The Role of Fetal Humeral Length in Determination of Gestational Age Compared with Femoral Length Using Ultrasonography

□ Moawia Gameraddin[1], Suzan Abdelmaboud[2], Sultan Al shoabi[1], MonaFadul[2].

1 Department of Diagnostic Radiologic Technology, Taibah University, AlmadinahAlmunawarah ,P.O.box 30001. Saudi Arabia.
2 Faculty of Radiological Sciences and Medical Imaging, AlzaiemAlazhari University, Khartoum- Sudan.

Abstract: Background: Assessment of fetal gestational age with ultrasound provides high accuracy and reliability, as ultrasound is safe, easy operating and cheap imaging modality. Objectives: to estimate the GA with HL and FL, to establish the role of HLwhich could be applied to determine the fetal GA, to compare between FL and HL? Methods: there were 113 normal pregnancies (singleton) had been selected for the study during the second and third trimesters. They were scanned with ultrasound using 3.5MHz probe applying the obstetrics protocol to measure the fetal bony biometrics. The length of femoral diaphysis was measured from upper end to lower end excluding epiphysis. The humeral length was measured from upper to lower end of diaphysis. The fetal humerus was identified by the region of the chestin which the pumping heart is a gross marker. The fetal femur is visualized at the region of fetal pelvis when the fetal urinary bladder is clear, then the probe is swept at various degrees and motions. Results: Statistical tests such as correlation and T-test had been used between humeral length and fetal length to analyze and get the correlation coefficients and significant values. There was a strong positive correlation between gestational age (last menstrual period) and humeral length (r=0.80). Also strong correlation exists between gestational age and femoral length(r=0.89). There was no significant difference between humeral length and femoral length (p-value=0.630).Conclusion: The estimation of gestational age with fetal humeral length and femoral length still remain the most common measurements to assess the fetal growth. The fetal humeral length is an accurate biometry as well as femoral length. Evaluation of gestational age with humeral length and femoral length joined together is more accurate than usingfemoral length alone.

Keywords: role, humeral, length, determining, femoral, gestational age, ultrasonography.

I. Introduction

Ultrasound has become one of the primary tools to evaluate fetal growth during pregnancy, the diagnostic ultrasound uses high Frequency (3. 5 –7. 5 MHz) low intensity sound waves which are transmitted through the tissue by the transducerthatconsists of piezoelectric crystals which emit ultrasound beam and received the reflected signals then these signals are transformed into pictures on the monitor as gray scale.The ultrasound for pregnancy can be applied trans- abdominally or endo-vaginalyscanning [1,2].

The fetal humeral length is not widely used as biometric parameter for determining the gestational age (GA) although it easy to be imaged with ultrasound and measured. The study aims to clarify the role of humeral length in determining the GA with comparison with the femoral length.

Femoral length (FL) and humeral length (HL) of great interest in obstetric practice, they are helpful in the estimation of fetal age especially in women do not remember that the date of their last menstrual period or whose fundal height on abdominal examination does not corresponding to the date they used the prenatal multiplier method for predication of limb length Discrepancy [3, 4].

Femoral length, humeral length, tibia and ulna were used in combination to allow of good estimation of fetal age that may be useful when the biparietal diameter measurement be unreliable, unobtainable or abnormal, they used in BPD/FL ratio and BPD/HL ratio as categorical variable in Down syndrome [3]. The accuracy of estimating fetal age in 2nd and 3rd trimester as pregnancy progresses due to increasing biological variation, the gestational age estimates done early in the 2nd trimester more accurate than measurement done later in the second trimester or in the third trimester [3, 4].

In general, the accuracy of gestational age prediction in the 2nd trimester is approximately +7 days before 20 weeks and +10 days after 20 week; the accuracy of fetal age prediction in the 3rd trimester is about +21 day. Previous studies have not identified differences in any of the following fetal sonographic parameters: biparietaldiameter (BPD), head circumference, abdominal circumference, and femur length [5, 6].

There were few studies in Sudan concerning estimation of GA using the fetal humeral length. The purpose of this study is to determine the GA using sonographic measurement of the fetal humeral length

(HL)and to confirm that it is reliable and essential method in estimation of gestational age compared with femoral length (FL) in second and third trimesters in normal fetuses.

II.   Materials and Methods

This is a descriptive cross-sectional study which conducted in Dream Specialized hospital in Khartoum State from the period of August to October 2012. There were 113 normal Sudanese pregnant ladies in second and third trimestershad been selected randomly to satisfy the study. They were referred for routine obstetric examination to check fetal health care.Informed consentwas taken from each pregnant; they were told that thesonographic examination may take longer time than routine examination.The inclusion criteria include: history of amenorrhea, certain date of the first day of the last normal menstrual period and regular menstrual cycles. The exclusion criteria were every individual that not satisfy the inclusion criteria.

