ULTRASONOGRAPHIC ESTIMATION OF FOETAL GESTATIONAL AGE BY HUMERUS LENGTH AND ITS COMPARISON WITH FEMUR LENGTH

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ABSTRACT

AIMS AND OBJECTIVES

To estimate foetal gestational age by measuring humerus length on ultrasonography in second and third trimesters of normal pregnancies. To compare it with conventional parameter femur length for verification of its accuracy and usefulness in foetal biometry.

MATERIAL AND METHODS

This prospective cross-sectional study includes 100 healthy women with uncomplicated singleton gestations in the period of 14 to 40 weeks. The average gestational age of the foetus was calculated by using routine biometric parameters. The foetal femur length and humerus length were measured and are compared with standard tables. The gestational age was correlated with femur and humerus lengths. The humerus length was compared with femur length.

RESULTS

Data obtained from 100 normal singleton gestations pertaining to gestational age, femur length and humerus length were statistically analysed and compared. Correlation coefficients and p-values were calculated. The association of GA with FL and HL showed positive correlation and are significant. [Gestational age and femur length: r-0.995, p<0.001**, Gestational age and humerus length: r-0.993, p<0.001**, Femur length and Humerus length: r-0.998, p<0.001**] Scatter graphs for GA and FL, GA and HL, FL and HL also shown good correlation between the variables.

CONCLUSIONS

Humerus length is a good parameter for estimation of foetal gestational age. Compared with femur length, humerus length is similar and reliable in estimation of foetal gestational age and there is no much difference between the two parameters.

KEYWORDS

Ultrasonography, Gestational Age, Femur Length and Humerus Length.

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INTRODUCTION: Estimation of foetal gestational age is very essential in any obstetric practice. Ultrasonography plays a very important role in the estimation of foetal gestational age. It is a very safe, convenient, economical, noninvasive, accurate and easily available technique for assessing foetal gestational age.

Many ultrasound parameters currently are in use for the estimation of foetal gestational age. Biparietal Diameter, (BPD), Head Circumference, (HC), Abdominal Circumference (AC) and Femoral Length (FL) are considered to be the reliable parameters and are currently used as routine conventional parameters for estimation of foetal gestational age. The prediction of gestational age by these parameters almost corresponds to menstrual age by correct known Last Menstrual Period (LMP) dates.

In general, the accuracy of gestational age prediction in the second trimester is approximately +7 days before 20 weeks, +10 days after 20 weeks and in the third trimester is about +21 days. Previous studies have not identified differences in any of the foetal sonographic parameters BPD, HC, AC and FL.[1,2] Sonographic measurements of ossified shafts of foetal long bones is possible after 12 weeks of gestation.[3] Foetal femur length is one of the commonly used ultrasonographic parameter for foetal gestational age estimation and is accurate in the estimation of gestational age.[4] There was no difference in the predicted femur length in north Indian foetuses compared to study done by Hadlock et al.[5]

Humerus length is not a widely used biometric parameter. Both femur and humerus are being long bones, they can be very easily imaged and measured on ultrasonography for the purpose of calculation of gestational

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age of the foetus in second and third trimesters. Use of lengths of two or more bones in predicting gestational age is necessary and mean gestational age obtained from such combinations is preferred.[6]

AIMS AND OBJECTIVES: The aims and objectives of the present study are:

- To estimate ultrasonographically foetal gestational age by measuring Humerus length in second and third trimesters of normal singleton pregnancies.
- To compare foetal gestational age obtained by Humerus length with Femur length for verification of its accuracy and usefulness in foetal biometry.

MATERIAL AND METHODS: This cross-sectional prospective study consisting of 100 healthy women with uncomplicated singleton pregnancies in the group of 14 to 40 weeks of gestation based on LMP who were referred to the Department of Radiodiagnosis of our hospital for routine antenatal ultrasonographic examination. The study was conducted during the period from January to June 2016. Sonoline G50 ultrasound system with 3.5 MHz curvilinear probe was used to carry out transabdominal sonography for the purpose of measuring humerus and femur length.

