

Value of intrauterine fetal length measurement in assessment of fetal age

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Abstract

Background: A perfect assessment of fetal gestational age is a fundamental procedure in different circumstances including clinical, forensic and archaeological.

Objectives: The present study aimed to estimate the value of fetal femur length measurement in gestational age assessment.

Patients and methods: The present study is an observational study, conducted on one hundred pregnant women. Their ages ranged from 18 to 34 years admitted to department of Obstetrics and Gynecology, South Valley University Hospitals from August 2020 to August 2021.

Results: Femur length (FL) ranged between 1.7cm – 6.5cm with a mean value of 4.5±1.2. Biparietal diameter (BPD) ranged between 3.2cm – 8.9cm with a mean value of 6.6±1.4. Abdominal circumference (AC) ranged between 11.1cm – 31.6cm with a mean value of 22.5±6.0. Fundal level ranged between 17 – 36 with a mean value of 26.7±5.4. Agreement coefficient between gestational age by FL and the age of gestation by last menstrual period, BPD, AC and fundal level was (0.992, 0.992, 0.990 and 0.992 respectively) and the correlation was statistically significant.

Conclusion: The present work revealed clear associations between the parameters of the femoral growth and the gestational age that demonstrate the significance of these dimensions in the gestational age assessment, and they can be broadly used in forensic circumstances and for investigational functions.

Keywords: Femur length; Gestational age; Intrauterine.

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Introduction

Forensic osteology in humans is the application or study of bones of humans in the forensic science field to help injustice administration (Garg and Goyal, 2021).

Forensic identification is considered as one of the most substantial lawful concerns that is a straight forward right for a dead or a living subject with no kind difference and is essential with respects to religious, ethical, social sides and human rights. Because of the worldwide statement of human rights declaring that “All human beings are equal before the law and are entitled without any discrimination to equal protection of the law,” correspondingly it is essential to establish the rights of the fetus (Dagalp et al., 2013).

It is important to recognize the condition of viability of the fetus body at the birth time. The viability inspection has to designate whether delivery took place within the standard period of gestation and if the baby is full mature to live biologically out of the uterine cavity of his mother. Furthermore, it is crucial to decide if the baby was dead at the birth time or died later. Consequently, recording of different body and head measurements are usually essential (Keeling, 2008).

The estimation of age is the most significant identification element that requires thoughtful analysis. On the other hand, literature reviewing the infant and fetus group of ages is uncommon. Number of researches made comparison between dental age to skeletal age focusing on the estimation of the dental and bone age (Bassed et al., 2012).

There are methods used to determine the fetal age, including menstruation and clinical

examination, as well as ultrasound imaging (Amy and Henry, 2008).

Biometric measurements using ultrasound decide the age of gestation depending on the statement that the fetus or embryo size is nearly constant with its age. Biologic difference in size is more in the period of the third trimester than in the first trimester. Consequently, gestational age estimation using Ultrasound in the 1st trimester is more appropriate than late in the 3rd trimester (Aaron et al., 2008)

Use of multiple parameters such as biparietal diameter (BPD), crown-rump length (CRL), femur length (FL) in the fetal age estimation is applicable only in the condition of the normal growing of the fetus. Presence of Congenital malformations of the head shape, abdominal region, and skeletal system in addition to presence of other disorders must be considered (Mehrdad et al., 2000).

The measurement of the femur length (FL) is carried out from the greater trochanter of femur to the lateral femoral condyle (Magdi et al., 2020). It is used to evaluate age of gestation and has accurateness as respectable as that of the BPD. Therefore, it is considered as a proper substitute in the fetal head malformation cases, or in the condition of brachycephalic or dolichocephalic shape of the fetal head, or in the condition of unreliable measurements of head because of certain abnormal fetal position (Synnove et al., 2005).

Therefore, the current study aimed to estimate the value of measurement of FL in gestational age assessment.

