



## Morphometric Study of Fetal Femur Length By Ultrasonography In Determination Of Gestational Age In Southern Part of Rajasthan

|                        |  |
|------------------------|--|
| <b>Jaiswal Pratima</b> | Professor Anatomy, Government Medical College Kota           |
| <b>Ghulyani Tuhin</b>  | Senior demonstrator, Government medical college, Kota        |
| <b>Masih F. W</b>      | Associate professor Anatomy, Government Medical College Kota |
| <b>Rathore K.B.</b>    | P.G. Resident, Anatomy, Government Medical College Kota      |

### ABSTRACT

**INTRODUCTION:** Gestational age (GA) is defined in weeks beginning from LMP (Last menstrual period) prior to conception. Accurate determination of Gestational Age (GA) is fundamental and important to clinical obstetrics, primarily as it can significantly affect the obstetric management and neonatal outcome. Ultrasound is most widely accepted method for determining fetal anthropometric measurement. Fetal femur length (FL) is an important and accurate parameter to determine the gestational age.

**AIMS:** Present study was carried out to determine gestational age (GA) with the help of ultrasonography measurement of the femur length (FL) in southern Rajasthan (Hadoti region)

**Material & Methods:** Two hundred normal gravid females with known last menstrual period (LMP) were studied who came for ante-natal checkup at Govt. Medical College and attached group of hospital Kota (Rajasthan). Gestational age (GA) was determined by last menstrual period and fetal femur length (FL) was measured using ultrasonography. Statistics was applied to correlate GA with the FL.

**Results:** Mean FL value at 16 weeks, 24 weeks, 32 weeks and 38 weeks of gestation age were 2.4, 3.6, 6.2 and 7.4 cm respectively. The mean growth rate of FL were was 2.1 cm between 13 to 20 weeks of gestation and 1.0 cm between 21 weeks to 24 weeks and then progressively reduced to .99 between 28 to 32 weeks and further to 0.82 cm between 32 to 36 weeks of gestation. The mean growth rate per week was almost constant between 13 to 32 weeks i.e. 0.25 cm per week and then reduced to 0.21 cm between 32 to 36 weeks of gestation. Strong positive correlation was found between FL and GA.

**Conclusion:** FL was found to be useful morphometric parameter in determining the gestational. The mean femur length values of present study compares well with most of the others foreign and Indian studies with little differences. Variation in values may be because of anthropometric differences between the population due to genetic, nutritional, racial and environmental factors.

### KEYWORDS

Femur length, Gestational age, Ultrasonography,

### Introduction:

Gestational age is defined in weeks beginning from LMP (Last menstrual period) prior to conception<sup>1</sup> Accurate determination of Gestational Age (GA) is fundamental and important to clinical obstetrics, primarily as it can significantly affect the obstetric management and neonatal outcome<sup>2</sup>. Different fetal biometric measurements are valuable for estimation of Gestational Age, assessment of growth & differentiation of normal from abnormal fetus.<sup>3</sup> Ultrasound is most widely accepted method for determining fetal anthropometric measurements<sup>4,5</sup>. Fetal femur length (FL) is an important parameter for determining GA.<sup>6</sup> Many studies have emphasized its usefulness.<sup>6,7,8</sup> Almost all fetal biometric growth centiles using sonographic anthropometric parameters have been derived from data from European and American population<sup>9,10,14</sup>, only a few on Asian women<sup>11,12,19</sup>. Fetal anthropometric data from Indian population is limited. Prenatal measurement of fetal parameter, estimated size & weight vary among different population<sup>(13)</sup> hence biometric values of one population may overestimate or underestimate the fetal age if used for others population with different demographic characteristics<sup>14</sup>.

**AIM:** This study was designed to determine the Gestational Age by fetal femur length measurement in the local population of Rajasthan and to compare these values with other studies.

**MATERIAL & METHODS:** A prospective study was performed on 200 pregnant women between 13 weeks to 36 weeks of gestation at Government Medical College and attached group of hospitals Kota (Rajasthan). All measurements were done with grey scale real time sonography machine (Toshiba color Doppler Nemio XG) using 3.5 MHZ curvilinear transducer. A completely filled F form (in compliance to PCPNDT Act) duly signed by radiologists and women undergoing sonography was submitted prior to examination. The present study was approved by institutional research review board i.e. ethical committee. Femur length was measured using a straight line measurement between ends of femoral diaphysis and metaphysis excluding the cartilages<sup>8,13,15</sup>

The women included were both of rural and urban areas. Gravid women who fulfilled the following criteria were included in study :

- Healthy females, with age between 18-35 years.
- With singleton pregnancy and cephalic presentation.
- With known last menstrual period (LMP) and regular 28-30 days cycles.
- Women who did not develop maternal or foetal complications during pregnancies.
- Women who had haemoglobin not less than 10 gm. & not hypertensive.