Healthy women with uncomplicated singleton pregnancies between 14 to 40 weeks with accurate last menstrual period dates were selected and included for the study. Unknown and inaccurate LMP, multiple gestations, intrauterine growth retarded foetuses, placental and liquor abnormalities, foetal congenital anomalies were excluded from the study. Patients with any other obstetric disorders and maternal systemic disorders like hypertension, diabetes etc. were screened and excluded from the study.

All the patients were examined in supine position using 3.5 MHz convex transducer. Foetal head was identified to determine presentation of the foetus and then heart was located to confirm viability. A general survey of the foetus was done to rule out any anomalies. Liquor quantity was assessed. Placental location and maturity was noted. The measurement of femur and humerus were done as follows: To locate foetal femur, the transducer was moved transversely across the abdomen till iliac bones and bladder were seen. Then, turning the probe sagittaly, the long femur bone was identified manipulating the probe depending upon the position of thigh. Both the calcified ends of the femur was defined in long axis. Ultrasound cursers were placed at both ends of the diaphysis and the length was measured in mms [Figure-1].

To locate humerus bone, the transducer was slided upwards transversely towards thorax of the foetus to locate beating heart of the foetus. Then, with a probe rotation of 90 degrees, probe was moved side wards to identify scapula and then the adjoining long bone, the humerus, with probe movements depending upon the position of foetal arm. The ends of the diaphysis of humerus in long axis was imaged. By placing the ultrasound cursers on both ends of the diaphysis, the length was measured in mms [Figure-2]. It is measured in a plane such that the bone was as close as possible to a right angle to the ultrasound beam. Care was taken to ensure that the full length of the bone was visualised and the view was not obscured by shadowing from adjacent bony parts.[7]

The foetal gestational age was calculated by using BPD, HC, AC and FL measurements in weeks. Femur length measurements were compared with standard nomogram by Hadlock et al. The humerus length measurements were compared with standard nomogram by Jeanty et al to obtain gestational age.[8]

RESULTS: All the data was compiled and tabulated. Descriptive and inferential statistical analysis was carried out. Mean with standard deviation were calculated. Pearson correlation between study variables was performed to find the degree of relationship.

A total of 100 normal singleton gestations were examined with respect to their gestational age, femur length and humerus length. Among the 100 patients in the study, group 44 women were primiparous and 56 multiparous. Their age ranged from 19 to 35 years with a minimum age of 19 years and maximum age of 35 years. Majority of the pregnant women (88%) were in the age group of 20 to 30 years. Pregnant women with gravida 1 to 5 having 0 to 4 children were seen in the study group.

Among the 100 patients included in this study, the gestational age wise frequency was determined from 14 to 40 weeks. The number of measurements (frequency) ranged from 01 to 09 for each week of gestational age, thus covering all the weeks [Table-1].

The mean FL and HL along with their standard deviation were calculated for all the GA from 14 to 40 weeks. The minimum femur length in this study was 13.8 mm at 14 weeks and maximum was 79.4 mm at 40 weeks. The minimum humerus length was 13.1 mm at 14 weeks and maximum was 69 mm at 40 weeks. The mean femur length was 50.21 mm ± 17.14 mm (13.8-79.4 mm) and mean humerus length was 45.49 ± 14.36 mm (13.1-69 mm) [Table-2].

It was observed that the femur length gradually increased from 13.8 mm to 79.4 mm and humerus length increased from 13.1 mm to 69 mm along with the increasing foetal GA from 14 to 40 weeks. It was observed that the FL and HL measurements in first few weeks, i.e. from 14 to 18 weeks were almost equal to each other showing a linear relationship. There after the femur length was seen increasing at higher rate than humerus with increasing gestational age. Foetal femur bone was longer than humerus at term. It is also observed that the growth rate of both FL and HL was well correlated with increasing gestational age. [FL: r-0.995, p<0.001 and HL: r-0.993, p-<0.001] Pearson correlation test was used to test the samples and corresponding p-values were calculated [Table-3].