Patients and methods

The present study is an observational (cross-sectional) study which was conducted on one

hundred pregnant women who were admitted to department of Obstetrics and Gynecology, South Valley University Hospitals from August 2020 to August 2021 and met the inclusion criteria. 40 cases were in their second trimester while 60 cases were in their third trimester. Age of fetus ranged between 17-36 weeks.

Patients

1- Inclusion criteria:

- Patients with maternal age from 18 to 34 years old.
- Singleton pregnancy.
- No anomaly recognized perinatally.
- No OCP use, at least for in the third trimester.
- No drug abuse.
- No utilization of cigarettes or alcohol.

2- Exclusion criteria:

- Multiple pregnancies.
- Pregnancies with fetal anomalies.
- Subjects suffering from diseases recognized to have an effect on the standard growth of fetus (e.g., chronic hypertension(HTN), diabetes mellitus(DM)).

Methodology

All the included females in the present study underwent the next:

- **Personal history:** (name, age, duration of marriage, residence, parity, special habits).
- **Menstrual history:** (the menstrual age is estimated by the last menstrual period in women with reliable menstruation).
- **Clinical examination;** the uterus size could be evaluated by abdominal palpation and ultrasound study to assess age of the fetus, femur length,

biparietal diameter and abdominal circumference.

Statistical analysis

At the end of our study, the data were collected, entered to the computer and underwent analysis utilizing the SPSS software package version 20. The description of Qualitative data was performed utilizing percentage and numbers. On the other hand, to authenticate the distribution normality, the Kolmogorov-Smirnov test was utilized. The description of the Quantitative data was done utilizing range (maximum and minimum), mean and SD. The level of Significance of the attained results was considered at P value <0.05 was significant. For categorical variables, Chi-square test was utilized to make comparison between dissimilar groups. For normally quantitative variables, Student t-test was utilized to make comparison between 2 groups in the study. On the other hand, Mann Whitney test was utilized for abnormally quantitative variables, to make comparison between 2 groups in the study).

Ethical Considerations

The current study has been approved by the Ethics Committee of Faculty of Medicine, South Valley University, Qena, Egypt. **Ethical approval code:** SVU-MED-FMT010-1-21-6-207

Results

Regarding demographic data of the studied group. Age was ranged between 19-34 years with mean value 26.2 ± 4.0 years. Cases were from rural 54 (54.0%) while cases from urban were 46 (46.0%). Body mass index (BMI) was ranged between 25-32 kg/m^2 with mean value $28.5 \pm 1.8 \text{ kg/m}^2$. Parity was ranged between 0-3 with mean value 1.7 ± 0.8 (**Table 1**).

Regarding ultrasound findings of the studied group. Femur length (FL) ranged between 1.7cm

– 6.5cm with a mean value of 4.5±1.2. Biparietal diameter (BPD) ranged between 3.2cm – 8.9cm with a mean value of 6.6±1.4. Abdominal circumference (AC) ranged between 11.1cm – 31.6cm with a mean value of 22.5±6.0. Fundal level ranged between 17 – 36 with a mean value of 26.7±5.4 (Table 2).

Comparison between assess gestational age by last menstrual period (LMP) and by femur length and it shows highly statistically significant Correlation between femur length measurement methods when it compared by last menstrual period. (Table 3 and Fig.1).

Agreement coefficient between gestational age by femur length and the age of gestation by biparietal diameter (BPD), last menstrual period (LMP), abdominal circumference and fundal level was (0.992, 0.992, 0.990 and 0.992 respectively) and the correlation was statistically significant (Table 4).

Table 1. The distribution of studied sample in accordance with demographic data.

Variables	Number	Percent
Age (years)		
Range	19-34	
Mean± S.D.	26.2±4.0	
Residence		
Rural	54	54.0%
Urban	46	46.0%
BMI		
Range	25-32	
Mean± S.D.	28.5±1.8	
Parity		
Range	0-3	
Mean± S.D.	1.7±0.8	

Table 2. Ultrasound findings of the studied group: FL, BPD, AC and fundal level.

