Indian Journal of Forensic Medicine and Pathology
Volume 5 Number 2, April - June 2012

Gestational Age Estimation using Femur Measurements

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Abstract

Background: Assessment of foetal femur growth parameters is one of the key - for estimation of foetal gestational age, and determination of population growth characteristics. The present study was to evaluate the relationships between the crown-rump length (CRL) and foetal femur growth parameters and the gestational age during the second and third trimesters.

Material & Method: Fifty six dead normal spontaneously delivered foetuses of second & third trimester of pregnancy were collected from the department of Obstetrics & Gynaecology, Government Medical College and Hospital, Aurangabad. A total of eight parametric variables were obtained from bilateral femora using a sliding calliper. Obtained data were statistically analyzed by unpaired t-test and Pearson correlation coefficients.

Result: There was no significant difference observed in growth patterns between the male and female during the second and third trimesters. A significant relationship between the studied foetal growth parameters and the gestational age was found. It appears that foetal CRL and femur growth parameters are accurate for the calculation of gestational age.

Key words: Forensic Anthropology; Foetuses femur collection; Growth parameters.

Introduction

The first two months of intrauterine life is termed as an embryo which become foetus from third month until birth. Foetal growth is defined as time dependent change in body dimensions that occurs throughout pregnancy. Estimation of foetal gestational age [1, 2, 3], and determination of population growth characteristics [4] were objectives of different investigations. The correlation of foetal growth with gestational age was depicted in Graphs [5]. However, most of published studies were used long bones and foetal femur length by ultrasonic measurements for assessment of gestational age. Concerning this subject, in the literature few parametric studies on femoral measurements in dead foetuses were found.

The purpose of this study was to evaluate the relationships between foetal crown-rump length, femur growth parameters and gestational age during second and third trimesters. The results 1ere compared with similar studies of other worker.

Aims and Objectives

1. To compare male and female foetal parameters.

2. To evaluate the relationships between the crown-rump length (CRL), foetal femur growth parameters and the gestational age during second and third trimesters.

3. To demonstrate the correlation of all these parameters with each other.

4. To compare the measurements with that of previous studies.

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(Received on 22.01.2012, accepted on 24.03.2012)

5. To compare the results of Ultrasonic & Radiological studies with actual measurements of the aborted foetuses of various gestational age.

Materials & Methods:-

Fifty six normal spontaneously delivered dead foetuses of second and third trimesters were collected from Department of Obstetrics and Gynaecology, Government Medical College and Hospital, Aurangabad. At the time of abortion, foetal gestational age was between 20 and 34 week. There were 28 foetuses of male and female each. Each sex group includes 18 second trimester and 10 third trimester foetus. Twins foetuses with gross anomalies were rejected. All specimens used in present study were fixed with 10% formalin solution by immersion and dissected them as early as possible.

In order to view, both sides of foetal femora, a fine dissection in front of thigh was performed. The soft tissues were removed from their joining acetabular cavities. Upper end and lower end of femur was made free from tibia and fibula. In addition to crown-rump length, total eight parametric variables were obtained from head, neck, shaft and distal end of bilateral femora using a milimetric sliding calliper.

Measurements were designed as follows:

1. Crown-rump length (CRL) - Length from crown of head to most dependent part of trunk. (With the neck and back in a straight line)

2. Head transverse diameter (HTD) - Maximum antero-posteriar diameter of femur head.

3. Head vertical diameter (HVD) – Maximum vertical diameter of the femur head.

4. Neck Vertical Diameter (NVD) – Minimum diameter of femur neck in supero-inferior direction.

5. Greater Trochantre - Head Fovea Distance (GTHFD) – Distance from tip of greater trochantre to centre of head fovea.

6. Midshaft Transverse Diameter (MSTD) – Minimum transverse diameter at middle of femur shaft. (Perimeter at middle)

7. Femur Length (FL) – Distance from tip of greater trochantre to lower end of lateral condoyle.

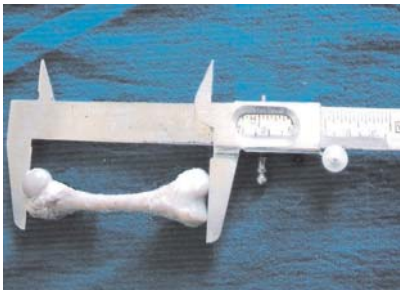
8. Head Fovea – Medial Condoyle Length (HFMCL) – Distance from centre of head fovea to lower end of medial condoyle.