The Sonographic procedure:

The pregnancies were examined with ultrasound using 3.5 MHz transducer in supine position.Sagittal, coronal and transverse views through the fetus were obtained to confirm viability and presentation.Longitudinal scanning through the fetal chest to measure the humerus, the chest was identified with heart pumping. Thenultrasoundwas directed through the fetal pelvisto catch the femur for measurement.

Humerus scanning technique

Slide the transducer until the fetal heart is identified within the fetal chest and scanning through fetal ribs/thorax and shoulder girdle leading to the adjacent humerus and rotate the transducer until the full length of humerus is obtained. The measurement of humerus length between two points at either end of the bone shaft and three or more measurements are taken in each examination to obtain the accurate mean measurement.

Femur scanning technique

By scanning through the transverse section of the fetal lower abdomen until the iliac bones are visualized and the cross-sectional of femur is seen at this point then rotation the transducer until the full length of femur is visualized. The measurement of femur is made from the center of each end bone which represents the length of metaphysis, three or more measurementswere taken in each examination to obtain accurate measurement and the accurate ones should be within 1mm of each other and one femur only was examined.

Statistical analysis:

Data were analyzed and initially summarized as mean ± SD in a form of comparison tables. Statistical analysis was performed using the standard Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 16 for windows. Statistical tests used were correlation and T-test. The statistical significant p-value was 5%, values less than 5% were considered to be significant.

III.   Results

The study variables were quantitative data and had been analyzed using Pearson correlation and T-test. Table1 showed distribution parity status among the study population. Table 2 showed comparison between FL and HL using independent T-test. There was no significant difference between the two variables (p-value=0.630). Figure 1 and figure 2 showed the correlation of HL with GA, and FL with GA respectively. The significant correlation of gestational age (with last menstrual period LMP) with Femur length and humeral length had been demonstrated in table 3.

Table1: the parity distribution among the study population

Parity	Frequency	Percentage
Null Para	50	44.2%
Multi Para	63	55.8%
Total	113	100

Table 2: Comparison between femoral length and humeral length

	T-value	P-value
FL & HL	0.482	0.630

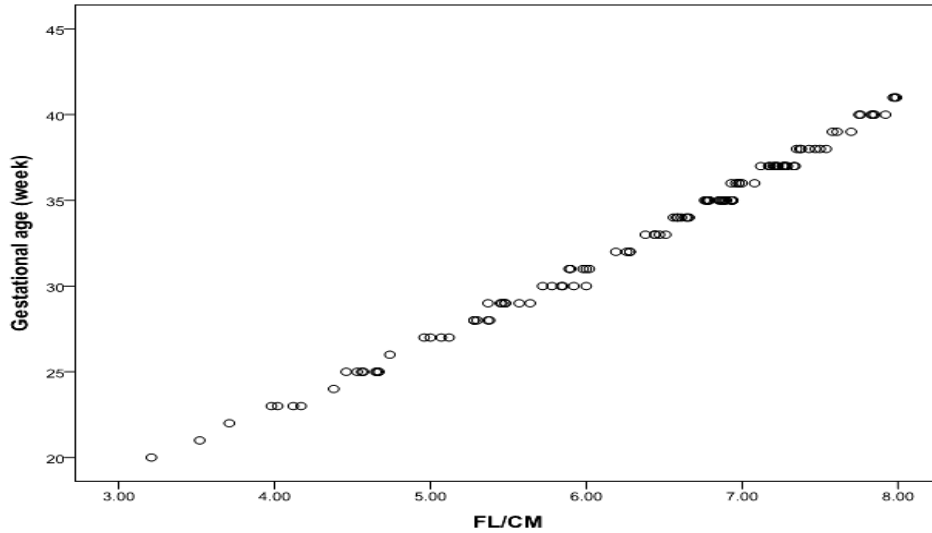*There is no significant difference (0.630 >0.05)*

