correlation (r = 0.9827 and p<0.05) between FL and GA.[19] Another study in Khartoum state on 100 pregnant women of 2nd and 3rd trimester also found strong and significant positive correlation between FL and GA (r=0.966 and p=0.000).[18] In addition, a study in Turkey carried out among 1411 fetuses from 13th weeks of gestation found significant positive linear relationship between FL and GA (r^2 =0.927 and p<0.001).[20] The results of all these studies are analogous with the present study.

In the current study, the correlation between gestational age and fetal foot length is stronger than the relation between gestational age and femur length (r=0.984 vs. r=0.979).Majmudar DK et al. involved one hundred singleton pregnant women from 25th week of gestation and found the relation between FTL and GA was stronger than relation between FL and GA (r=0.920 vs. r=0.864).[21] The findings of this study align closely with those of the current study. Different findings were noticed by the study in Sudan on 100 pregnant women from 26th weeks of gestation where the correlation between FTL and GA was less strong than relation between FL and GA (r=0.72, p=0.00 vs. r=0.84, p=0.00).[22] This dissimilarity may be due to ethnic variation.

Limitations

Though the samples were homogenous but were obtained only from a particular zone. Study's relatively small sample size is one of its limitations, which could have an impact on how well the results apply to bigger, more varied populations. Furthermore, the study was limited in its relevance to other geographic or ethnic groupings because it was undertaken in a particular region. So, the present study may not be truly representative of Bangladeshi population as a whole.

Conclusion

With the advancement of time as there is increasing rate of congenital anomalies of fetuses, it is high time to search for new parameters for correct assessment of gestational age. A strong significant positive linear relationship between fetal foot length and gestational age was observed in this study. Also, foot length gave more accurate estimation of gestational age over traditional femur length. So, it can be concluded that we can consider fetal foot length as a useful and dependable ultrasonographic fetal biometric parameter to measure gestational age.

Recommendations

Insights from the findings and understanding the research problems thefollowing suggestions can be made regarding further studies:

- To enhance accuracy in evaluation a larger sample can be evaluated
- Multicentre study can be executed in different regions.

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Disclosure

All the authors declared no competing of interest.

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