9. Distal Breadth (DB) – Maximum distance between two epicondoyles.

Data collected were applied for following statistical tests: - A] Mean. B] Standard Deviation. C] Unpaired t-Test. D] Correlation Coefficient (r). The SPSS-11 was used for statistical analysis. Unpaired t-Test was used to compare male and female foetal parameter. Pearson correlation coefficient were calculated and analyzed to determine the relationships between foetal femur parameter, CRL and GA (wk).

Fig 1: Anterior view of femur

Fig 2: Measurement of femur length



Results

Comparative results of investigation in between male and female were recorded in Tables 1 and 2. Results were shown no significant differences in growth patterns between male and female during second and third trimesters as P > 0.05.

Table 1: Means, standard deviations, t and p values for femur parameters - gender comparative results of the second trimester foetuses (mm)

Parameters	Females	Males	t	P
HTD	10.30 ± 1.56	10.61± 1.59	0.352	0.731
HVD	10.20 ± 1.48	11.05± 1.77	0.911	0.380
NVD	10.20 ± 1.35	10.55± 1.50	0.437	0.670
GTHFD	11.60 ± 1.85	12.00± 1.67	0.413	0.630
MSTD	05.10 ± 0.22	05.38± 0.78	0.790	0.440
FL	60.50 ± 4.84	64.05± 6.53	1.000	0.310
HFMCL	57.90 ± 4.64	61.33± 6.28	1.000	0.300
DB	16.50 ± 2.17	17.66±2.78	0.800	0.430

Table 2: Means, standard deviations, t and p values for the femur parameters- gender comparative results of the third trimester foetuses (mm)

Parameters	Females	Males	t	P
HTD	18.00 ± 04.01	17.7 ± 4.17	0.137	0.893
HVD	18.00 ± 03.80	17.2 ± 4.32	0.375	0.713
NVD	18.77 ± 03.83	17.9 ± 4.14	0.412	0.687
GTHFD	19.00 ± 03.89	18.2 ± 4.48	0.364	0.721
MSTD	05.95 ± 01.61	07.1 ± 1.14	1.410	0.178
FL	80.68 ± 14.33	83.7 ± 11.7	0.396	0.698
HFMCL	77.50 ± 13.98	81.1 ± 13.0	0.487	0.634
DB	22.54 ± 03.91	24.5 ± 4.01	0.919	0.391

Therefore, data of both male and female in second and third trimester were combined. In present study, means of linear measurements at 20 and 34 weeks of gestation and approximate growth averages of measured parameters per week were shown in Table 3. A comparison of these results showed that there was a variable rate of increased in linear growth.

Table 3: Values of approximate growth average of all growth parameters (mm)

Parameters	Growth (mm)			Average Growth Per Week (mm)
	Mean at 20 Week	Mean at 34 Week	Difference	
HTD	10.90	21.62	10.72	0.76
HVD	11.50	21.00	09.50	0.67
NVD	09.75	22.00	12.25	0.87
GTHFD	10.58	23.00	12.42	0.88
MSTD	05.00	08.12	03.12	0.22
FL	58.50	95.75	37.25	2.66
HFMCL	55.66	92.38	36.72	2.62
DB	15.33	27.37	12.04	0.86

Mean increments in linear growth of FL and HFMCL were 37.25 mm and 36.72 mm, respectively during 14 weeks of gestational period. In FL and HFMCL growth averages were 2.66 mm/week and 2.62 mm/week, respectively. Other measurements were exhibited variable growth averages for example, in proximal epiphysis, GTHFD and HTD were 0.88 mm/week and 0.76 mm/week, respectively. In distal epiphysis, growth average in DB was 0.86 mm/week. Statistical comparisons of correlations coefficients for all measured parameters were summarized in Table 4.

All correlations were significant at P < 0.001 level.

The CRL was shown highly significant correlations with GA (r = 0.881), with HFMCL (r = 0.857), and with FL (r = 0.842). Highly significant correlations were also found between HFMCL and FL (r = 0.995). The GA was found to be highly correlated with both HFMCL (r =0.818) and FL (r =0.804). All other measurements in Table 4 were shown variable degrees of significant associations between their values.

