

**Original article**

## **Ultrasonographic study of fetal femur length in foetuses of Rohilkhand region Bareilly, U.P., India**

**Dr.Preeti Agarwal<sup>1</sup>, Dr. Atul Mehrotra<sup>2</sup>**

1- M.D, Senior Resident, Department of Anatomy, Rohilkhand Medical College and Hospital, Bareilly, (UP).

2- M.D, Associate Professor Department of Radiology, Rohilkhand Medical College and Hospital, Bareilly, (UP).

**Corresponding author:** Dr.Preeti Agarwal.

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**Abstract:**

**Aim:** To construct new reference charts & equations for fetal femur length in relation to gestational age in Rohilkhand region, Bareilly.

**Material and methods:** A total of 700 women were scanned using technique originally described by O'Brien et al. The descriptive statistics (mean and standard deviation) were performed for the measurements of femur lengths at weekly intervals. Each interval was centred on a week, so that from 11 weeks and 4 days up to 12 weeks and 3 days has been considered as 12<sup>th</sup> week. Mean and standard deviation were calculated and compared with available data of other population using t test. Regression equation was calculated and the predicted femur length was compared with available data of other studies.

**Results:** The results suggested that fetal growth with respect to femur length may not be adequately assessed by using reference charts obtained from other populations. We have created new reference ranges for fetal femur length in the Rohilkhand region.

**Conclusion:** To assess gestational age with the help of ultrasound we have tried to establish normal ranges of fetal growth for femur length measurement from 11 weeks of gestational age onwards using linear and multiple regression analysis of data. Regression analysis was done to find out best fit model to derive gestational age from femur length. We found cubic regression equation as best fit model for

Rohilkhand population. This can be because of difference in racial, nutritional and many other factors between different population studied.

**Key words:** Transducer, Femur length, Gestation Age.

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**Introduction:**

Accurate determination of gestational age is fundamental to obstetric care and is important in a variety of situations. There are various methods of gestational age assessment. In the past gestational age was established by a combination of the historical information and the physical examination of the patient. Clinician used to rely on the menstrual history and the maternal sensation of fetal movement ("quickening"). Other factors include assessment of uterine fundal height size, by bimanual examination, in the first trimester, initial

detection of fetal heart rate by Doppler (10–12 weeks) or auscultation (19–21 weeks). However, all the above mentioned measurement techniques are also fraught with error, even in the best of circumstances. It has been estimated that 20% to 40% of women are not sure of their LMP. Some of the reasons for this uncertainty include metrorrhagia, oligomenorrhea, bleeding in the first trimester of pregnancy, pregnancy following use of intrauterine devices or oral contraceptives, and pregnancy during the postpartum period. In the first trimester, gestational sac mean diameter and

crown-rump length measurements have become the primary means of evaluating gestational age.<sup>1</sup> In the second and third trimesters, fetal head, body and extremity measurements have been commonly used to assess gestational age. The parameters most commonly measured include femur length, head circumference, abdominal circumference and biparietal diameter.<sup>1,2</sup>

Fetal long bones can be adequately examined and measured by ultrasound; however, the femur is the largest of the long bones, least moveable, and easiest to image. Femur length (FL) measurements may be used to accurately predict gestational age between 12 weeks' gestation and term. The accuracy of gestational age prediction based on femur length is greatest in the second trimester and least near term. The use of locally developed charts means that the factors that may influence fetal biometry, including maternal age and nutritional status, maternal weight and size can be identified, facilitating accurate prediction of small for date and growth retarded fetuses. Therefore here in this study we have tried to establish growth charts for fetal femur length for the Rohilkhand population.

