

## FETAL GESTATIONAL AGE ESTIMATION BY FETAL FOOT LENGTH MEASUREMENT AND FETAL FEMUR TO FOOT LENGTH RATIO IN INDIAN POPULATION - A PROSPECTIVE STUDY

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**ABSTRACT: BACKGROUND:** Multiple parameters are in use for the accurate assessment of the gestational age by ultrasound, but the literature suggests that fetal foot length can be used to estimate gestational age, when other parameters are not available for measurement. Foetal femur/ foot length ratio can help in differentiating the foeti that have dysplastic limb reduction, from those whose limbs are short because of constitutional factors/IUGR. A prospective study was done to measure the fetal foot length for gestational age and to evaluate fetal femur to foot length ratio in pregnant women of 16-37 weeks gestation. **MATERIALS & METHOD:** One hundred and three normal singleton pregnant women of 16-37 weeks gestation were examined for routine obstetrics ultrasound. In these patients fetal foot length measurements were taken and the gestational age was assessed. In addition, fetal femur length to foot length ratio was calculated in each patient. **RESULTS/OBSERVATION:** Linear relationship between foot length and gestational age was present with a  $R^2$  value of 0.90 ( $p < 0.001$ ) and the fetal femur length/foot length ratio was found to be more than or equal to 0.92. The foot length can be a reliable parameter for use in assessment of gestational age and as most skeletal dysplasias spare the feet, the fetal femur length/foot length ratio can be used to detect most skeletal dysplasia. **CONCLUSIONS:** Foetal foot length is a reliable parameter for assessment of gestational age and femur length/foot length ratio is approximately 1 and a ratio of  $< 0.92$  shall be useful in the detection of most skeletal dysplasia.

**KEYWORDS:** Foetal foot length, Ultrasound, Femur length, Gestational age.

**KEYMESSAGES:** Fetal foot length measurement is a reliable means of estimating the gestational age. Additionally, the fetal femur length to foot length ratio is useful in the detection of most skeletal dysplasias.

**INTRODUCTION:** The fundamentals of the peri-natal care are accurate assessment of gestational age and evaluation of the fetal growth. Multiple parameters of the fetal anatomical measurements by ultrasound are in use for the assessment of gestation, which are fetal crown to rump length (CRL), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL). All these measurements give an accurate assessment of the fetal gestational age. However, gestational age assessment may be difficult in fetus with anencephaly, hydrocephalus, and short limb dysplasia. Study of literature suggests that fetal foot has a characteristic pattern of normal growth and the fetal foot could be used to estimate gestational age.<sup>1</sup> The evaluation of the fetal femur/ foot length ratio can also be a useful parameter to differentiate fetuses that have dysplastic limb reduction, from those whose limbs are short because of constitutional factors/IUGR.<sup>2</sup>

The present prospective study was designed to correlate the fetal gestational age by ultrasonic measurement of the fetal foot length in pregnant Indian women between 16-37 weeks of

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pregnancy and to evaluate the fetal femur to foot length ratio, to rule out the possibility of dysplastic anomalies.

The present study aims to study whether fetal foot length measurements can be used to reliably estimate the gestational age and to calculate the relationship between the fetal femur length and foot length.

**SUBJECTS AND METHODS:** A prospective study was conducted on one hundred and three normal singleton pregnant women attending the Department of Radio-Diagnosis, Imaging and Interventional Radiology of N.S.C.B. Subharti Medical College, Meerut and Meerut Scan center, Meerut, for a routine antenatal ultrasound examination.

The gestational ages of patients varied between 16 weeks and 37 weeks, as per the LMP of the patient. All these patients had undergone a prior ultrasound examination at or before 14 weeks of gestation to confirm the gestational age. The ultrasound examination was done on GE Logique book XP unit and Medison unit with a 3.5MHz transducer. The fetal foot was measured from skin edge overlying heel to the distal end of the longest toe, either 1<sup>st</sup> or 2<sup>nd</sup> toe, on either the plantar or sagittal views by electronic calipers [Figure 1-2].

The Femur diaphyseal length was measured by measuring only the ossified portions of diaphysis and metaphysis, an internationally accepted method and the femur length/ foot length ratios were calculated for each.

**RESULTS:** The gestational ages of the fetuses ranged from 16-37 weeks with the majority of patients (38.8%) between 22 weeks -24 weeks gestation (by previous ultrasound measurement).

The relationship between the fetal foot length and the gestational age and fetal femur length to foot length ratio was calculated Tables 1 and 2.