Variables	Min.- Max.	Mean± S.D.
Mean of FL (cm)	1.7cm - 6.5 cm	4.5±1.2
Mean of BPD (cm)	3.2cm - 8.9 cm	6.6±1.4
Mean of AC (cm)	11.1cm - 31.6 cm	22.5±6.0
Fundal level (weeks)	17weeks - 36 weeks	26.7±5.4

Table 3. Correlation between gestational age by femur length (FL) and gestational age by last menstrual period (LMP).

Variables	GA by femur length	
	R	P
GA by LMP	0.994	< 0.001*

r_s: Pearson’s correlation P: Probability
*: Statistically significant (p< 0.05)

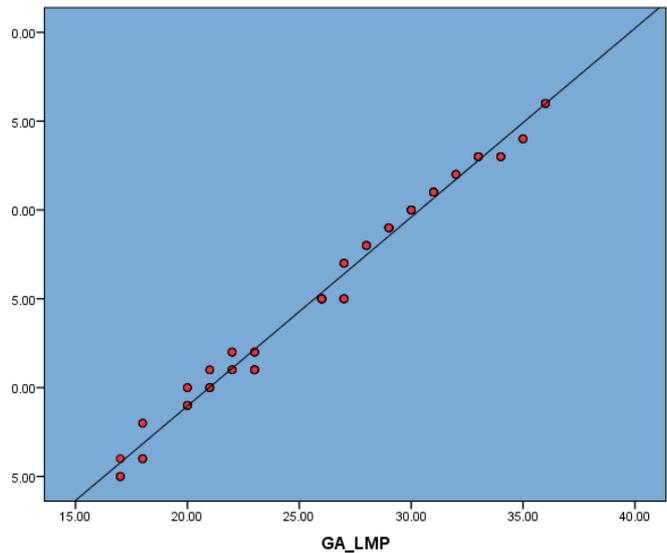


Fig.1. Correlation between gestational age by femur length(FL) and gestational age by last menstrual period (LMP).

Table 4. Agreement analysis (Interclass correlation) of gestational age (GA) between different techniques.

Variables	Agreement coefficient (Interclass correlation)	95% CI	P
GA by FL and GA by LMP	0.992	0.988-0.994	< 0.001*
GA by FL and GA by BPD	0.992	0.988-0.995	< 0.001*
GA by FL and GA by AC	0.990	0.985-0.993	< 0.001*
GA by FL and GA by fundal level	0.992	0.988-0.994	< 0.001*

CI: Confidence interval *: Statistically significant ($p < 0.05$).

Discussion

It has been reported that the FL of the fetus could be utilized in assessing the age of gestation and as a screening tool for the congenital anomalies detection. The FL measurement using US is not only an exact gestational age indicator but also it is strongly correlated with the age of gestation. An average normal age of gestation is about 40 weeks, normally ranging from 38-42w. Dependable gestational age estimation is crucial because of allowing suitable antenatal care scheduling, informing obstetric decisions of management and facilitating the accurate understanding of the assessment of the fetal growth (**Shah and Keseri, 2018**).

The present study aimed to estimate the value of measurement of FL in assessment of gestational age. The present study was a prospective study carried out at the Department

of Obstetrics and Gynecology, South Valley University Hospitals from August 2020 to August 2021.

The present study revealed that age was ranged between 19-34 years with mean value 26.29 ± 4.051 years. Cases were from rural 54 (54.0%) while cases from urban were 46 (46.0%). Body mass index was ranged between 25-32 kg/m² with mean value 28.52 ± 1.888 kg/m². Parity was ranged between 0-3 with mean value 1.79 ± 0.820 .