This table indicates that the association of GA with FL and HL are positively correlated and are significant. No significant difference was seen between these two variables. Gestational age wise, both femur and humerus lengths were compared. The association between HL and FL for GA is also

positively correlated and are strongly significant (p-FL: <0.001** and p-HL: <0.001**). These are supported by the scatter graphs GA versus FL, GA versus HL and FL versus HL shown good correlation between gestational age and the two variables [Figure- 3, 4 and 5].

Gestational Age	Frequency	Gestational Age	Frequency
14	2	28	1
15	3	29	4
16	1	30	5
17	1	31	2
18	3	32	5
19	2	33	1
20	5	34	6
21	5	35	5
22	7	36	6
23	9	37	5
24	3	38	4
25	2	39	3
26	4	40	1
27	5	**Total**	**100**

Table 1: Gestational Age Wise Distribution of Patients

Variables	Total (n)	Mean	Standard Deviation	Minimum	Maximum
GA (weeks)	100	28.52	07.59	14.00	40.00
FL (mm)	100	50.21	17.14	13.80	79.40
HL (mm)	100	45.49	14.36	13.10	69.00

Table 2: Descriptive Statistics

Variables	r Value	p Value
Gestational age and Femur length	0.995	<0.001**
Gestational age and Humerus length	0.993	<0.001**
Femur length and Humerus length	0.998	<0.001**

Table 3: Pearson Correlation Test and p-Value

Fig. 1: USG Image of Foetal Femur Measuring 40.5 mm Corresponding to 23.1 wks. of Gestational Age

Fig. 2: USG Image of Foetal Humerus Measuring 37.4 mm Corresponding to 23.1 wks. of Gestational Age

