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Foetal Foot Length - A Parameter to Estimate the Gestational Age Using Ultrasonography and its Relation with Femur Length

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ABSTRACT

Introduction: Foetal biometry is an important parameter to assess the gestational age of the foetus and has to be standardised based on the screening population. Foetal foot length has a characteristic pattern of normal growth and could be used to estimate gestational age. Aims- To establish the relationship between the foetal foot length and the gestational age and the femur length using the femur/ foot length ratio.

Materials & Methods: The foetal foot length and femur length was noted by ultrasonography and the relation of foot length with gestational age and femur length were calculated.

Results: There was a positive correlation between foot length and gestational age. The femur/foot length ratio was between 0.84 and 1.02.

Conclusion: Foetal foot length can be used as an additional parameter to estimate gestational age.

Key Words: Crown rump length, Femur length, Femur/ foot length ratio, Foetal biometry, Foot length, Gestational age, Ultrasonography

INTRODUCTION

Ultrasonography has emerged as a simple modality to assess the gestational age of foetuses because of its painless, non-invasive, non-ionizing, safe, portable, redoable, ease of access and relatively inexpensive nature.^{1,2,3} Accurate knowledge of gestational age is important for appropriate obstetric care, scheduling, interpretation of certain antepartum tests, determination of foetal growth and designing interventions to prevent preterm births and related morbidities.^{4,5,6}

Foetal biometry is an important parameter to assess the gestational age of the foetus and has to be standardised based on the screening population. Various parameters have been used for this like crown-rump length, biparietal diameter, head circumference, abdominal circumference, femur length and humerus length.^{7,8,9}

Foetal foot length has a characteristic pattern of normal growth and could be used to estimate gestational age.

^{10,11,12,13,14} Femur/foot length ratio can also be used to identify dysplastic limb and to differentiate it from constitutional factors and growth retardations.^{1,2,3} The present study aims to establish the relationship between the foot length and the gestational age and the femur length using femur/ foot length ratio.

METHODOLOGY

The study was done in the Department of Radiology of a certain medical college in Karnataka, with a Philips HD6 ultrasound system over one year. The study subjects were 152 pregnant women of age 20 to 30 years attending the routine antenatal screening with the gestational age of 15 to 40 weeks. The gestational age was calculated by the last menstrual period and confirmed by the crown-rump length in early pregnancy ultrasound scan. The subjects were invited to participate in the study with written consent obtained un-

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der the approval of the institutional ethical committee (Ref: SDMIEC:023). The patients with known complications of pregnancy like oligohydramnios, polyhydramnios, diabetes, hypertension, pre-eclampsia and multiple gestations were excluded from the study. Femur length was measured as the maximum diaphyseal length of bone using electronic callipers. Foot length was measured as the longest distance from the posterior most of the foot to the tip of the first or second toe whichever was longer. The mean value of foot length and femur length for each gestational week was calculated from 15 to 40 weeks. The correlation and regression analysis were done to quantify the relationship using Microsoft Excel.

RESULTS

The mean values of measurements of foot length and femur length are shown in table 1. The ratio of femur length to foot length ratio was calculated and was found to be between 0.84 and 1.02. It was observed that the foot length linearly increased from 1.8cm at 15weeks to 8.34cm at 40weeks of gestation. It can be interpreted with a 95% confidence interval that gestational age can be calculated from foetal foot length. The simple linear regression analysis shows a linear relationship between foot length and gestational age (gestational age = $3.92 \times \text{foot length} + 7.41$) with high positive correlation ($r = 0.99$, $p < 0.001$). There was also a linear relation between foot length and femur length (femur length = $0.88 \times \text{foot length} + 0.41$) with good correlation ($r = 0.99$, $p < 0.001$). The summary of relations of foot length with gestational age and femur length is summarized in table 2 and shown in Figures 1 and 2.

DISCUSSION

The accuracy of estimation of gestational age by the traditional parameters like crown-rump length, biparietal diameter, head circumference, abdominal circumference and femur length decreases as the pregnancy advances to the third trimester.¹⁰⁻¹⁵ Hence several researchers are of opinion that in addition to these, ancillary biometric and non-biometric measurements can help to reduce the biological variability among foetuses.^{16,17,18} Streeter et al showed that the foetal foot has a characteristic pattern of normal growth and can be used to estimate the gestational age.²² Several researchers have reported a strong correlation between foot length and gestational age similar to our study with R^2 value of 0.988.¹⁹⁻²² The diaphyseal length of the femur is almost equal to foot length throughout the pregnancy with the ratio between them ranging from 0.84 to 1.02. There also was a strong positive correlation between them. This was in line with the findings of Dusty et al, Lakshmi et al and Hong SW.^{1,2,3} This ratio can

be used to detect most skeletal dysplasias and limb abnormalities.²³

CONCLUSION

There is a linear relationship and positive correlation between the foot length and the gestational age and also between the foot length and the femur length. Therefore, foetal foot length can be used as an additional parameter to estimate the gestational age and also to detect any abnormalities in the growth of limbs by comparing with femur length.