Figure 1: **Scatter plot shows the prediction system to estimate the Gestational age in weeks by using the femur length (FL) in cm**
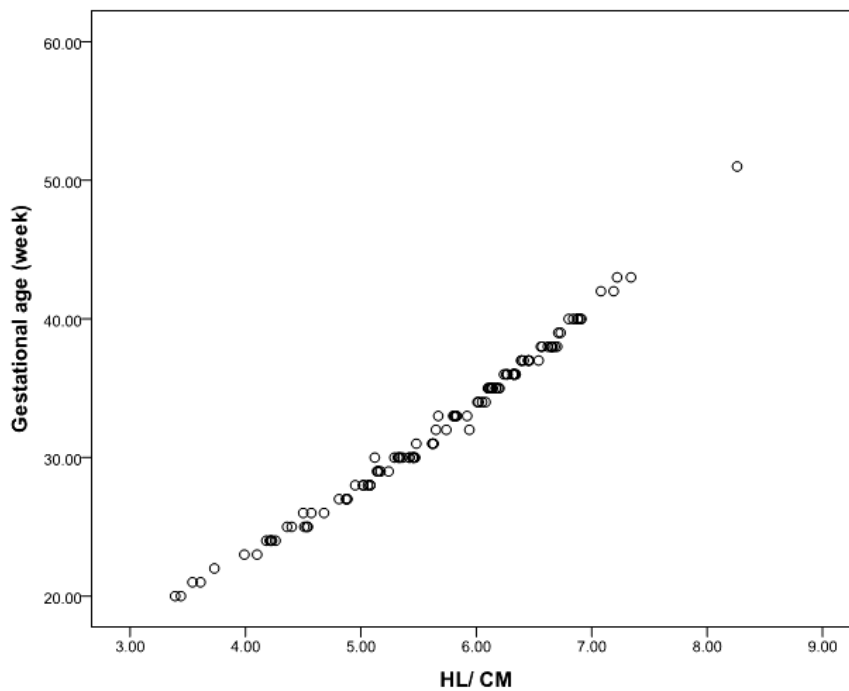

Figure 1: Scatter plot shows the prediction system to estimate the Gestational age in weeks with using the humeral length (cm)

Table 3: Correlation of gestational age with femoral lengthand humeral length.

Gestational age		Femoral length	Humeral length
LMP	Correlation	0.89	0.80
	P-value	0.000	0.000

LMP: last menstrual period

IV.   Discussion

This study done on 113 pregnant Sudanese healthy women surely about last menstrual period (LMP) and have regular menstrual cycle and normal fetus to describe accuracy of ultrasound in estimation of gestational age by humeral and femoral lengths which is the main objective of the study.

The ultrasound is accurate diagnostic technique in evaluation of gestational age and non –invasive and reliable. The ultrasonographic morphometric models derived from trans-abdominalsonographicmeasurements in second and third trimester's pregnancy showed a good reliability in estimating fetal long bones length. Using multiple parameters in estimation of gestational age is better than one parameter. The rate growth of humerus rate was 1.9mm growth per week in late second trimester and 1mm per week in third trimester. The rate growth of femur rate 1.9mm growth per week in late second trimester and 1mm per week in third trimester.

An accurate survey of the fetus in second and third trimesters includes measurement of fetal long bones. Although the purpose of this study was to determine gestational age using sonographic measurement of humerus, it should be noted that one of the main reasons for knowing what normal anatomy looks like is to be able to recognize abnormalities.The parity status of the study population composed of 44.2% null parity and 55.8% multiparity.

A study conducted by Rosati et al., (2002) revealed that the differences in accuracy in predicting bone length usingformulae derived from data acquired during early pregnancy can be related to the fact that systematic variations in themeasurement of FL and HL occur particularly during the firsttrimester of pregnancy, a period in which the upper and lowerbones are quite difficult to measure accurately [7, 8]. In present study we have measured the humeral length and femur length in order to confirm the role of fetal humeral length as biometric parameter which could be used to determine the gestational age.

The study revealed that there was no significant difference between FL and HL (p-value=0.630, which is >0.05). This result confirmed that HL is similar as FL to calculate the gestational age. There was strong correlation between HL and GA; this correlation is not so different from the correlation of FL with GA (0.89 vs.0.80). These results reflect the validity of HL and FL in determining the gestational age. So, the FL and HL measurements were useful to detect bone abnormalities that associated with Down syndrome. A study conducted by Roberto et al., (2005) had studied humerus and femur length in fetuses with Down syndrome. He concluded that there was no significant differences in the detection rate and false-positive rate were found between the humerus and femur lengths. When the humeral and femoral lengths were combined, we observed a remarkable reduction in the false-positive rate. These results suggest that the combination of femoral and humeral lengths may permit a more efficient use of ultrasound in screening for Down syndrome than the use of either alone [9]. As both FL and HL lengths ere used together for detecting Down syndrome, this support our finding which supposed that humeral length is similar to femoral length. The Australian Society for Ultrasound in Medicine (ASUM) has put Statement on Normal Ultrasonic Fetal Measurements [10]. They have established a humeral length chart and recommended to be used for determination of fetal gestational age. This finding is obviously consistent with our result.

V. Conclusion

The ultrasound plays a great role to assess fetal bone biometrics as it is sensitive and accurate. The study concluded that both femoral and humeral length s were similar and reliable to estimate the gestational age. There was strong positive correlation between humeral length and gestational age. The humeral length is a basic fetal bone biometry in determination of the gestational age and could be used in accompanied with femoral length to detect fetal bone abnormalities.

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