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Research Article

**CORRELATION BETWEEN FEMUR LENGTH ESTIMATION ON
ULTRASONOGRAPHY AND LAST MENSTRUAL PERIOD FOR
PREDICTION OF GESTATIONAL AGE DURING THIRD TRIMESTER**¹Dr Neelam Shehzadi, ²Dr Saira Saeed, ³Dr Maham Munir Awan¹FCPS PGR, Diagnostic Radiology General Hospital Lahore, ² associate Professor Diagnostic Radiology General Hospital Lahore, ³Assistant Professor Radiology CPEIC Multan.

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Abstract:

Background: Childbirth typically occurs around 40 weeks from the last menstrual period (LMP). The accurate dating of pregnancy is critically important for pregnancy management from the first trimester to delivery and is particularly necessary for determining viability in premature labor and in postdates deliveries. Femur length measures the longest bone in the body and reflects the longitudinal growth of the fetus.

Objective: To determine the correlation between femur length estimation on ultrasonography and last menstrual period for prediction of gestational age during third trimester

Material & Methods

Study Design: It was cross sectional study

Setting: Department of Radiology, Lahore General Hospital, Lahore

Duration: 6 months

Data collection: 100 pregnant females were enrolled. LMP of female and gestational age was noted. Then females underwent ultrasonography. The femur imaged with a 3.5 MHz curvilinear transducer aligned longitudinally along the thigh. Femur length measured by electronic calipers after clear visualization of the ends of the femoral shaft, femur length was noted. All the collected data was entered and analyzed on SPSS version 21.

Results: The mean age of females was 29.33±6.79 years, mean BMI was 25.17±5.64 kg/m². Mean femur length was 31.49±2.427mm and mean gestational age was 32.09±2.33 weeks. A strong positive correlation found between femur length and LMP = r=0.747 (p<0.05).

Conclusion: The femur length estimation on ultrasonography had strong correlation with LMP for prediction of gestational age during third trimester.

Keywords: Menstrual Period, Gestation, Ultrasonography, Femur Length.

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INTRODUCTION:

The accurate dating of pregnancy is critically important for pregnancy management from the first trimester to delivery and is particularly necessary for determining viability in premature labor and in postdates deliveries. [1] Prior to the widespread use of ultrasound, caregivers relied on a combination of history and physical examination to clinically determine gestational age. [2] Rapid and accurate determination of gestational age may be vital to the appropriate care of the critically ill pregnant patient and improve obstetric care through allowing the optimal timing of necessary interventions and the avoidance of unnecessary ones. Ultrasound scans are considered to be the most cost-effective, accurate and safe methods for measurement of various fetal parts in pregnant women. [3]

Ultrasound gave clinicians a method to measure the fetus and therefore to estimate gestational age. Certain menstrual dating, for example is less certain than previously thought. When ultrasound is performed with quality and precision, there is evidence to suggest that dating a pregnancy using ultrasound measurement is clinically superior to using menstrual dating with or without ultrasound, and this has been advocated and adopted in other jurisdictions. [4] It is suggested that the measurement of fetal femur length is a more precise index of gestational age than is the biparietal diameter. [2] One study showed that the correlation between true gestational age (on LMP) and femur length was $r = 0.901$ ($P < 0.001$). [5] One more study showed that a moderate correlation is present between true gestational age (on LMP) and femur length was $r = 0.63$ ($P < 0.001$). [6] But one study showed that the weak correlation between gestational age (on LMP) and femur length was $r = 0.168$ ($P < 0.001$). [7]

Rationale of this study is to determine the correlation between femur length estimation on ultrasonography and LMP for prediction of gestational age during third trimester. Literature has reported that femur length estimation on USG can be helpful in determining the gestational age, particularly in females who are unsure of dates of LMP. But controversial results have been found in literature. Moreover, no local evidence is present in this regard which can help in deciding whether to rely on femur length assessment. So we want to conduct this study to get local magnitude which in future we can use to implement the use of femur length assessment on USG and can help in prediction of gestational age.

Objective:

To determine the correlation between femur length estimation on ultrasonography and last menstrual period for prediction of gestational age during third trimester.

MATERIALS AND METHODS:

Study Design: Cross sectional study

Setting: Department of Radiology, Lahore General Hospital, Lahore.