It is important to illustrate that the femur length of the fetus has been recorded for gestational age assessment in the present study. Use of multiple parameters: abdominal circumference, biparietal diameter, femur length in the fetal age estimation is proper only in the condition of normally growing fetus.

Comparison between assess gestational age by last menstrual period and by each of BPD, FL and AC and it show highly statistically significant correlations between ultrasonic measurement methods when it compared by last menstrual period. Also, femur length showed significant positive correlation with biparietal diameter, abdominal circumference and fundal level.

In line with our finding, **Shah and Keseri, (2018)** demonstrated that US was detected to be efficient to evaluate the exact FL for dissimilar gestational weeks.

Gregory and John (1981) anticipated a novel way for the gestational age prediction in early second trimester by femur length measurement through the using of ultrasound. Construction of a curve of growth of the calcified femur section was done indicating the age of gestation might be expected with 95 percentage confidence limits to \pm six days.

Frank et al. (1982) examined the relation between gestational age and femur length by utilizing cross-section analysis of three hundred and thirty-eight (338) normal fetuses between twelve and forty weeks of gestation. The gestational age prediction from FL had changeability of \pm nine days and half between twelve and twenty-three weeks. After twenty three weeks changeability augmented up to \pm twenty-two days.

The strong correlations of gestational age with femur length ($r = 0.905$) and crown-rump length ($r = 0.997$) designate that besides crown-rump length, fetal femur length could be well-thought-out as one of the gestational age estimators.

Ming-Neng et al. (1982) examined the FL and its relation to the age of gestation by using ultrasound. They found a significant correlation between gestational age and femur length.

John and Gregory, (1982) examined the relation between FL and the age of gestation; they indicated that with ultrasound, the femur length could be determined; the gestational age could be estimated.

In UK, a size chart for FL of fetus considering the growing changeability with increasing age of gestation was assembled by **Lyn and Douglas, (2003)**.

Also, our study revealed that agreement coefficient between gestational age by femur length and gestational age by biparietal diameter (BPD), last menstrual period (LMP), abdominal circumference and fundal level was (0.992, 0.992, 0.990 and 0.992 respectively) and the correlation was statistically significant indicating that femur length is highly correlated to gestational age and other parameters. Therefore, the use of all these parameters

together may have benefit over using femur length only to exclude any defects related to abnormality in fetal femur.

In agreement with our results, **Frank et al. (1987)** revealed that the multiple parameters use in the fetal age estimation shows a substantial benefit over any other parameter utilized alone and the developed regression equations from a middle-class white population has been found appropriate to fetuses from a population with dissimilar racial and socioeconomic features.

Also, **Hebah et al. (2014)** established that the chief way to follow-up growth of the fetus in 3rd trimester not the measurement of BPD only as it becomes inadequate in the condition of gestation beyond thirty weeks and the BPD must be used together with other measurements to highlight the standard fetus growth and keep away from wrong ultrasound measurement.

Vivek et al. (2014) indicated that combination of BPD, HC, AC, FL, humeral length (HL) is more perfect in the prediction of gestational age than any single parameter, predominantly in the 3rd trimester.

We recommend that a conformable size chart for fetal parameters be constructed with a large number of patients. Also, a similar large scale and multi-center study should be conducted. It would also be ideal to carry out a study on other neonatal anatomical parameters. Studies should be conducted on bilateral neonatal anatomical parameters to detect the difference for the prediction of gestational age.

Conclusion

Clear association is present between the parameters of the femoral growth and the gestational age demonstrate the significance of these dimensions in the gestational age assessment, and they can be broadly used in

forensic circumstances and for investigational functions. The FL measurement can be regarded one of the dependable methods for gestational age assessment.

Abbreviations

- **FL:** femur length.
- **BPD:** biparietal diameter.
- **AC:** abdominal circumference.
- **LMP:** last menstrual period.
- **GA:** gestational age.
- **HC:** head circumference.
- **HL:** humeral length.

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