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Fetal Foot Length as a Parameter for the Estimation of Gestational Age in Pregnancy

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Abstract

Background: Gestational age assessment is of critical importance in the management, decision-making, prognostication, and follow-up of newborn infants. It is also essential for research and epidemiology. There are several parameters used for the assessment of gestational age however, a search for more accurate and reliable parameters exists. We in the current study tried to evaluate the accuracy of fetal foot length for estimation of gestation age. **Methods:** N=100 females with singleton pregnancies of 15 to 40 weeks of gestation underwent standard ultrasound fetal biometry and foot length measurements. These measurements have been used to date the pregnancies. Standard fetal biometry including BPD, FL, HC, & AC was also recorded along with the kidney length. A single observer performed ultrasonographic measurements of fetal foot length, femur length, biparietal diameter, and abdominal circumference with the help of General Electric RT 3600 equipped with a 3.5 ~ 5.0 MHz transducer. **Results:** The ultrasonographically measured foot length from 15 to 40 weeks of gestation the mean foot length at 15 weeks of gestation was 1.58 ± 0.10 cms and at the 40 weeks of gestation the Mean foot length was 7.65 ± 0.07 cms. A positive correlation coefficient (r) of foot length versus gestational age was derived ($r = +0.89$). **Conclusion:** that there is a linear relationship with a strong positive correlation between foot length and gestational age. A fetal foot length can be an alternative fetal parameter used to assess the gestational age if routine parameters are not conclusive.

Keywords: Foot length, Femur length, Biparietal diameter, Abdominal circumference, Gestational age

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Introduction

The ultrasound has revolutionized the diagnosis and the management in the field of Medicine, more so in Obstetrics where it has been a major contributor in management decision making. It has played a major role in bringing down maternal and fetal mortality and morbidity. In Obstetrics, it is useful in the confirmation of the pregnancy, to rule out any anomalies of the fetus, to observe the growth pattern of the fetus, and a host of other parameters. Gestational age estimation is one of the important steps in the management of pregnancy and related consequences, especially in preterm deliveries.

In assessing the gestational age, the fetal femur length, the biparietal diameter, and the abdominal circumference are considered usually, after 24 weeks of gestation.^[1] In assessing the gestational age, the fetal foot length opens the possibility of finding the gestational age even though various studies with various organs are under active consideration and research.^[2] It was in 1920 Streeter first showed the characteristic pattern of normal growth of fetal foot and proposed that it could be used to estimate the gestational age.^[3] Bohem et al.,^[4] had described four stages of development of the fetal foot. Which were stage one (second month): The foot is in ninety

degrees equinus and adducted. Stage two (beginning of the third month): The foot is in ninety degrees equinus, adducted, and markedly supinated. Stage three (middle of the third month): The foot dorsiflexes at the ankle, but a mild degree of equinus is still present and marked supination persists. The first metatarsal remains adducted. This stage corresponds to the fetal period of development. Stage four (beginning of the fourth month): The foot pronates and reaches a position of mid-supination. A slight metatarsus varus remains. The equinus is not present. [4] WM Hern et al., [5] used the foot length as an independent variable and showed that foot length tends to have a linear relationship with knee-heel length. Marcer et al., [6] reported fetal foot length as a reliable predictor for estimation of gestational age and is particularly useful when other parameters may not accurately predict gestational age in cases such as hydrocephalus, anencephaly, or short-limb dwarfism. Therefore, we in the current study tried to determine the accuracy of fetal foot length in the estimation of gestational age.

Materials and Methods

This cross-sectional study was conducted in the Department of Obstetrics and gynecology in association with the Department of Radiodiagnosis. Prathima Institute of Medical Sciences, Naganoor, Karimnagar. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study. A convenient sampling method was adopted for the study.

Inclusion Criteria

1. Only singleton pregnancies between 15- and 40-weeks' gestation
2. Successive antenatal cases presenting to our Hospital.
3. Women who have had a dating scan done.

Exclusion Criteria

1. Patients with the following have been excluded
2. Multiple pregnancies
3. IUGR/ Structural anomalies
4. Oligohydramnios and polyhydramnios
5. PIH & GDM

N=100 females with singleton pregnancies of 15 to 40 weeks of gestation underwent standard

ultrasound fetal biometry and foot length measurements. These measurements have been used to date the pregnancies. Standard fetal biometry including BPD, FL, HC, & AC was also recorded along with the kidney length. A single observer performed ultrasonographic measurements of fetal foot length, femur length, biparietal diameter, and abdominal circumference with the help of General Electric RT 3600 equipped with a 3.5 ~ 5.0 MHz transducer.