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Table 1: Summary of femur length and foot length ratio

Gestational age in weeks	No of foetuses	Mean of foot length in cm	Mean of Femur length in cm	Femur length/ foot length ratio
15	1	1.8	1.73	0.96
16	1	2.03	1.7	0.84
17	5	2.32	2.25	0.97
18	3	2.83	2.82	1.00
19	4	3.11	3.12	1.00
20	10	3.26	3.29	1.01
21	15	3.61	3.58	0.99
22	8	3.97	3.9	0.98
23	9	4.36	4.1	0.94
24	11	4.38	4.26	0.97
25	7	4.53	4.6	1.02
26	2	5.03	4.67	0.93
27	4	5.1	5.01	0.98
28	5	5.33	5.22	0.98
29	5	5.75	5.55	0.97
30	2	5.98	5.83	0.97
31	4	6.02	5.94	0.99
32	3	6.25	6.13	0.98

Table 1: (Continued)

Gestational age in weeks	No of foetuses	Mean of foot length in cm	Mean of Femur length in cm	Femur length/ foot length ratio
33	3	6.58	6.54	0.99
34	3	6.66	6.74	1.01
35	6	7.1	6.69	0.94
36	11	7.37	6.91	0.94
37	19	7.63	7.07	0.93
38	7	7.89	7.08	0.90
39	3	8.04	7.46	0.93
40	1	8.34	7.56	0.91

Table 2: Summary of relationship of foetal foot length with gestational age and femur length

X axis	Y axis	Regression equation	Correlation coefficient	P value
Foot length	Gestational age	$3.92x \text{ foot length} + 7.41$	0.994	0.000*
	Femur length	$0.88x \text{ foot length} + 0.41$	0.987	0.000*

*P<0.001

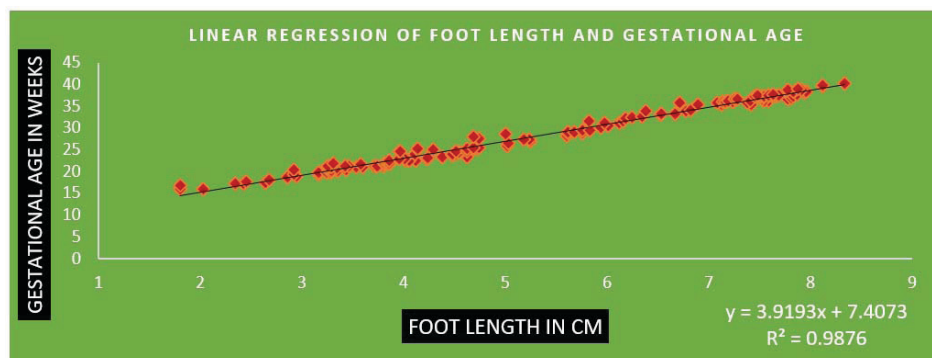


Figure 1: Linear regression plot of foot length in cm and gestational age in weeks.

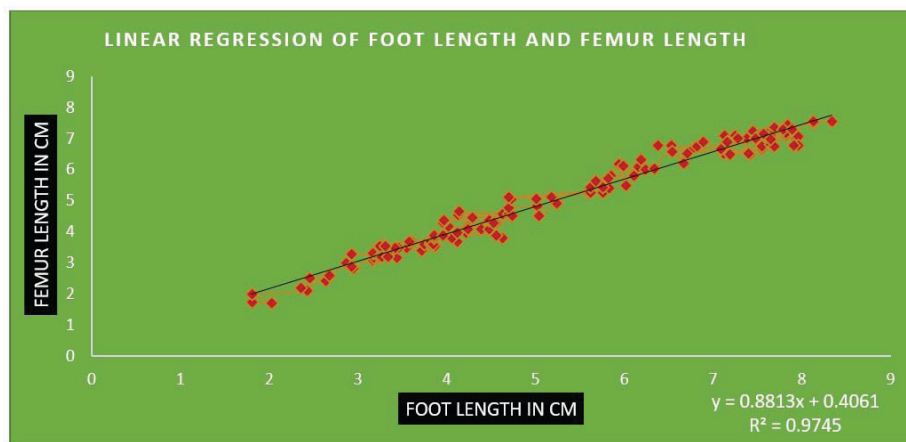


Figure 2: Linear regression plot of foot length in cm and femur length in cm.