Menstrual Age	No of fetuses	5 <sup>th</sup> (mm)	50 <sup>th</sup> (mm)	95 <sup>th</sup> (mm)
16 weeks	4	17	21	23
17 weeks	3	20	25	28
18 weeks	7	23	27	31
19 weeks	5	25	31	34
21 weeks	8	29	35	40
22 weeks	12	33	38	43
23 weeks	17	35	42	46
26 weeks	10	42	49	54
28 weeks	4	47	54	59
30 weeks	3	52	59	63
31 weeks	4	54	62	66
32 weeks	3	56	63	68
33 weeks	6	60	66	71
35 weeks	4	65	69	76
36 weeks	9	67	72	78
37 weeks	4	70	74	80

**Table 1: The relationship between the fetal foot length percentile and gestational age**

A significant linear relationship between these parameters was present & demonstrated a strong correlation with a R<sup>2</sup> value of 0.90 (p less than 0.001)

Menstrual age	No. of fetuses	Femur length Mm (50 <sup>th</sup> percentile)	Foot length mm (50 <sup>th</sup> percentile)	Ratio of femur length to foot length
16 weeks	4	20	21	0.95
17 weeks	3	23	25	0.92
18 weeks	7	26	27	0.96
19 weeks	5	30	31	0.96
21 weeks	8	35	35	1
22 weeks	12	38	38	1
23 weeks	17	40	42	0.95
26 weeks	10	49	49	1
28 weeks	4	54	54	1
30 weeks	3	57	58	0.99
31 weeks	4	60	62	0.96
32 weeks	3	62	63	0.98
33 weeks	6	64	66	0.96
35 weeks	4	68	69	0.98
36 weeks	9	70	72	0.97
37 weeks	4	72	74	0.97

Table 2: The femur length/foot length ratio

The femur length to foot length ratio was found to be equal to or more than 0.92 throughout this gestational age range.

The foot length and femur length measurements are shown at different gestational ages in three different patients [Figure 3-4-5].

**DISCUSSION:** Antenatal ultrasound examination has been an indispensable imaging modality in assessing gestational age. Multiple parameters are used for assessing the fetal age as crucial decisions have to be made on the basis of fetal biometric measurements. Advent of modern ultrasound units with high resolution has made accurate assessment of even fetal extremities possible. Streeter, in 1920, showed that the fetal foot has a characteristic pattern of normal growth. He proposed that the fetal foot could be used to estimate the gestational age.<sup>1</sup> Mercer et al, in 1987, found that the fetal foot length is a reliable parameter for use in assessment of gestational age and is particularly useful when other parameters do not accurately predict gestational age, like in hydrocephalus, anencephaly, short limb dysplasia. They reported a strong correlation between foot length and gestational age with an R<sup>2</sup> value of 0.981.<sup>3</sup> Other authors have also reported similar results.<sup>4,5</sup> Very few such studies could be found in literature from India<sup>6</sup>. Recent study of Drey et al also found data of fetal foot length measurements close to that of Mercer et al.<sup>7</sup>

The femur length to foot length ratio i.e. ratio of the ossified femur length to foot length on the plantar view has been studied by several authors.<sup>1,2,8,9</sup> The ossified femur length is almost equal to the foot length throughout the gestational age. If the fetus is constitutionally small or there is symmetrical IUGR, the ratio is generally greater than or equal to 0.9.<sup>10</sup> Other authors have reported

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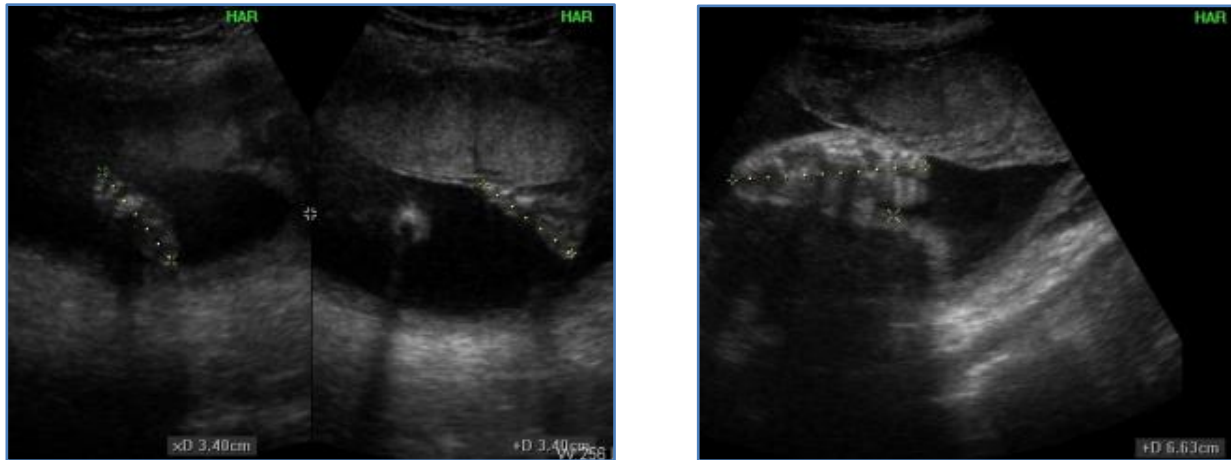
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ratio  $>0.85$ , as the cut off.<sup>2,8</sup> However, in most skeletal dysplasias characterized by limb shortening, the ratio has been reported as less than 0.9 because of the relative sparing of hands and feet.<sup>10</sup> Thus, the ratio may help to differentiate fetuses that have dysplastic limb reduction from those whose limbs are short because of IUGR/ constitutional factors.<sup>2,9</sup> Recently, Meiorowitz et al have reported foot length is approximately equal to femur length throughout the gestation and the ratio can be used to detect most skeletal dysplasias. However, they found that as 29.4% of foot lengths from large for gestational age fetuses are above the 90<sup>th</sup> percentile and 60.6% foot lengths in small for gestational age are less than 10<sup>th</sup> percentile, foot length cannot be used to assess gestational age in fetuses with growth abnormality.<sup>11</sup>

