



**ORIGINAL RESEARCH PAPER**

**Radiology**

**“ANTENATAL MEASUREMENT OF HUMERAL LENGTH IN THE ASSESSMENT OF GESTATIONAL AGE AND ITS COMPARISON WITH OTHER PARAMETERS: AN OBSERVATIONAL STUDY TO ASSESS THE DIAGNOSTIC ACCURACY BY ULTRASONOGRAPHY AT A TERTIARY HOSPITAL IN WESTERN RAJASTHAN”**

**KEY WORDS:** ultrasound; humeral; assessment; gestation; pregnancy; limb; skeletal.

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**ABSTRACT**

**BACKGROUND:** The fundamentals of peri-natal care are accurate assessment of gestational age and evaluation of the fetal growth. Several anatomical parameters are in use for the assessment of gestational age, such as the fetal crown rump length (CRL), Bi parietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC) and Femur length (FL). All these parameters give accurate assessment of fetal gestational age. However, gestational age assessment may prove difficult in cases of hydrocephalus, anencephaly and hydrops. In situations such as these , other parameters must be adopted for the assessment of gestational age. One such parameter is the fetal humerus length (HL). This can be easily assessed and measured. Fetal humerus length can be used as an alternative parameter to estimate gestational age when other routine parameters are not conclusive. Fetal humerus length has a characteristic pattern of normal linear growth pattern between 14-40 weeks of gestational age. The humerus length has been studied by several authors. Very few studies are done by Indian authors regarding fetal humerus length measurement and its use in fetal gestational age estimation. Information regarding nomogram for the local population is not available. The need for this study is imperative as it helps us to establish a linear relationship between the fetal humerus length and gestational age of the fetus and to develop a nomogram in the local population.

**OBJECTIVES:** \* Assess the relationship between fetal humerus length, gestational age and develop a nomogram for the local population

\* To establish the accuracy of it as a reliable indicator for prediction of gestational age in comparison with routine parameters

**MATERIALS AND METHODS:** A cross sectional study was done on 100 normal singleton pregnant women between 14-40 weeks of gestation referred to the department of Radio diagnosis, S P Medical College, Bikaner, Rajasthan in a period of 20 months ranging from Jan 2020 to June 2021. A detailed history of the pregnant women was taken regarding menstrual and obstetric background.

**RESULTS:** A nomogram for fetal humerus length in our local population was obtained. There is an established linear relationship between humerus length and gestational age.

**CONCLUSION:** The study developed a nomogram for fetal humerus length at various gestational ages in our local population. Fetal humerus length can be used as reliable parameter for assessment of gestational age and is particularly useful when other parameters could not be measured.

**INTRODUCTION:**

In the past, gestational age has been established by a combination of historical information and physical examination. Unfortunately, the last menstrual period cannot be used in all pregnant women because 10 to 40% of all pregnant women seen in the obstetric clinics have no accurate knowledge of their LMP or a history of irregular menstrual cycles. Estimation of fetal gestational age from palpation of the uterus may be affected by conditions like uterine fibroids and maternal body habitus. Therefore, in most pregnant women, the estimation of fetal gestational age using last menstrual period cannot be accurately used and hence alternative methods are required for assessment of gestational age.

Ultrasound helps as a problem-solving tool in various situations like antenatal vaginal bleeding, abdominal pain, cervical insufficiency, significant discrepancy between uterine size and clinical dates, suspected ectopic pregnancy, suspected fetal demise, suspected amniotic fluid abnormalities, suspected placental abruption, premature rupture of membranes, evaluation of placental location, history of previous congenital anomaly and screening for fetal anomalies.

Sonographic measurements of the fetus provide information regarding fetal gestational age and growth. They are used to assign gestational age, EDD, estimated fetal weight and diagnose growth disturbances (1). Fetal biometry is a method to evaluate fetal anatomy and growth. Numerous ultrasound biometric parameters are used to determine gestational age. Commonly used biometric parameters are crown rump length, bi-parietal diameter, head circumference, femur

length and abdominal circumference to determine gestational age, fetal weight and growth in different trimesters (2,3).

Fetal gestational age estimation is of paramount importance in obstetric practice to assess growth and well-being, distinguish pre-term from term infants, antepartum care, critical interpretation of antenatal tests, screening for aneuploidy and successful planning of appropriate intervention or treatment (4).

Fetal biometry is an important part of the regular examinations performed during the second and third trimesters of pregnancy to assess fetal gestational age and fetal growth. Ultrasound is widely used in clinical practice in obstetric imaging (5).