#### **Material and methods:**

**Place of study:** This study was conducted in Department of Anatomy, in collaboration with Department of Obstetrics and Gynaecology and Department of Radiology at Rohilkhand medical College and Hospital, Bareilly and associated hospital R.K Nursing Home, Bareilly. A prospective, cross sectional, observational study to create reference ranges for femur length of fetuses of women from Rohilkhand region with the help of ultrasound examination. Our study group consisted of pregnant women from Rohilkhand region, Bareilly (U.P.) who were referred to Department of Radiology for their routine antenatal sonographic assessment as a part of antenatal care. Among 815

pregnant women scanned, 700 women fitted the inclusion criteria. A total of 115 women were excluded for the following reasons: uncertain date of last menstrual period, pre-existing menstrual disorders, history of prolonged substance abuse (alcohol, smoking etc), multiple pregnancies e.g twin gestation, fetal malformations, chronic maternal disease e.g diabetes mellitus, chronic hypertension, medication that could affect the growth of the fetus e.g teratogenic drugs, existing endocrine disorder, pre-existing or existing gynaecological disorders. No fetuses were excluded on the basis of abnormal biometry or birth weight. All the women whether primigravida or multigravida were included in this study those between 12 to 42 weeks of gestation. Informed consent was taken from the pregnant females and they participated voluntarily. The menstrual age was established by reference to last menstrual period in patient with history of regular menses i.e known date of the beginning of the last menstrual period.

**Data acquisition:** For fetal biometric measurements, real-time transabdominal ultrasonogram was taken using "Model - Logiq V5 (Making - GE)" ultrasound machine equipped with a 3.5-MHz convex transabdominal probe. The measurements were taken to the nearest millimetre.

**Fetal biometrics:** The technique originally described by O'Brien et al. was used to align the transducer along longest axis of the femur. The long axis of the fetus is found by obtaining a longitudinal section through fetal spine and aorta. The transducer is then turned 90 degrees to produce a cross sectional image of the fetal trunk at the level of umbilical vein. The transducer is then moved down the fetus, maintaining this angle, to the fetal pelvis. Since the fetal femur is usually flexed, the transducer must be rotated 30 to 45

degrees towards the fetal abdomen in order to visualize the longest possible image of femur.

Lateral and medial aspects of femur have different appearance. The lateral aspect is straight, whereas the medial aspect is curved. If a medial femur length is obtained, the femur may then be thought to be bowed. To ensure that one has the longest femoral length, measurements are taken along an axis that shows both the round echogenic cartilaginous femoral head and the femoral condyles. The straight lateral surface is measured

rather than medial surface which is bowed. Femur Length has been measured in a plane where the full femoral diaphysis is seen almost parallel to the transducer and the measurement is made from one end of the diaphysis to another. In the third trimester, particular care was taken not to include the epiphysis in the measurement. The distal femoral epiphyses are visible after 32 weeks. The proximal tibial epiphysis becomes visible at around 35 weeks. A Statistical analysis was performed on the data thus obtained.

**Figure 1**



**Figure showing fetal femur length estimation.**

**Statistical analysis:**

The data was entered and analyzed in a computer, using MS Excel 07 and Statistical Package for Social Sciences (SPSS) version 10.0. The descriptive statistics (mean and standard deviation) were performed for the measurements of femur lengths at weekly intervals. Each interval was

centred on a week, so that from 11 weeks and 4 days up to 12 weeks and 3 days has been considered as 12<sup>th</sup> week. Comparative tables of mean and standard deviation of this study and the available data of other studies were made to compare the data obtained in this study.

**Results:**

Femur length which has been measured was earliest available in a pregnancy of 11 weeks 4 days in our study. It has been measured up to maximum of 42 weeks 3 days. The measurement of mean femur length ranged from 7 mm to 74.5mm during 12 to 42 weeks period of gestation. The best fit model for estimating femur length from gestational age in our study was cubic

regression equation and correlation coefficient was as follows:

**Cubic regression equation:  $FL = -0.0013GA^3 + 0.077GA^2 + 1.082GA - 11.22$**   
**( $r^2 = 0.933$ )**

The data obtained by using the regression equation in studies done by **Jeanty et al.**<sup>5</sup> and **Hadlock et al.**<sup>6,7</sup> and those obtained from regression equation of this study are tabulated in table 1.

