ASSESSMENT OF GESTATIONAL AGE BASED ON ULTRASONIC FEMUR LENGTH OF FETUS

M. Honarvar and M. Allahyari

Department of Obstetrics and Gynecology, Faculty of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract - The ultrasonic measurement of the fetal femur length is a sensitive and precise variable for estimation of fetal growth and development. The objective of this study was to predict gestational age in fetuses older than twenty-four weeks of gestation by ultrasonic measurement of the femur length. In this study, pregnant mothers were identified by the criteria of normality, such as well-known LMP, regular menstrual cycles, no use of oral contraceptive pills for the prior 3 months, no smoking, no history of diabetes. The relation between gestational age and fetal femur length was determined by cross-sectional analysis of 900 normal fetuses (≥ 25 weeks) using real - time ultrasonography. Mathematical modeling of the data demonstrated that the femur growth curve is always linear beyond 24 weeks of gestation. The following regression equation was derived : GA (week) = 5.2 FL (cm) + 2, SD~ ±5 days (Honarvar's Formula 2). According to this data, the error in estimation of GA for given FL is less than 6 days. This equation appears to be clinically reliable and easy to use. Previous normal ultrasonic fetal femur length curves for other populations may underestimate or overestimate normal fetal age for Iranian population.

Acta Medica Iranica 37 (3): 134-138; 1999

Key Words: Gestational age, femur length

INTRODUCTION

In all pregnancies, it is important to determine gestational age. In this connection, the measurement of the crown-rump length (CRL) and biparietal diameter (BPD) are precise methods and, applied commonly. However, the BPD is not always a reliable indicator of gestational age due to genetic or position-related alterations in head shape and in congenital anomalies such as hydrocephaly, microcephaly, anencephaly, etc.

Moreover, fetal femur length (FL) can be used as an adjunct in estimating menstrual age, and as a screening device for the detection of congenital anomalies(1) (e.g., dwarfism, osteogenesis imperfecta).

Meanwhile, ultrasonic FL is not only an accurate indicator of gestational age it has also been shown to have a stronger correlation with gestational age (GA) than BPD (2-5).

It is also possible to identify abnormal fetal growth with the measurement of normal growth curve for femur length during pregnancy which can be used in following the progressive growth of fetus (6). Infants who deviate from physiologic norms of FL for GA have increased perinatal mortality and morbidity. Thus, symmetric growth retardation can be identified in all instances by shortened ultrasonic femur lenghts.

On the other hand, the fairly common practice of using mean values determined for one population as the basis for judging the individual fetus drawn from another population compounds the problem of lack of sensitivity in two ways: It ignores the fact that all normal fetuses within a population do not conform to mean values and does not take into account interpopulation variation in fetal anthropometric characteristics. Raman and coworkers(4) have shown a significant difference in limb length growth of Indians compared with non-Indians. The present report is a detailed account of our experience with estimating GA in the fetuses of more than twenty-four weeks' gestation in an Iranian population.

MATERIALS AND METHODS

1062 femur length measurements were obtained. This study consists of 900 pregnant women, dated by accurate (last menstrual period (LMP). 162 of these were studied serially and had at least two measurements made throughout their pregnancies. The patient population is described in Table 1. Women who participated in this study demonstrated criteria of normality such as:

1- Regular menstrual cycles, at least for three menses.
2- No use of oral contraceptives (OCP), for at least three months prior to the study.
3- Delivering live - born neonates
4- No anomaly known perinatally or postnatally
5- No history of alcohol or cigarette use
6- No history of drug abuse
7- No family history of dwarfism
8- No history diabetes or chronic hypertension

Multiple gestations (i.e., twins) were excluded. The number of fetuses as well as means femur lenght at each gestational age is demonstrated in table2.

The FL is defined from the proximal to the distal metaphysis. For measuring FL, the present study utilized the technique originally described by O'Brien and coworkers (6), the long axis of the fetus was first identified and the transducer was then turned 90° to produce a cross-sectional image of the fetal trunk. After several femur length meausrements were made within a 2mm range, the average measurement was considered optimal. All examinations were performed by one of the authors using a linear-array real-time system with a 3.5 MHZ focused transducer (Hitachi EUB 40).

Table 1. Obstetrics data for normal patients (N = 900).