Table 4: Correlation coefficients (r) between crown-rump length and femur parameters and with the gestational age (week)

	DB	HFMCL	FL	MSTD	GTHFD	NVD	HVD	HTD	GA(wks)
CRL	0.857	0.857	0.842	0.790	0.842	0.850	0.860	0.849	0.881
GA(wks)	0.797	0.818	0.804	0.644	0.800	0.855	0.805	0.817	
HTD	0.908	0.925	0.936	0.705	0.972	0.985	0,986		
HVD	0.892	0.910	0.919	0.696	0.961	0.971			
NVD	0.900	0.924	0.930	0.664	0.975				
GTHFD	0.912	0.924	0.934	0.688					
MSTD	0.851	0.834	0.824						
FL	0.970	0.995							
HFMCL	0.970								

Discussion

In present study, high correlations between femoral parameters and GA were studied. Results indicated that growth was increased in all of evaluated growth parameters (Table 4). The significant correlations of GA with FL (r = 0.804) and CRL (r = 0. 881) indicate that in addition to CRL, foetal femur length can be considered one of the estimators of gestational age.

Taner Ziylan et al (2003) [6] were evaluated relationships between foetal crown-rump length, foetal femur growth parameters and gestational age during second and third trimesters. Their study was reported the significant correlations of GA with FL (r = 0.905) and CRL (r = 0. 997). Shalev et al. (1985) [7] study were also reported correlation coefficients of GA with FL (r =0.989).

Table 5: Comparative values of the approximate growth average per week

Parameters /Growth Avg. per Wk	Taner Ziylan et al [6] (Turkish Population)	Present Study (Indian Population)
HTD	0.37	0.76
HVD	0.52	0.67
NVD	0.26	0.87
GTHFD	0.51	0.88
MSTD	0.16	0.22
FL	2.21	2.66
HFMCL	2.17	2.62
DB	0.64	0.86

The differences in above values are population specific and the foetal femur parameters were comparatively less in Turkish population.

Measurement of foetal parameters by ultrasonography has an important role in calculating gestational age, foetal maturity and growth pattern. It helps in prognosis of child after birth. It provides an idea about rate and pattern of normal or abnormal growth.

Table 6: The methodological variation in measurement of femoral foetal length

GA in Wk	Ultrasound			Radiological	Morphometric (Present Study)
	Hadlock[8]	Merz[9]	Rajan[10]	Zeba Khan[11]	
20	32	31	31	29.33	58.5
22	38	36	36	-	64.0
24	43	42	42	42	69.5
26	48	48	47	-	74.5
28	52	53	51	50	80.7
30	57	56	55	-	85.5
32	62	61	60	60.75	90.0
34	66	66	63	-	95.7

Yeh et al.(1982) [3] were studied relationship of femur length to GA by ultrasonography. They suggested that there was a strong correlation between femur length and GA. Likewise, Queenan et al.(1982) [12] stated that with ultrasonic determination of femur length, gestational age can be calculated and determined. Regarding current study, it was believed that published data different largely due to methodological differences. As expected, differences between current findings and earlier published data, involving ultrasound measurements of FL could easily distinguished due to differences in evaluation methods. The ultrasonic evaluations of FL were in fact carried out on ossified femur diaphysis and not on entire length of femur including proximal and distal epiphyses as they undergo postnatal ossification. Radiological study by Khan et al (2006) [11], Fazekas and Kosa (1978) [13], Warren et al (1999) [14] shows differences with present study due to diaphyseal lengths.

Conclusions

This study was based on CRL, foetal femur parameters & GA (wk). Cross sectional study was carried out in total of thirty two aborted male and female foetuses varying from normal, spontaneously delivered , dead foetuses of second and third trimesters were collected from 20 to34 wks of gestation at Department of Anatomy , Government Medical College and Hospital, Aurangabad. All parameters were analyzed statistically. Study concludes the fallowing points.

1. Study showed no significant differences in growth patterns between male & female foetuses during second and third trimester.
2. In present study, strong associations of different femoral growth parameters CRL and GA show importance of these foetal measurements in assessment of GA, and it might be widely applicable in forensic cases and for investigation purposes.
3. Accurate linear measurements of foetus allow a more complete profile of foetus and add a new dimension to measurement of its growth,
4. Methodological & Population specific differences seen in ultrasound, radiological and morphometric studies.

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