**Table 1: Comparison of predicted femur lengths at various periods of gestation**

Menstrual age (weeks)	Femur length (mm)					
	Jeanty et al#	Hadlock et al#	Hadlock et al*	This study*	This study^	This study#
12	9	8	14	13.92	8.48	10.61
13	12	11	16	16.16	11.56	13
14	16	15	19	18.40	14.60	15.45
15	19	18	21	20.64	17.58	17.95
16	23	21	23	22.88	20.51	20.48
17	26	24	26	25.12	23.39	23.04
18	30	27	28	27.36	26.21	25.62
19	33	30	30	29.60	28.99	28.22
20	36	33	33	31.84	31.71	30.82
21	39	36	35	34.08	34.38	33.42
22	42	39	38	36.32	37.00	36.01
23	45	42	40	38.56	39.56	38.58
24	48	44	42	40.80	42.08	41.13
25	51	47	45	43.04	44.54	43.64
26	54	49	47	45.28	46.95	46.12
27	57	52	49	47.52	49.31	48.54
28	59	54	52	49.76	51.61	50.91
29	62	56	54	52.00	53.87	53.21
30	65	58	57	54.24	56.07	55.44
31	67	61	59	56.48	58.22	57.59
32	70	63	61	58.72	60.32	59.65
33	72	65	64	60.96	62.36	61.62
34	74	66	66	63.20	64.36	63.48
35	77	68	69	65.44	66.30	65.24
36	79	70	71	67.68	68.19	66.87
37	81	72	73	69.92	70.03	68.38
38	83	73	76	72.16	71.81	69.75
39	85	75	78	74.40	73.55	70.98
40	87	76	80	76.64	75.23	72.06
41				78.88	76.86	72.98
42				81.12	78.44	73.74

\* Linear ^ Square# Cubic

Considering that comparison is easy when it is in tabulated form, the calculated data on the mean (average) and standard deviation of this study and the available data of other studies have been

tabulated. Mean and standard deviation of femur length in the studies carried in North-eastern Thailand by **Piyamas Saksiriwuttho et al.**<sup>9</sup> in 635 pregnant women, in London by **Snijders et al.**<sup>10</sup> in

1040 pregnancies, in Pakistan by **Shahida et al.**<sup>11,12</sup> in 358 pregnant women, along with mean

and standard deviation in this study is tabulated in table 2.

**Table 2: Comparison of mean and standard deviation of femur length**

Gestational age(weeks)	Piyamas et al.Thailand		Snijders et al. London		Shahida et al. Pakistan		This study	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
11	NA	NA	8	2	NA	NA	NA	NA
12	NA	NA	10	2.5	NA	NA	7.05	0.07
13	NA	NA	11	2.5	NA	NA	11.6	2.71
14	13.28	1.02	15	3	15.2	1.7	14.73	2.28
15	18.29	2.01	17	3.5	17	2	18.25	2.62
16	18.87	2.94	22	4	21.5	2.6	22.74	3.99
17	24.16	3.43	25	4	23.7	3.1	25.5	4.76
18	26.51	2	28	5	27.2	2.2	25.98	6.55
19	28.35	2.82	30	5	30.2	3.9	26.28	4.7
20	32.61	3.4	32	6	33	2.1	32.23	5.72
21	34.85	2.49	34	6	35.3	2.4	34.79	5.1
22	36.61	3.05	37	5	39.2	2.6	35.71	3.38
23	40.21	2.8	43	5	40.1	3.1	36.48	5.77
24	42.22	1.71	45	4	44.3	2.6	41.42	6
25	47	5.88	48	5	46	3.4	43.97	6.14
26	46	2.65	49	5	50	2.1	46.99	3.18
27	49.01	2.01	50	5	51.2	1.9	48	5.39
28	50.11	5.92	54	4	53.3	2.2	53.25	2.57
29	53.6	2.02	55	5.5	55.7	2.2	53.62	3.63
30	56.25	2.45	58	6	58.4	2.9	57.71	3.71
31	59.44	2.62	59	5.5	59.4	1.6	58.08	4.82
32	58.85	2.26	62	6	62.1	1.8	60.58	4.75
33	60.71	2.43	65	4	63.6	2.4	61.67	4.79
34	62.16	2.91	66	4	65.9	2.3	63.71	3.98
35	65.22	2.07	67	6	68.1	1.9	66.89	2.94
36	67.57	1.89	69	6	69.6	6.25	69.59	2.8
37	68.36	1.89	72	5	68.8	2.7	71.27	2.17
38	69.86	3.43	73	5.5	71.9	1.6	71.31	2.28
39	71.09	3.46	75	6	NA	NA	71.69	2.84
40	73.5	4.34	76	4	NA	NA	72.58	1.99
41	73.67	3.04	77	5	NA	NA	73	1.41
42	NA	NA	NA	NA	NA	NA	7.05	0.07