Statistical Methods

All the available data was uploaded on an MS Excel spreadsheet and analyzed by SPSS version 19 statistics. The descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean \pm SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at a 5 % level of significance. A p-value of < 0.05 was taken as significant. Pearson correlation between study variables is performed to find the degree of relationship. Regression analysis is performed to find the relationship and prediction potential of gestational age.

Results

Out of the n=100 cases studied we found n=55% cases from age group 19-24 years and n=35% cases from age group 25-30 years and 10% cases from age group 31 – 35 years. Primigravida cases were 65% and multigravida cases were 35% the mean number of cases in the study corresponding with the age of gestation is given in table 1. The ultrasonographically measured foot length from 15 to 40 weeks of gestation the mean foot length at 15 weeks of gestation was 1.58 ± 0.10 cms and at the 40 weeks of gestation, the Mean foot length was 7.65 ± 0.07 cms all the values have been given in Table 2.

Table 1: Frequency distribution of cases according to gestational age

GA (weeks)	Frequency	Percentage
15 – 20	25	25
21 – 25	19	19
26 – 30	21	21
31 – 35	22	22
36 – 40	13	13
Total	100	100

Table 2: Mean foot length in cms according to gestational age in weeks

Gestational age in weeks	Mean \pm SD (cms)	95% CI	Range
15	1.58 \pm 0.10	1.42 - 1.72	1.50 - 1.700
16	2.05 \pm 0.06	1.95 - 2.14	2.00 - 2.100
17	2.38 \pm 0.17	2.10 - 2.64	2.20 - 2.600
18	2.75 \pm 0.13	2.54 - 2.95	2.60 - 2.900
19	3.20 \pm 0.08	3.07 - 3.33	3.10 - 3.300
20	3.44 \pm 0.11	3.29 - 3.58	3.30 - 3.600
21	3.78 \pm 0.17	3.50 - 4.04	3.60 - 4.000
22	3.98 \pm 0.15	3.73 - 4.21	3.80 - 4.100
23	4.28 \pm 0.17	4.00 - 4.54	4.10 - 4.500
24	4.56 \pm 0.11	4.41 - 4.70	4.40 - 4.700
25	4.73 \pm 0.05	4.64 - 4.80	4.70 - 4.800
26	4.93 \pm 0.06	4.70 - 5.07	4.90 - 5.000
27	5.22 \pm 0.13	5.05 - 5.38	5.10 - 5.400
28	5.45 \pm 0.13	5.24 - 5.65	5.30 - 5.600
29	5.70 \pm 0.08	5.57 - 5.83	5.60 - 5.800
30	5.85 \pm 0.06	5.75 - 5.94	5.80 - 5.900
31	6.10 \pm 0.07	6.01 - 6.18	6.00 - 6.200
32	6.38 \pm 0.10	6.22 - 6.52	6.30 - 6.500
33	6.44 \pm 0.15	6.25 - 6.62	6.20 - 6.600
34	6.48 \pm 0.13	6.27 - 6.67	6.30 - 6.600
35	6.70 \pm 0.08	6.57 - 6.83	6.60 - 6.800
36	7.07 \pm 0.15	6.68 - 7.44	6.90 - 7.200
37	7.03 \pm 0.15	6.65 - 7.41	6.90 - 7.200
38	7.20 \pm 0.28	4.65 - 9.74	7.00 - 7.400
39	7.55 \pm 0.07	6.91 - 8.18	7.50 - 7.600
40	7.65 \pm 0.07	7.01 - 8.28	7.60 - 7.700

A critical analysis of table 3 with mean values of Foot Length (FTL), Biparital Diameter (BPD), Femur Length (FL) and Abdominal Circumference (AC) at important gestational age. A positive correlation coefficient (r) of foot length versus gestational age was derived ($r = +0.89$). Using linear regression model, the following equations were derived: $Y = 0.36 \times X + 12.7$ for estimation of gestational age from foot length [where $Y =$ Gestational age (weeks) and $X =$ Foot length (mm)]. $Y = 2.17 \times X + (-14.1)$ for estimation of foot length from gestational age where $Y =$ Foot length (mm) $X =$ Gestational age (weeks)