Demographic data	Number	Percentage
Parity		
Para 0	374	41.5%
Para 1	256	28.5%
Para 2 or more	270	30%
Economical class		
Low	72	8%
Middle	702	78%
High	126	14%
Mean Patient Age		
23.78 yr		

RESULTS

In this research the equation for GA as a function of FL was generated by means of regression analysis (Fig. 1) because from 25-40 weeks of gestation, the correlation of FL with GA appears to be best approximated by a linear relationship (r = 0.98, SD = 0.89 or ± 5 days)(7).

The regression equation for our data is:

GA (week) = 5.2 FL (cm) + 2, SD~ ± 5 days

(Honarvar's Formula 2)

The SD tends not to increase as femur length increases.

Predicted GA values of our study for specific FL measurements are demonstrated in table 2. The distribution of FL for each week of gestational age is presented in table 3 and the comparison of actual mean FL and that of FL derived from Honarvar's Formula is shown in table 4. There was no difference in the distribution of parity or in age between patients who delivered male and female infants. Gender does not seem to affect limb lenght (4).

Table 2. Predicted gestational age values for specific femoral length measurements.

Week	Number	%	Mean of FL(cm)	±2SD (mm)
25	63	7	4.36	± 4.12
26	60	6.66	4.55	±5.2
27	66	7.33	4.78	±6.1
28	65	7.22	4.94	±6.4
29	52	5.77	5.25	±1.5
30	55	6.11	5.47	±5.95
31	60	6.66	5.68	±6.28
32	57	6.33	5.83	±5.83
33	53	5.88	5.96	±5.76
34	50	5.55	6.28	±5.34
35	58	6.44	6.37	±7.24
36	66	7.33	6.58	±5.4
37	64	7.11	6.68	±7.87
38	48	5.33	6.79	±2.68
39	43	4.77	6.87	±3.06
40	40	4.44	7.21	±3.68
Total	900	100		

Table 3. Distribution of femur length for each week of gestational age.

Week	-2SD(mm)	-1SD(mm)	mean FL (mm)	+1SD(mm)	+2 SD (mm)
25	39.48	41.54	43.6	45.66	47.72
26	40.3	42.9	45.5	48.1	50.7
27	41.7	44.75	47.8	50.85	53.9
28	43	46.2	49.4	52.6	55.8
29	51	51.75	52.5	53.25	54
30	48.75	51.72	54.7	57.67	60.65
31	50.52	53.66	56.8	59.94	63.08
32	53.77	55.38	58.3	61.21	64.13
33	53.84	56.72	59.6	62.48	65.36
34	57.46	60.13	62.8	65.47	68.14
35	56.46	60.08	63.7	67.32	70.94
36	60.4	63.1	65.8	68.5	71.2
37	58.93	62.86	66.8	70.73	74.67
38	65.22	66.56	67.9	69.24	70.58
39	65.64	67.17	68.7	70.23	71.76
40	68.42	70.26	72.1	73.94	75.78