Duration Of Study: 6 months i.e. from October, 2018 to March, 2019.

Sample Size: Sample size of 100 cases were calculated with 5% type I error, 10% type II error and taking magnitude of correlation coefficient i.e. 0.63 for femur length and LMP.

Sampling Technique: Non probability consecutive sampling.

Sample Selection: Inclusion Criteria: Females of age 18-40years, parity<5, presenting with singleton pregnancy (on ultrasound) for routine antenatal checkup in third trimester (>28weeks). **Exclusion Criteria:** Females with fetal congenital anomaly, fibroid uterus or placental abruption and macrosomic fetus (on ultrasound), gestational diabetes (OGTT>140mg/dl) and females unsure of LMP dates.

Data Collection Procedure:

100 patients fulfilling selection criteria were enrolled in the study referred to Radiology Department, Lahore General Hospital, Lahore. Written informed consent was taken. Demographic detail (name, age, BMI, parity) was also noted. LMP of female was noted, discussed with obstetrician and gestational age on LMP was noted. Then all patients were undergo ultrasonography by a single senior sonologist having at least 4years' residency experience with assistance of researcher. The femur was imaged with a 3.5 MHz curvilinear transducer (Ultramark 9, ATL, Bothell, WA) aligned longitudinally along the thigh. A sterile gel-pad was facilitate imaging. Femur length was measured by electronic calipers after clear visualization of the ends of the femoral shaft. Femur length was noted on ultrasound in terms of millimeter. It was measured by ends of the femoral shaft). All this information was recorded through proforma.

Data Analysis:

The collected data was entered and analyzed using SPSS 21. Age, BMI and gestational age on LMP and femur length were presented as mean± Standard Deviation. Parity was presented as frequency. Pearson's correlation coefficient was calculated to measure correlation between gestational age on LMP and femur length. P-value≤0.05 was taken as significant.

RESULTS:

The mean age of females was 29.33±6.79 years. The mean gestational age on LMP was 32.09±2.33 weeks. The mean BMI of females was 25.17±5.64 kg/m². There were 25(25%) were primigravida, 14(14%)

were primiparous and 61 (61%) were multiparous. The mean femur length of fetus was 31.49±2.427mm. Table 1

There is strong positive correlation found between the femur length with gestational age on LMP of the females i.e. r=0.747. Fig 1

Table 1: Characteristics of patients

n	100
Age (years)	29.33±6.79
Gestational age on LMP (weeks)	32.09±2.33
BMI (kg/m²)	25.17±5.64
Primigravida	25 (25%)
Primiparous	14 (14%)
Multiparous (2-4)	61 (61%)
Femur length on ultrasound (mm)	31.49±2.43

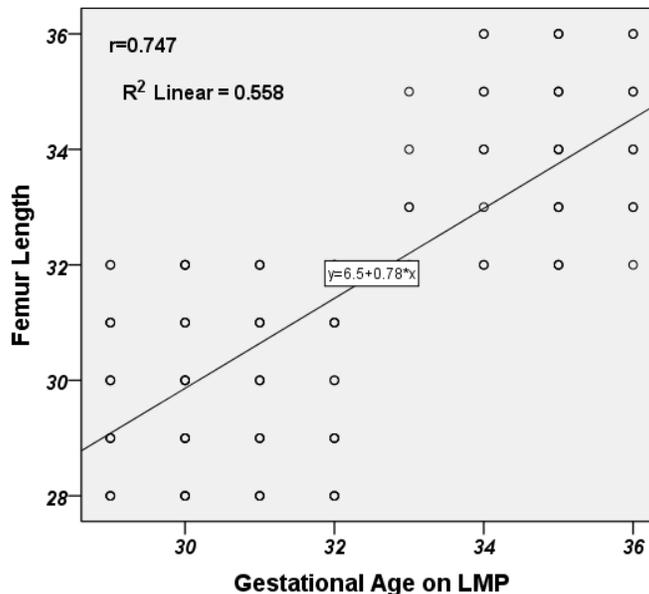


Fig 1: Correlation between femur length & gestational age

DISCUSSION:

Accurate estimates of gestational age are important for both clinical practice and public health activities. Clinically, estimates of gestational age identify infants at risk for adverse health outcomes because gestational age is a proxy for fetal development and is associated with infant survival. In the second and third trimesters, estimation of gestational age is accomplished by measuring the biparietal diameter, head circumference, abdominal circumference, and femur

length. These measurements are only as good as the quality of the images. [2,8].