Table 3: Comparison of means of Foot Length (FTL), Biparital Diameter (BPD), Femur Length (FL) and Abdominal Circumference (AC)

Gestational age in weeks	Mean FTL \pm SD (cms)	Mean BPD \pm SD (cms)	Mean FL \pm SD (cms)	Mean AC \pm SD (cms)
15	1.58 \pm 0.10	3.00 \pm 0.15	1.58 \pm 0.21	9.50 \pm 0.38
20	3.44 \pm 0.11	4.77 \pm 0.23	3.34 \pm 0.33	14.41 \pm 0.42
25	4.73 \pm 0.05	6.20 \pm 0.35	4.56 \pm 0.57	20.22 \pm 0.49
30	5.85 \pm 0.06	7.50 \pm 0.41	5.40 \pm 0.67	27.35 \pm 0.34
35	6.70 \pm 0.08	8.73 \pm 0.55	6.92 \pm 1.00	31.27 \pm 0.62
40	7.65 \pm 0.07	8.91 \pm 0.61	7.27 \pm 1.10	32.57 \pm 0.79

Discussion

One Hundred antenatal cases from the Department of Obstetrics and Gynaecology, PIMS, who have got a dating scan done, were selected for our study. Maternal diseases like gestational hypertension, diabetes, IUGR diagnosed during the study were not included. Multiple gestations were excluded, as growth is not uniform for both the fetus. The search for a single best parameter for the determination of fetal gestation age is an object of interest of late. In the last 10 years, the quality of ultrasound has increased enormously, and this has opened up new improved techniques. Initially, Biparital Diameter (BPD) was used, and its accuracy was found to be maximum between 12 – 20 weeks. [8] Technical problems such as where the head is dolichocephalic or brachycephalic the measurements are not reliable, and the head is direct occipito-posterior or direct occipito-anterior and when the head has entered the maternal pelvis (which occurs around 36 weeks in most of the primigravidas). [9] In the present study, fetal foot length showed a strong positive correlation with gestation age the correlation coefficient was +0.89. Goldstein I et al., [10] found a significant correlation between fetal foot length and gestational age the r values were +0.9 the p-values were 0.0001 which was significant. In our study, the values were nearly comparable to Goldstein I et al., results. Platt LD et al., [11] in their study on fetal foot length and menstrual age found R^2 values of +0.94. In the current study, the model for fetal foot length and menstrual age were in close agreement. Our results show that measurement of fetal foot length with ultrasound is reliable. Our study shows a linear relationship between fetal foot length and gestational age with a significant correlation between these parameters. This is in comparison with previous studies which conclude that the ultrasonographic measurement of foot length is a reliable indicator of gestational age. Meiorowitz et al., [12] found that there are limitations to the use of fetal foot length for gestational age assessment especially in fetuses with growth abnormalities. Therefore, we have excluded these cases. Campbell et al. found that fetal femur/foot length ratio to be approximately 1 throughout the gestation ages between 14 - 40 weeks. They have described

that the fetal/foot length ratio nomogram is a useful parameter to help differentiate fetuses that have dysplastic limb reduction from those whose limbs are short because of constitutional factors or IUGR. [8] Our observation shows a femur/ foot length ratio of ≥ 0.9 in 48% of cases and 1 in 52% of cases. IUGR by ruled out on ultrasound in this study. If the fetus is constitutionally small or there is symmetrical intrauterine growth retardation, the ratio is greater than or equal to 0.9, and in most skeletal dysplasias characterized by limb shortening, the ratio is generally less than 0.9 because of the relative sparing of the hands and feet. Johnson et al found femur/foot length ratio an additional ultrasonographic marker for identification of fetuses at increased risk for trisomy 21. [13] MCA Doppler and physical examination at birth whenever indicated. Congenital anomalies were also ruled out by ultrasound and after birth. Therefore, the fact that the majority of fetuses with femur/ foot length ratio of ≥ 0.9 in the present study perhaps is attributed to constitutionally small fetuses compared to the Western population.

Conclusion

Within the limitations of the current, it can be concluded that there is a linear relationship with a strong positive correlation between foot length and gestational age. A fetal foot length can be an alternative fetal parameter used to assess the gestational age if routine parameters are not conclusive. Femur/ foot length ratio was constantly ≥ 0.9 or 1 which can be considered normal because of constitutionally small fetuses in our country population.

Conflict of Interest: None

Source of support: Nil

Ethical Permission: Obtained

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