Ultrasonographic Assessment of The Fetal Foot Length for Gestational Age Estimation

Kutlugül YÜKSEL, İlker GÜNYELİ, Melike DOĞANAY, Mustafa UĞUR, Leyla MOLLAMAHMUTOĞLU
Ankara-Turkey

OBJECTIVE: To describe the relationships between gestational age and ultrasonographic measurement of fetal foot length.
STUDY DESIGN: A total of 462 ultrasonographic measurements were performed to describe the relationship between gestational age and fetal foot length at the Zekai Tahir Burak Woman Health Education and Research Hospital. The nomogram of fetal foot length versus gestational age between 15-42 weeks was constructed from the fetuses of healthy singleton pregnancies. All patients had normal ongoing pregnancies and known last menstrual periods.
RESULTS: A significant correlation was found between fetal foot length and gestational age ($r = 0.890$, $p < 0.0001$). Our results suggested that fetal foot length was a reliable marker for use in the assessment of gestational age.
CONCLUSION: This parameter is particularly useful when other measurements do not accurately predict gestational age, for example, dysplastic limb reduction and abnormal fetal head structure.
(Gynecol Obstet Reprod Med 2006; 12:000-000)

Key Words: Foot length, Gestational age, Ultrasound

Ultrasonographic assessments of fetal gestational age have been concern in various clinical applications. There have been many biometric markers. Fetal biometric studies have included head circumference, biparietale diameter, abdominal circumference, and femur length. While ultrasonographic growth curve for fetal limb bones has been described by several groups,[1-2-7] only a very small number of authors[3-6-8] have established biometric studies for fetal foot length.

As early as in 1920, Streeter[8] reported a strong relationship between fetal foot length and gestational age in a series of fetal pathologic specimens. In this study, fetal foot length nomograms were originally established using pathological speciments. More recently, Mercer and coworkers[4] demonstrated similar relationship between prenatal ultrasonographic measurements of the fetal foot and gestational age beyond the first trimester.

In our study, we planed to develop a nomogram for sonographic fetal foot length as a predictor of gestational age, in our patient population. The nomogram of fetal foot length versus gestational age between 15-42 weeks was constructed from the fetuses of healthy singleton pregnancy.

These studies proposed that the fetal foot was a reliable indicator of gestational age.

Zekai Tahir Burak Mother Health Training and Research Hospital

Address of Correspondence *Melike Doğanay*
Çukurambar Mah. 38.Cad.
Özalp Apt. No:7/39
100.Yıl, Ankara/Turkey

Submitted for Publication: 03.03.2005
Accepted for Publication: 07.02.2006

Material and Methods

We evaluated 462 healthy singleton pregnant women with 15-42 weeks gestation. They had a regular menstrual cycle and a certain date of their last menstrual periods. The gestational age based on their menstrual dating was recorded as completed week.

In this study, gestational age was confirmed in all cases by first trimester crown rump length measurement and than gestational age was confirmed by measuring biparietale diameter (BPD), head circumference, abdominal circumference, femur, tibia, fibula, humerus, radius, ulna, and foot length. Three fetuses with abnormalities of the extremities, four intrauterine growth retardation and six multiple pregnancies were excluded. Ultrasound measurements were made using linear array real-time equipment (ALOCA® SSB 1000 with a 3, 5 MHz transducer, 1540 m/Sn).

Figure 1. Sonograms of fetal foot in longitudinal plans, foot length 54 mm (25-week gestation).

Fetal foot length was measured in millimeters in the longitudinal (Figure 1) and plantar (Figure 2) view from the

heel to the first or second toes (whichever was longer) between electronically calipers. The relationship between foot length and gestational age was determined. These data were analyzed with x 2 test and polynomial regression analyses. The analytic values needed to calculate the individual confidence intervals were included for each model.Ü

Figure 2. Sonograms of fetal foot in plantar plans, foot length 57 mm (25- week gestation).

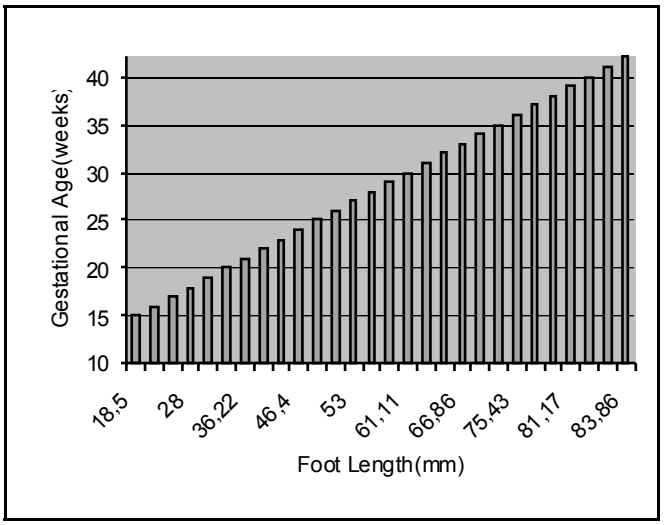

Figure 3. Scatter plot of ultrasonographic fetal foot size versus gestational age demonstrates a linear relationship

Results

Four hundred sixty two healthy pregnant women underwent routine ultrasonographic examinations had foot length measurements between 15 and 42 weeks gestation. At each gestational week, the median number of fetal foot measurements was 18 (range 12 to 22). A nomogram of fetal foot dimensions ± 2 standard deviation (SD) versus gestational age was outlined in Table I. In this table was given the values for the predicted mean and ± 2 SD of fetal foot length for a given menstrual age between 15-42 weeks.