In this study the mean femur length of the females was 31.49±2.427 mm and the mean value of gestational age on LMP of the females was 32.09±2.33 weeks. In our study a strong positive correlation found between the femur length with gestational age on LMP i.e. r=0.747. One study by Yeh et al., documented that he correlation coefficient of gestational age versus fetal femur length is statistically greater than that of the

gestational age versus fetal biparietal diameter. These results suggest that the measurement of the fetal femur length is a more precise index of gestational age than is the biparietal diameter.⁹ Shalev et al.,¹⁰ demonstrated that Linear regression analysis with the correlation coefficient of the femur growth-curve ($r = 0.989$, $p < 0.001$) and that of the biparietal diameter ($r = 0.985$, $p < 0.001$) showed that the former is as good as the latter. The femur growth-curve from 12 to 40 week's gestation with a mean ± 2 Standard Deviation was constructed. Estimation of fetal age by femur length measurement was compared with that assessed by the biparietal diameter in a further 54 women. A close correlation was found ($r = 0.993$, $p < 0.001$).

It is suggested that the measurement of fetal femur length is a more precise index of gestational age than is the biparietal diameter. [2] One study showed that the correlation between true gestational age (on LMP) and femur length was $r = 0.901$ ($P < 0.001$). [5] One more study showed that a moderate correlation is present between true gestational age (on LMP) and femur length was $r = 0.63$ ($P < 0.001$). [6]

The relation between gestational age and fetal femur length has been determined by cross-sectional analysis of 900 normal fetuses ($> \text{ or } = 14$ weeks of gestation) using real time ultrasonography. Mathematical modeling of the data has demonstrated that the femur growth curve is non-linear beyond 13 weeks of gestation. With the aid of a scientific calculator the data were analyzed and a simple second grade equation has been derived: gestational age (weeks) = $0.262(2)$ femur length (cm) + 2 femur length + 11.5 , S.D. approximately ± 5 days (Honarvar's Formula 3). With the use of this data, the error in the estimation of gestational age given as femur length is ± 5 days. [11] Sumit Babuta et al., [12] concluded in their study that in predicted gestational age by ultrasonography (USG) is attributed to the anthropometric difference between the two populations due to racial, genetic, nutritional, and socioeconomic factors.

Konje et al., [13] showed that the best model for estimating gestational age in late pregnancy included the variables kidney length, biparietal diameter, head circumference, femur length and abdominal circumference. This model accurately predicted gestational age with a standard error of ± 8.48 days. These models were slightly more accurate than models derived from the biometric indices of biparietal diameter, head circumference and femur length (± 9.87 days), biparietal diameter, head circumference, femur length and abdominal circumference (± 9.45 days) and biparietal diameter and femur length (± 9.9 days). Kidney length and femur length were the most

accurate single parameters for predicting gestational age using simple linear regression models (± 10.29 and 10.96 days, respectively); the abdominal circumference was the least accurate (± 14.54 days).

Johnsen et al., [14] resulted in their study that new chart for age assessment by means of femur length was based on 636 measurements. The 95% CI of the mean corresponded to < 1 day. The variation between the mean and the 90th percentile was 5, 6, and 7 days at 13, 18, and 23 weeks, respectively, similar to the results when using biparietal diameter or head circumference. Maternal age modestly influenced gestational age assessment (1.3 days/10 years, $P = 0.005$), whereas smoking, height, body mass index, multiparity, fetal sex, cephalic index, and breech presentation had no impact. But on the other hand one study showed that the weak correlation between gestational age (on LMP) and femur length was $r = 0.168$ ($P < 0.001$). [7]