Correlation was derived between GA and FL using Microsoft Excel 2013 software and correlation coefficient (r) was de-

rived.

**OBSERVATION:**

Table 1 shows the mean measurement of FL value by weeks of gestation and standard deviation. The fetal mean FL showed a linear increase from 13 weeks onward. Mean FL values at 16 weeks 24 weeks, 32 weeks and 38 weeks of gestation were 2, 4.3, 6.2 and 7.4 cm respectively. The mean growth rate is 2.1 cm between 13 to 20 weeks of gestation and 1.0 cm between 21 to 24 weeks and then progressively reducing to 0.99 between 28 to 32 weeks and further to 0.82 cm between 32 to 36 weeks of gestation. The mean growth rate per week was almost constant from 13 to 32 weeks i.e 0.25 cm per week and then reduced to 0.21 cm from 32 to 36 weeks.

Values obtained in this study for mean FL showed closed agreement with published chart of Hadlock while varies with other foreign and Indian studies.

**Table 1: Depicts values of fetal femur length obtained in this study**

| S. No | GA (in weeks) | N (number of cases) | FL Minimum (in cm) | FL Maximum (in cm) | FL Mean ± SD |
|-------|---------------|---------------------|--------------------|--------------------|--------------|
| 13    | 05            | 1.1                 | 1.1                | 1.5                | 1.22 ±.38    |
| 14    | 04            | 1.5                 | 1.5                | 1.7                | 1.66 ±.22    |
| 15    | 09            | 1.6                 | 1.6                | 1.9                | 1.74 ±.18    |
| 16    | 04            | 1.9                 | 1.9                | 2.1                | 2.00 ±.16    |
| 17    | 02            | 2.5                 | 2.5                | 2.7                | 2.61 ±.28    |
| 18    | 08            | 2.6                 | 2.6                | 2.8                | 2.75 ±.30    |
| 19    | 07            | 3.0                 | 3.0                | 3.1                | 3.05 ±.10    |
| 20    | 09            | 3.2                 | 3.2                | 3.4                | 3.31 ±.22    |
| 21    | 10            | 3.5                 | 3.5                | 3.7                | 3.60 ±.16    |
| 22    | 07            | 3.7                 | 3.7                | 4.0                | 3.86 ±.24    |
| 23    | 11            | 4.0                 | 4.0                | 4.2                | 4.11 ±.18    |
| 24    | 09            | 4.2                 | 4.2                | 4.4                | 4.31 ±.14    |
| 25    | 10            | 4.5                 | 4.5                | 4.8                | 4.66 ±.26    |
| 26    | 07            | 4.7                 | 4.7                | 4.9                | 4.82 ±.14    |
| 27    | 03            | 5.1                 | 5.1                | 5.2                | 5.13 ±.10    |
| 28    | 06            | 5.2                 | 5.2                | 5.4                | 5.26 ±.16    |
| 29    | 09            | 5.3                 | 5.3                | 5.7                | 5.51 ±.20    |
| 30    | 03            | 5.9                 | 5.9                | 5.9                | 5.90 ±0.0    |
| 31    | 09            | 5.9                 | 5.9                | 6.1                | 5.95 ±.14    |
| 32    | 10            | 6.1                 | 6.1                | 6.5                | 6.25 ±.28    |
| 33    | 11            | 6.2                 | 6.2                | 6.5                | 6.39 ±.18    |
| 34    | 09            | 6.5                 | 6.5                | 6.7                | 6.63 ±.15    |
| 35    | 12            | 6.6                 | 6.6                | 7.1                | 6.84 ±.24    |
| 36    | 07            | 7.0                 | 7.0                | 7.3                | 7.07 ±.24    |
| 37    | 07            | 7.1                 | 7.1                | 7.3                | 7.20 ±.12    |
| 38    | 12            | 7.4                 | 7.4                | 7.5                | 7.42 ±.09    |