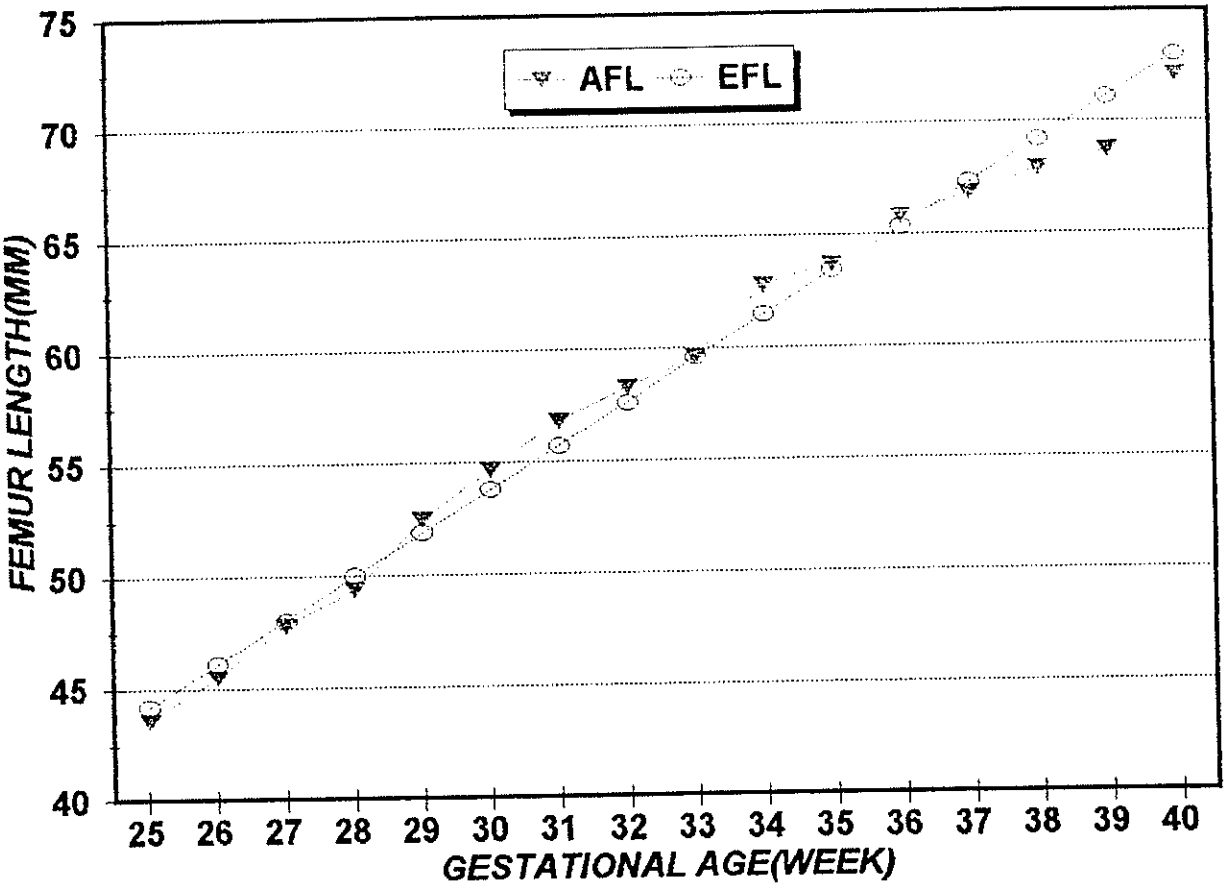

Fig 1. A comparison of AFL and EFL

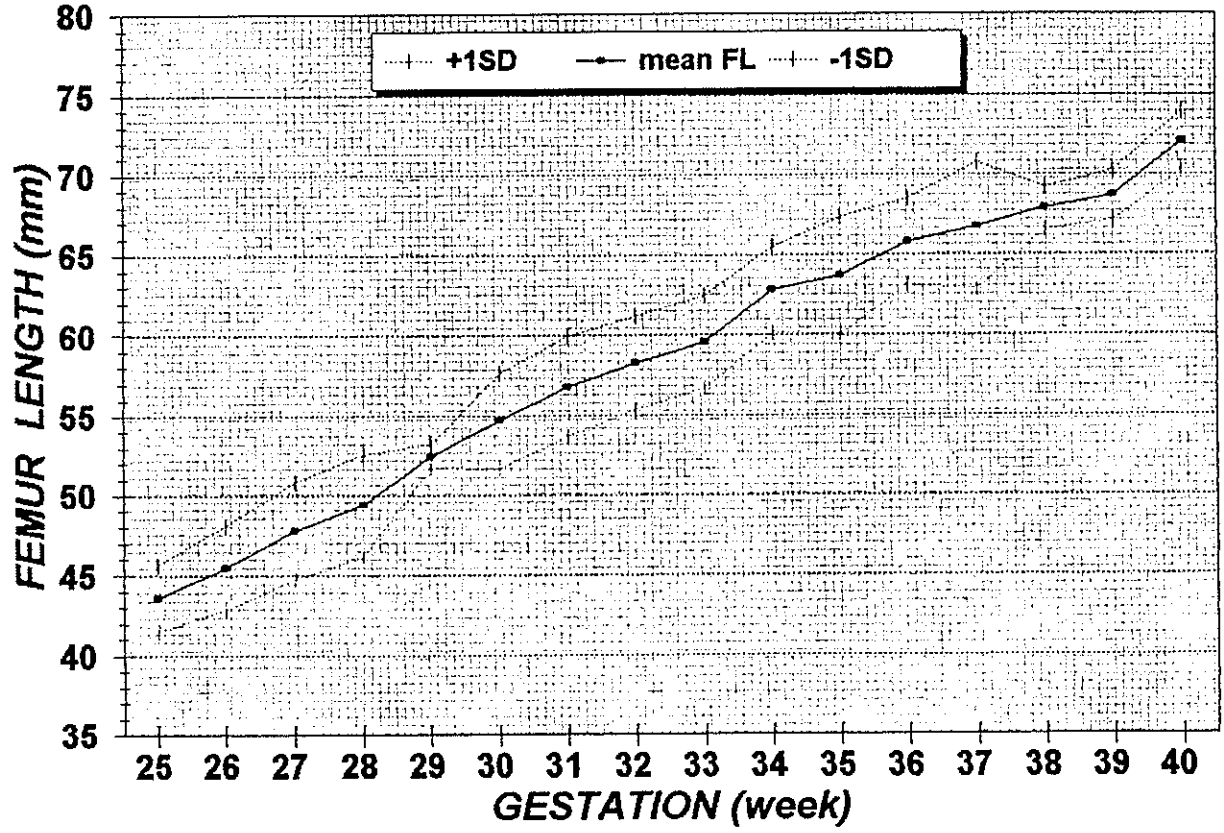

Fig 2. FL against GA, mean ± 1SD

Table 4. A comparison of the mean femur length to our predicted formula.

Week	mean FL (cm)	FL derived by GA = 5.2 FL + 2	d* (mm)
25	4.36	4.42	6
26	4.55	4.61	6
27	4.78	4.80	2
28	4.94	5	6
29	5.25	5.19	-6
30	5.47	5.38	-9
31	5.68	5.57	-11
32	5.83	5.76	-7
33	5.96	5.96	0
34	6.28	6.15	-13
35	6.37	6.34	-3
36	6.58	6.53	-5
37	6.68	6.73	5
38	6.79	6.92	-13
39	6.78	7.11	14
40	7.21	7.30	9

d* = difference between estimated FL and actual FL (FL derived by our formula - mean FL)

DISCUSSION

The mean femur length at each gestational age in this study was compared with that of two ultrasonic fetal femur length tables. At 25-33 weeks the mean difference between our values (linear function) and the data of Hadlock and coworkers (7) (linear function) is 2.2mm. After 33 weeks, our data does not correlate with the work of Hadlock, but correlates better with the work of Jeanty and coworkers (8) (linear quadratic function), the mean difference being 3.6mm. This may be due to number of cases, method for measuring FL, devices and other factors especially genetic differences.

There are major controversies in the reported GA variability (±2SD) from 23 to 40 weeks. For exmaple, Hadlock (7) reported that variability during this period is (±3-3.5 week), but Yeh and coworkers (9) reported a 95% confidence interval of ±5 days. The present study based on analysis of over 900 fetuses, indicate that the variability during this period is ±5 days. Therefore it appears that the FL provide a more accurate estimate of GA below 25 weeks, but after this point FL may provide an adequate estimate of GA. On the other hand, Sabbagha and coworkers (10) suggest that the precision of a single measurement of the BPD as a function of GA has a variation ranging ±7 days at 16 weeks and increasing