The use of ultrasound for determination of fetal weight spans over three decades now, with varied attempts at the use of different biophysical parameters. Initial attempts to estimate fetal weight by ultrasound were made on the basis of measurements of individual single fetal parameters such as Biparietal Diameter or Abdominal Circumference. Weight estimates obtained by these parameters were found to have high standard deviation up to 11.9%. [15] Subsequent reports demonstrated that accuracy of the estimate was improved by the use of multiple fetal parameters. The methods that gave reasonably accurate results and the simplest to apply are those based on the use of two parameters, namely, abdominal circumference in combination with biparietal diameter or femur length. Further attempts to improve the predictive value of sonography in fetal weight estimation have resulted in the use of more parameters combined. Hadlock et al. (1984) showed that using femur length in addition to head measurements and abdominal measurements significantly improved fetal weight estimation. [15]

More recently, the addition of thigh circumference to head, abdominal and femur length measurements gave even better predictive value and hence better identification of high risk pregnancies. A study was done to obtain an estimated fetal weight from the fetal parameters of head circumference - abdominal circumference, biparietal diameter - abdominal circumference and femur length - abdominal circumference, and to highlight the predictive value of this procedure, by comparing the estimated fetal weight with the actual birth weight. [15] Recent

advances in fetal imaging have been result of technological achievements in sonography and magnetic resonance imaging, with dramatic improvements in resolution and image display. A sonographic examination performed with the exacting recommended standards of American Institute of Ultrasound in medicine offers vital information about fetal anatomy, physiology, growth and well-being. Limbs are traditionally assessed during pregnancy as markers of fetal growth, nutrition, and gestational age. However, evaluation of fetal limbs and identification of abnormalities may also aid in the diagnosis of various chromosomal and non-chromosomal conditions as well as narrow the differential diagnosis in cases where associated abnormalities have also been identified. [16]

Fetal long bone lengths show a high correlation with gestational age and a low inter-observer variation, thus suggesting their usefulness in the assessment of the menstrual age as an alternative basis, when it is impossible to obtain reliable measurements of the biparietal diameter (e.g. deep pelvic engagement of the vertex, dolichocephaly). Long bone length may be used for monitoring fetal growth and for diagnosing bone dysplasias. [17] Knowledge of gestational age is critical for obstetric decision making throughout the pregnancy. Gestational age and fetal weight are the two most important determinants of fetal viability and survival. Without the accurate knowledge of gestational age, diagnosis of such conditions as prolonged or post-term pregnancy and intrauterine growth restriction is often impossible. Appropriate management of preterm labor or a medically complicated pregnancy depends on an accurate estimate of fetal age and weight. [17]

Because of its size, visibility, ease of measurement and less mobility than distal limb bones, the femur is preferred over other long bones as a means of predicting menstrual age.¹⁷ In the 2nd & 3rd trimester of pregnancy, the fetus has grown sufficiently in size so that anatomic details are clearly identified, visualized, and measured. Optimal imaging can be difficult in some clinical situations, such as in a late pregnancy abnormal lie when the head is deep in the maternal pelvis or maternal obesity. [18]

The accurate dating of pregnancy is critically important for pregnancy management from the first trimester delivery, and is particularly necessary for determining viability in premature labour and in post-dates deliveries.¹⁹ Ultrasonic studies have proven useful in determination of gestational age in first and second trimester, but their accuracy in third trimester

is not reliable because of biologic variations like racial differences in fetal biometric measurements and inter-population variations. [20] Obstetrical ultrasound technicians routinely measure biparietal diameter, head circumference, abdominal circumference, and femur length to estimate gestational age in an outpatient setting. [3] When ultrasound is performed with quality and precision, there is evidence to suggest that dating a pregnancy using ultrasound measurements is clinically superior to using menstrual dating with or without ultrasound, and this has been advocated and adopted in other jurisdictions. [4]

Ultrasound estimation of gestational age in the first trimester is therefore more accurate than later in pregnancy. [21] When performed with quality and precision, ultrasound alone is more accurate than a “certain” menstrual date for determining gestational age in the first and second trimesters (≤ 23 weeks) in spontaneous conceptions, and it is the best method for estimating the delivery date. The aim of this research was exploring the accuracy of ultrasonic measurement of biparietal diameter and femur length in assessing gestational age in the third trimester of pregnancy. [22]

CONCLUSION:

This study concluded that the femur length estimation on ultrasonography had strong correlation with LMP for prediction of gestational age during third trimester.

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