**Table 2: Comparison of Fetal femur length (in cm) with other foreign studies**

| S.N. | GA (in-weeks) | Hadlock <sup>13,14</sup> (American) | Jaenty <sup>15,16</sup> (American) | A. Beigi <sup>19</sup> (Iranian) | SQ RASHID (Bangladesh) <sup>17,18</sup> | Present Study |
|------|---------------|-------------------------------------|------------------------------------|----------------------------------|---|---------------|
| 1    | 13            | 1.1                                 | 1.2                                | 1.0                              | 1.0                                     | 1.2           |
| 2    | 14            | 1.5                                 | 1.6                                | 1.2                              | 1.3                                     | 1.6           |
| 3    | 15            | 1.8                                 | 1.9                                | 1.4                              | 1.7                                     | 1.7           |
| 4    | 16            | 2.1                                 | 2.3                                | 1.7                              | 2.0                                     | 2.0           |
| 5    | 17            | 2.4                                 | 2.6                                | 2.0                              | 2.4                                     | 2.6           |
| 6    | 18            | 2.7                                 | 3.0                                | 2.3                              | 2.7                                     | 2.8           |
| 7    | 19            | 3.0                                 | 3.3                                | 2.6                              | 3.0                                     | 3.1           |
| 8    | 20            | 3.3                                 | 3.6                                | 2.9                              | 3.2                                     | 3.3           |
| 9    | 21            | 3.6                                 | 3.9                                | 3.2                              | 3.5                                     | 3.6           |
| 10   | 22            | 3.9                                 | 4.2                                | 3.5                              | 3.8                                     | 3.9           |
| 11   | 23            | 4.2                                 | 4.5                                | 3.8                              | 4.0                                     | 4.1           |
| 12   | 24            | 4.4                                 | 4.8                                | 4.0                              | 4.3                                     | 4.3           |
| 13   | 25            | 4.7                                 | 5.1                                | 4.3                              | 4.5                                     | 4.7           |
| 14   | 26            | 4.9                                 | 5.4                                | 4.5                              | 4.8                                     | 4.8           |
| 15   | 27            | 5.2                                 | 5.7                                | 4.8                              | 5.0                                     | 5.1           |
| 16   | 28            | 5.4                                 | 5.9                                | 5.0                              | 5.2                                     | 5.3           |

|    |    |     |     |     |     |     |
|----|----|-----|-----|-----|-----|-----|
| 17 | 29 | 5.6 | 6.2 | 5.3 | 5.4 | 5.5 |
| 18 | 30 | 5.8 | 6.5 | 5.5 | 5.6 | 5.9 |
| 19 | 31 | 6.1 | 6.7 | 5.7 | 5.8 | 6.0 |
| 20 | 32 | 6.3 | 7.0 | 6.0 | 6.0 | 6.3 |
| 21 | 33 | 6.5 | 7.2 | 6.2 | 6.2 | 6.4 |
| 22 | 34 | 6.6 | 7.4 | 6.3 | 6.4 | 6.6 |

**Table 3: Comparison of Fetal femur length (in cm) with other Indian studies.**

| S.N. | GA (in weeks) | Rajan <sup>22</sup> | Ila Gujaria <sup>20</sup> | Present Study |
|------|---------------|---------------------|---------------------------|---------------|
| 1    | 13            | 1.4                 | 1.0                       | 1.2           |
| 2    | 14            | 1.7                 | 1.4                       | 1.6           |
| 3    | 15            | 2.2                 | 1.8                       | 1.7           |
| 4    | 16            | 2.3                 | 2.1                       | 2.0           |
| 5    | 17            | 2.8                 | 2.4                       | 2.6           |
| 6    | 18            | 2.9                 | 2.8                       | 2.8           |
| 7    | 19            | 3.2                 | 3.1                       | 3.1           |
| 8    | 20            | 3.4                 | 3.4                       | 3.3           |
| 9    | 21            | 3.7                 | 3.7                       | 3.6           |
| 10   | 22            | 3.9                 | 4.0                       | 3.9           |
| 11   | 23            | 4.2                 | 4.3                       | 4.1           |
| 12   | 24            | 4.6                 | 4.4                       | 4.3           |
| 13   | 25            | 4.7                 | 4.6                       | 4.7           |
| 14   | 26            | 5.1                 | 5.0                       | 4.8           |
| 15   | 27            | 5.3                 | 5.2                       | 5.1           |
| 16   | 28            | 5.5                 | 5.3                       | 5.3           |
| 17   | 29            | 5.6                 | 5.5                       | 5.5           |
| 18   | 30            | 6.2                 | 5.8                       | 5.9           |
| 19   | 31            | 6.4                 | 6.1                       | 6.0           |
| 20   | 32            | 6.7                 | 6.2                       | 6.3           |
| 21   | 33            | 6.8                 | 6.3                       | 6.4           |
| 22   | 34            | 7.0                 | 6.6                       | 6.6           |
| 23   | 35            | 7.1                 | 6.7                       | 6.8           |
| 24   | 36            | 7.4                 | 6.9                       | 7.1           |
| 25   | 37            | 7.5                 | 7.1                       | 7.2           |
| 26   | 38            | 7.6                 | 7.2                       | 7.4           |