NA= not available.

**Discussion:**

Ultrasound is probably the most important innovation in obstetric care in the past 50 yrs. It looks into the anatomy of unborn foetus and determines the gestational age, any fetal and placental anomaly and assesses the amniotic fluid

volume. In this cross sectional study, we have tried to establish normal ranges for femur length for the Rohilkhand population. Each woman contributed to one set of measurement, taken during a routine ultrasound examination. The mean (average) and standard deviation of femur length in millimetres

was calculated for each week. The mean of femur length increased as the menstrual gestational age increased. The mean of femur length increased suddenly from 12 to 17 weeks (7.05mm in 12<sup>th</sup> week to 25.5mm in 17<sup>th</sup> week). A gradual growth of about 1.5mm to 3 mm was seen every week, as the weeks progressed in late 2<sup>nd</sup> trimester. But the growth was less (1-1.5mm) from 36 weeks onwards.

The predicted femur length in the present study is almost equal to the predicted femur length in the study done by **Hadlock et al.**<sup>6,7</sup> Much difference is seen in the predicted value of femur in the study carried by **Jeanty et al.**<sup>5</sup> The difference in femur length gradually increases from 12 to 40 weeks. The predicted femur length is greater in their study than ours by 3mm from 18 to 19 weeks, by 5mm from 20 to 21 weeks, by 6mm from 22 to 23 weeks, by 7mm from 24 to 25, by 9 mm from 26 to 27 weeks, by 10mm from 27 to 30 weeks, by 11 mm from 31 to 40 weeks. Comparison of the mean femur length obtained in this study with those of study carried in North-eastern Thailand by **Piyamas Saksiriwuttho et al.**<sup>9</sup> showed that the femur lengths are almost equal up to 21 weeks. Thereafter a steady difference of 2 mms is maintained up to 26 weeks. This difference is maintained up to 41 weeks however minimal, the average femur length being 73.67mm in Thailand foetuses and 73mm in North Indian foetuses at 41 weeks. The mean femur length of Pakistan foetuses, in the study carried by **Shahida et al.**<sup>11,12</sup> is greater by 3-4mm than North Indian population from 22 to 27 weeks however from 28 weeks onwards was comparable. The comparison of our

mean femur length with those of the study of **Snijders et al.**<sup>10</sup> carried in London shows that initially in Indian fetuses it was almost comparable till 21 weeks and from 22 weeks onwards 3-4mm less than those of London. The standard deviation in our study is greater than those of other studies. This may be because of wide variability of data collected from females of varied socioeconomic strata having different nutritional status and physical structure.

#### **Conclusion:**

To assess gestational age with the help of ultrasound we have tried to establish normal ranges of fetal growth for femur length measurement from 11 weeks of gestational age onwards using linear and multiple regression analysis of data. The predicted femur length in the present study is almost equal to the predicted femur length in the study done by Hadlock. The predicted femur length in the study carried out by Jeanty, was more than predicted femur length of our study. Regression analysis was done to find out best fit model to derive gestational age from femur length. We found cubic regression equation as best fit model for Rohilkhand population. This study provides us a chart derived from cubic regression equation to determine gestational age from femur length measurement of fetuses in Rohilkhand region of North India. So far gestational age estimation was dependent on western charts based on previous studies. Charts generated based on our study clearly demarcates from studies done on other population. This can be because of difference in racial, nutritional and many other factors between different population studied.

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