to ±14 days by 27 weeks while increasing still further to ±21 days in from 29-40 weeks. Serial observations have shown that the variability is substantially increased and the precision is decreased over time, thereby decreasing the utility of this measure. This can also be demonstrated by the significantly higher correlation coefficient of the relationship of GA versus FL (r=0.955) as compared with that of GA versus BPD (r= 0.648) and supported by the smaller standard deviation for each parameter estimate where the fetal FL is the dependent variable, as contrasted with BPD (9).

Finally, this article suggests that previous normal ultrasonic fetal femur length curves of one population is unsuitable and inappropriate for other populations. The estimated quadratic growth curve of femoral length amongst the three ethnic groups clearly showed that the rate of growth of the Indian fetuses was faster than that of the Malays and Chinese. The growth curve was, however, similar amongst the three ethnic groups (4). We therefore, suggest that mean values determined for one population should not be used as the basis for judging the individual fetus drawn from another population, because of the significant interpopulation variation observed in fetal femur lengths.This should also be taken into account when growth charts are being used and fetal weight formula are being calculated using limb lengths. In conclusion, in each population, fetal femur length must be studied independently for making a better operational and functional decision in the field of obstetrics and gynecology.

Acknowledgments

I am grateful to Dr. Mahboobeh Allahyari, medical student, for help with the history taking and pregnancy questionnaires, and for analyzing the data. I wish to express my debt to Dr. Dehbashi (Chairperson of Dept. Obs/Gyn) for his encouragement, and great patience.

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