**FIGURE -1 Femur length at 14 weeks of gestation**



**FIGURE -2 Fetal Femur length at 35 weeks of gestation**

**DISCUSSION**

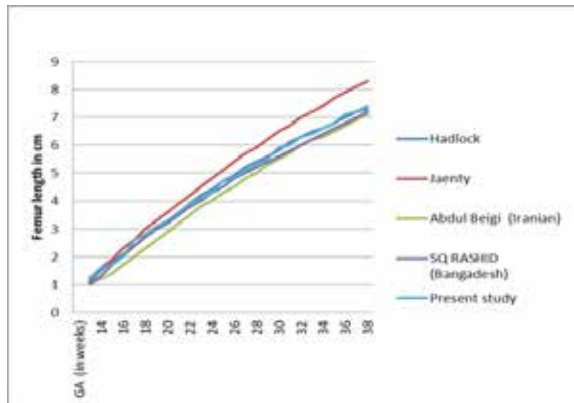
Estimation of gestational age by ultrasonography is of high importance for diagnosis, investigation and treatment of fetus in vitro. Accurate assessment of gestational age by sonography can be of great importance in management and taking decisions during pregnancy even in women with reliable dates, error in gestational age calculation can arise. Therefore prediction from ultrasound is more accurate. Among all the parameters used to determine GA, femur length has proved to be the one of the most accurate parameter<sup>13</sup>.

A comparison of the mean values in the present study against the standards of Hadlock , Jeanty, SQ Rashid and A. Beigi and other Indian studies was also done. All the values of FL in the study by A. Beigi (Iranian) were lower in comparison to present study. Mean FL at 18 and 30 weeks in his series were 2.3 and 5.5 cm in comparison to 2.8 and 5.9 cm in the present study. Mean FL values obtained by Jeanty were higher than the present study. The mean FL at 20 and 30 weeks in his series were 3.6 and 6.5 cm as against 3.3 and 5.9 cm in this study. The mean FL values of present series are in close approximation with Hadlock and SQ Rashid series. In comparison with other Indian studies our mean FL values are comparable with Ila Gujaria series but are lower than Rajan FL value.

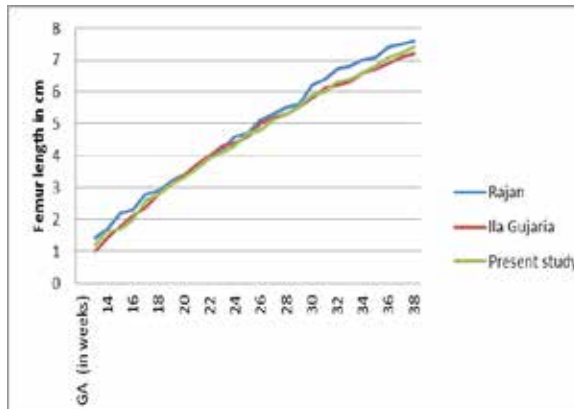
The mean FL values of present series compares well with most of the other studies by western and Indian workers with little difference. This difference in mean FL charts may be because of

1. Non uniformity in sonar methodology.
2. An inter-observer error.
3. Difference in socio-economic, racial and ethnic background.
4. Difference in genetic and environmental factor

The growth determined by FL, is relatively independent of nutritional growth and retardation.