A statistically significant linear relationship was found between fetal foot length and gestational age ($r=0.890$, $p<0.0001$; Fig 3). A practical formula has calculated as fetal foot length (mm)=Gestational age × 2 in 24-40 weeks of gestations. The above relationship was best described linear and polynomial regression.

Table I. Nomogram of the fetal foot length.

		Ultrasonographic fetal foot length	
Gestational age	Number of fetuses	Lower limit-Upper limit(mm)	Mean (mm)±SD
15 week	18	17-24	18.56±2.19
16 week	22	20-24	21.45±1.29
17 week	12	21-25	23.5±1.38
18 week	14	26-31	28±1.83
19 week	16	30-35	31.13±1.64
20 week	20	25-36	31.5±3.47
21 week	18	34-40	36.22±1.99
22 week	16	35-46	39.88±3.14
23 week	22	41-50	43.82±3.57
24 week	20	44-50	46.40±1.96
25 week	18	46-54	48.22±2.49
26 week	22	47-53	51±1.9
27 week	16	50-56	53±1.7
28 week	18	53-61	56.22±2.49
29 week	20	54-69	59.4±4.52
30 week	18	59-66	61.11±2.09
31 week	16	56-63	61±2.14
32 week	16	57-65	63.25±261
33 week	14	59-73	66.86±4.38
34 week	16	65-80	71±5.18
35 week	16	70-73	71.13±0.99
36 week	14	73-80	75.43±2.57
37 week	18	74-84	77.11±3.1
38 week	12	78-89	80.33±4.28
39 week	12	80-84	81.17±1.48
40 week	12	80-83	81.67±1.2
41 week	12	82-86	84.33±1.63
42 week	14	82-87	83.86±1.68

Discussion

Our study is the one of the rare ultrasound studies in the literature to date on fetal foot length. In this study, we restricted our sample population to less than 15 week's gestation because of the limitations in ultrasound resolution.

We demonstrated that prenatal ultrasonographic measurements of the fetal foot between 15 and 42 weeks in normal pregnancies were most accurately described by a linear relationship.

Our study reporting a correlation between fetal foot length and gestational age provided the accurate information on fetal growth and the reliable assessment of gestational age. Previous investigators had suggested that fetal foot length was a reliable predictor of gestational age.[3-4-5-6] The mean values obtained in our study were almost identical to

those of Mercer et al.,[4] Goldstein at al.,[3] Platt et al.,[6] and Merz et al.[5]

In this paper, fetal foot length was shown to be a reliable indicator of gestational age. We demonstrated that, after 24 week's gestation, fetal foot length in our population was approximately twice of estimated gestational week.

Ultrasonographic fetal foot length measurement should be undertaken when other parameters do not accurately predict gestational age and especially fetal growth abnormality is suspected.

References

1. Chitty LS, Altmann DG, Henderson A, Campbell S: Charts of fetal size. Femur length. Br J Obstet Gynecol 1994; 101:132-5.
2. Exacoustos C, Rosati P, Rizzo G, Arduini D: Ultrasound measurements of fetal limb bones. Ultrasound Obstet Gynecol 1991; 1:325-30.
3. Goldstein I, Reece A, Hobbins JC: Sonographic appearance of the fetal heel ossification centers and foot length measurements provide independent markers for gestational age estimation. Am J Obstet Gynecol 1988; 159:923-6.
4. Mercer BM, Sklar S, Shariatmador A, Gilleson MS, D'Alton ME: Fetal foot length as a predictor of gestational age. Am J Obstet Gynecol 1987; 156:350-5.
5. Merz E, Oberstein A, Wellek S: Age-related reference ranges for fetal foot length. Ultraschall in Med 2000; 21:79-85.
6. Platt LD, Medearis AL, Devore GR, Horenstein JM, Carlson DE, and Brar HS: Fetal foot length; relationship to menstrual age and fetal measurements in the second trimester. Obstet Gynecol 1988; 71:526-31.
7. Snijders RJM, Nicolaides KH: Fetal biometry at 14-40 weeks gestation. Ultrasound Obstet Gynecol 1994; 4:34-48.
8. Streeter GL: Weight, sitting height, head size, foot length and menstrual age of the human embryo. Contrib Embryol Carnegie Inst 1920; 11:143.