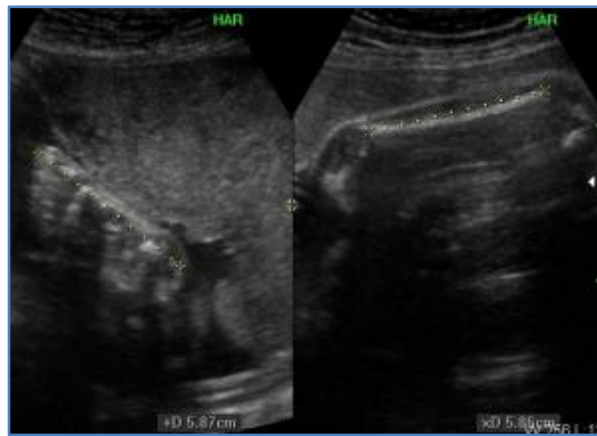
**CONCLUSION:** Our study concludes that fetal foot length is a reliable parameter for use in assessment of gestational age and is particularly useful when other parameters cannot predict gestational age like in fetal hydrocephalus or anencephaly. Femur length/ planter foot length ratio is approximately 1 and a ratio of  $< 0.92$  will prove useful in detection of most skeletal dysplasias.

### REFERENCES:

1. Streeter GL. Weight, sitting height, head size, foot length and menstrual age of the human embryo. *Contrib embryo Cornege Inst* 1920; 11:143-170.
2. Campbell J, Henderson A, Campbell S. The foetal femur/ foot length ratio: A new parameter to assess dysplastic limb reduction. *Obstetrics and Gynecology* 1988; 72 (2): 181-4.
3. Mercer BM, Sklar S, Shariatmadar A, Gillieson MS, D Alton ME. Foetal foot length as a predictor of gestational age. *Am J Obstet Gynecol* 1987; 156 (2):350-5.
4. Shaley E, Wener R, Zuckerman H & Megory E. Reliability of sonographic measurement of the foetal foot. *Journal of Ultrasound in Medicine* 1989; 8 (5): 259-62.
5. Platt LD, Medearis AL, Gregor DR. Foetal foot length relationship to menstrual age and foetal measurement in 2<sup>nd</sup> trimester. *Obstet Gynecol* 1988; 71: 526-31.
6. Mhaskar R, Agarwal N, Takkar D, Buskshee K, Anandalakshmi, Deorari A. Foetal foot length – a new parameter for assessment of gestational age. *Int J Gynaecol and Obstetrics*. 1989; 29 (1):35-8.
7. Drey EA, Kang MS, Mc Farland W, Darney PD. Improving the accuracy of foetal foot length to confirm gestational age. *Obstet and Gynecol*. 2005; 105 (4): 773-78.
8. Seeds JW. The routine screening obstetrical ultrasound examination. *Clin Obstet Gynaecol*. 1996; 34: 825-26.
9. Hershey DW. The fetal femur foot length ratio: a new parameter to assess dysplastic limb reduction. *Obstet Gynecol*. 1989; 73:682.
10. Glance P, Chitayat D, Azouz EM. Foetal musculoskeletal system chap 41, *Diagnostic ultrasound 1988 2<sup>nd</sup> Ed volume 2 Mosby (Missouri) Rumack*.
11. Meiorowitz NM, Ananth CV, Similian JC et al. Foetal length in fetuses with abnormal growth. *J Ultrasound Medicine*. 2000; 19:201-05.



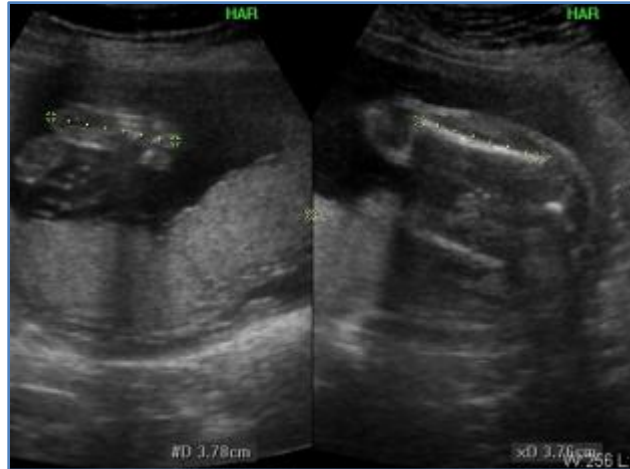
**FIG. 1 & 2: Foetal foot length measurement on plantar and sagittal**



**FIG. 3: Foetal foot and femur lengths at 28 weeks**



**FIG. 4: Foetal foot and femur length**



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