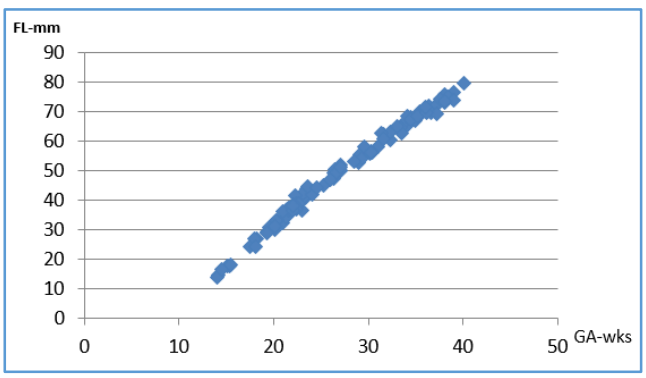

Fig. 3: Scatter Graph of GA with FL

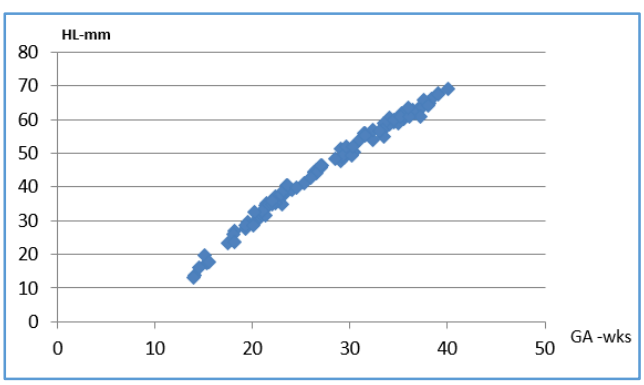

Fig. 4: Scatter Graph of GA with HL

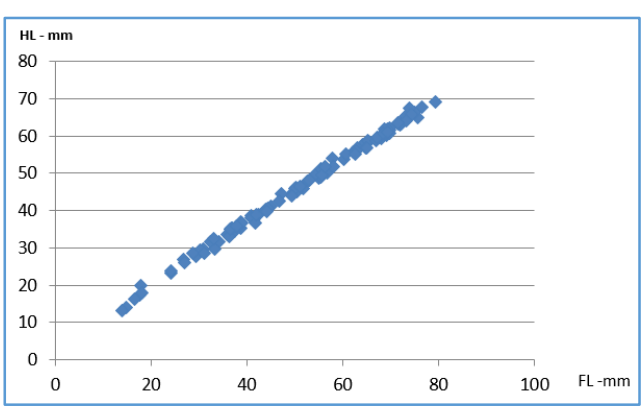

Fig. 5: Scatter Graph of FL with HL

DISCUSSION: This study with 100 normal singleton gestations having regular menstrual cycles with correct last menstrual periods were taken up for assessment of foetal gestational age by humerus length on ultrasonography and was compared and correlated with that of conventional parameter femur length. In obstetrics, ultrasonography is noninvasive, very accurate and easily available tool for assessment of foetal gestational age. Among the many parameters presently in use for foetal gestational age assessment, foetal long bone measurements are reliable indicators for gestational age in second and third trimesters of gestation. Therefore, foetal femur and humerus lengths can be good parameters for gestational age assessment. The humerus length measurement for assessing foetal gestational age can be undertaken in all routine antenatal biometry as foetal humerus can be imaged and measured after 12 weeks. The rate of growth of femur was 1.9 mm per week in late second trimester and 1.0 mm per week in third trimesters.(9)

The femur length is already an established ultrasound parameter for estimation of foetal gestational age. Foetal humerus length is not currently used parameter for assessment of gestational age. There are very few studies on estimation of gestational age by humerus length. Humerus is difficult to define accurately because of its proximity to chest wall and continuity with scapula and clavicle.[10] The available studies are in agreement that humerus length can be a useful parameter for gestational age assessment.

In a study done by Moawia Gameraddin et al (2015) revealed that there was no significant difference between FL and HL. The result confirmed that HL is similar as FL for calculation of GA and there was a strong correlation between HL and GA. In another study carried out by Vivek Patre et al (2015) correlation coefficient calculated for HL and GA (0.9704) was found it to be a reliable parameter. A statistically significant curvilinear correlation was observed between HL and GA indicating it to be a reliable indicator of foetal GA. HL would contribute to maximum accuracy next to FL among all the other parameters.

Our observations in this study are also consistent with previous studies. Gestational age calculated by Humerus length recorded in this study by using Jeanty et al tables and correlates well with gestational age calculated by LMP dates. Correlation coefficients calculated does not show any significant difference between FL and HL. The Pearson correlation coefficient and corresponding p-values calculated indicates that the association of GA with FL and HL are positively correlated and are significant. These are supported by the scatter graphs. Scatter plots GA versus FL, GA versus HL and FL versus HL shown good correlation between gestational age and the two variables. All these suggests humerus length is a reliable parameter for estimation of foetal gestational age and there is no much difference between the two indicators in establishing foetal gestational age.

The maximum error in predicting gestational age with humerus length is 2.3 weeks and percentage accuracy is 82% and with that of femur length it is 3 weeks and 86%, respectively.[10] Combination of both the parameters can be more efficient in establishing accurate gestational age. It can be assumed that humerus length is the most accurate parameter next to femur length in assessing foetal gestational age.

Antenatal long bones measurement helps in detecting dwarfism prenatally. Foetal femur length can be used as a screening device for diseases affecting foetal limb growth e.g. dwarfism and osteogenesis imperfecta.[4] Foetal long bone measurements facilitate prenatal diagnosis of skeletal dysplasia.[7] Shortening of foetal long bones such as humerus and femur is a sonographic soft marker for screening Down syndrome in the second trimester.[11]

CONCLUSION: From the observations of this study, it can be concluded that humerus length is a good parameter for estimation of foetal gestational age. Compared with femur length, humerus length is similar and reliable in estimation of foetal gestational age. Humerus length can be used as an additional parameter for estimation of gestational age in routine foetal biometry.

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