Graph: 1 Graphical presentation of femur length with other Indian studies



Graph 2 Showing comparison of FL values of present study with other Indian studies

Regression equation was derived  $GA = 6.55 + 4.12(FL)$

**CONCLUSION**

Femur length is one of the most accurate biometric measurements in determining the gestational age, is independent of nutritional growth and retardation. Our analysis confirmed that fetal anthropometric measurements significantly differ among different population group due to racial, genetic, ethnic and socioeconomic factor. Therefore, population specific measurements should be made to generate population specific data. India is a diverse country with various races, nutritional habits & environmental factors hence a larger study on different regions of India is warranted. Thus, biometric curves of one population may overestimate or underestimate gestational age and EDD when used for other racial or ethnic groups. Hence, a large scale study at national level in other Indian population is required to generate population-specific reference tables and further studies are recommended to support the above mentioned findings.

**REFERENCES**

1. Macgregger S, Sabbgha R, Glob.lib.womens'med., (ISSN:1756-2228) 2008; DOI IO:3843/GLOWM.10206
2. Sabbgha RE, Hughey M. Standardization of sonar cephalometry and gestational age. *Obstetrics and Gynecology* 1978;52:402-6
3. Hohler CW. Ultrasound estimation of gestational age. *Clinical Obstetrics and Gynecology*; 1984, 27:314-326
4. Nouborg E et al. Prenatal Ultrasound examination and risk of childhood leukemia: Case control study. *British medical journal*; 2000;320:280-283
5. Nyborg WL. Safety of medical diagnostic ultrasound. *Seminars in ultrasound CT, and MRI*, 2002, 23:377-386
6. O'Brien GD, Queenan JT, Campbell S, Assessment of gestational age in the second trimester by real time ultrasound measurement of the femur length. *Am. J. Obstet Gynecol.* 1981;139: 540-545
7. Campbell S, Warsof SL, Little D et al. : Routine USG screening for the prediction of gestational age, *Obstet Gynecol* 1985: 45;613-20
8. Goldstein R, Pitfalls in femur length measurement, *J Ultrasound Med, Apr 1987;6(4)*, pp203-7. PMID : 3295286
9. Altman GA, Chitty LS, Henderson A, Campbell S, charts of fetal size: Methodology; *British journal of Obstet gynecology* 1994;101:29-34
10. Lessoway VA et al. Ultrasound fetal biometry charts for North Caucasian American Population, *Journal of Clinical Ultrasound* 1998;26:433-453
11. Zaidi S, Sharda, Omair A. Sonographic fetal measurement in a cohort of population of Karachi, Pakistan. *Journal of Pakistan Medical Association*: 2009;59:246-249
12. Lai FM, Yeo GSH. Reference charts of fetal Biometry in Asians *Singapore Med. Journal*: 1995;36:628-636.
13. Hadlock FP, Deter RL, Harrist RB, Fetal Estimating fetal age: computer assisted analysis of multiple fetal growth parameters. *Radiology* 1984;152(2); 497-502. PMID: 6739822
14. Hadlock FP, Harrist RB, Shah YP, Estimating fetal age using multiple parameters: A prospective evaluation in a racially mixed population *Am J Obstet Gynecol* 1987;156 (4); 955-7. PMID: 6378468
15. Jeanty P, Fetal limb biometry, *Radiology* 1983;147: 601-602.
16. Jeanty P, Rodesch F, Dekbeke D, et al, Estimation of gestation age from measurement of fetal long bones. *J Ultrasound Med* 1984; 3:75-79
17. Rashid SQ. A Study correlating the menustral age and fetal age in Bangladeshi population Bangladesh *J Ultrasonogr* 1999; 6: 3-8
18. SQ RASHID. Gestational age predicted by femur length in Bangladesh. *Journal of Bangladesh College of physicians and surgeons.* September 2010; Vol 28, No. 3 : PP 162-166
19. A. Beigi, F. Zarrin Koub. Ultrasound assessment of fetal biparietal diameter and femur length during normal pregnancy in Iranian women. *International Journal of Gynaecology & Obstetrics* 69 (2000); 237-242
20. Ila Gujaria. Estimation of gestational ages by measuring the femur length: A Sonography study. *Int J Pharma Bio Sci.* Jan 2013; 4(1): (B) 213-219
21. Nishtha Singh, P.K Sharma, A.K. Singh: Ultrasonographic. Study of Femur Length in fetuses of North Indian women's. *Journal of Pharmacy and Biological Sciences.* volume 5, Issue 1 (Jan-Feb. 2013), PP 28-31
22. Rajan R, Girija B, Vasantha R. Ultrasound fetal Growth parameters. *J Obstet Gynecol India*, 1991; 41(1), 139-14.