However traditional biometric parameters have some limitations, for example, conditions affecting shape of skull (cranial malformations) will affect BPD and HC, abdominal conditions like hydrops affect AC measurements, and lower limb abnormalities will affect femur length (6); hence there is a necessity for alternative measurement to assess gestational age.

The present study mainly focusses on the role of fetal humerus length for the measurement to assess gestational age and development of HL (Humerus length) nomogram in local population. Not only this, humerus length will also provide a useful adjunct in addition to the regular parameters used.

**MATERIALS AND METHODS**

Duration of study – January 2020 to June 2021

**b. Sample size** – 100 cases which are normal singleton pregnant women.

**C. INCLUSION CRITERIA –**

All patients with singleton pregnancies between 14 to 40 weeks of gestation.

Patient who are sure of the dates of their last menstrual period. Normal antenatal patients with no associated risk factors.

**D. EXCLUSION CRITERIA –**

1. Twin pregnancies
2. Pregnancies involving anomalies such as anencephaly, hydrocephalus, Short limb dysplasia, IUGR.

**Imaging Protocol**

All examinations are performed using a grey-scale real time sonography machines, Aloka Prosound using a 3 to 5 MHz curvilinear transducer. Other materials used are aqua saline jelly and Sony ultrasound thermal paper roll.

Prior to examination, complete form – F (in compliance to PC&PNDT act) filled by the patient along with consent is taken. Signature by the radiologist in accordance with PCPNDT rules is taken. Each scan was referred from the obstetrician after a complete antenatal checkup.

Detailed menstrual history was obtained from the patient. After confirming no anomaly was present, following four parameters were measured.

1. Bi-parietal diameter: Fetal head was imaged in axial plane. The BPD was measured from outer surface of the skull table near to the transducer to inner margin of the opposite skull table which is away from transducer.
2. Head circumference: Head circumference is imaged in the same plane as BPD. It was traced along the outer perimeter of the calvarium.
3. Abdominal circumference: AC is measured in axial view of the fetal abdomen at the level of stomach and hepatic portion of the umbilical vein. The measurement was taken along the outer edge of the abdomen including skin.
4. Femur length: FL measured along the long axis of the diaphysis from the greater trochanter to the lateral condyle, with both ends clearly visible. Femur closest to the abdominal wall was measured.
5. Humerus length: The humerus length is measured along the long axis of the diaphysis from greater trochanter to lateral condyle by electronic calipers.

The fetal gestational age and EDD were calculated by the LMP method by adding 9 months and 7 days to the first day of last menstrual period. After this, the gestation age was obtained with respect to each parameter and mean gestational age was calculated. Each parameter was measured in cms and gestational age in weeks, and their mean was calculated. These means were then compared with published western nomograms (Hadlock's) for each parameter. The observations collected were used to compare gestational age given by USG with gestational age calculated by the traditional LMP method.

**STATISTICAL ANALYSIS:**

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions.

**Chi-square test** was used as test of significance for qualitative data.

Continuous data was represented as mean and standard deviation.

**Pearson correlation** was done to find the correlation

between two quantitative variables and qualitative variables respectively.

**Graphical representation of data:** MS Excel and MS word was used to obtain various types of graphs such as bar diagram, Pie diagram and Scatter plots.

**p value** (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

**Statistical software:** MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyze data.

**RESULTS:**

Mean age of subjects was 25.76 ± 4.043 years. Majority of the subjects were in the age group 21 to 25 years (50%), 28% were in the age group 26 to 30 years, 13% were in the age group 31 to 35 years and 2% were in the age group >35 years.

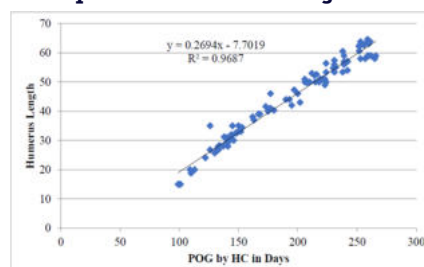
In the study 100% had regular menstruation, had no history of smoking, had no history of alcohol intake, had one fetal, had adequate Amniotic Fluid Index, 3% had breech presentation, 55% had cephalic presentation and 42% had variable presentation. In the study there was significant positive correlation between Head Circumference and POG by Head Circumference. I.e., with increase in Head circumference there was increase in POG by Head Circumference and vice versa. In the study there was significant positive correlation between Humerus length and POG by Head Circumference, POG by Biparietal Diameter, POG by Abdominal Circumference and POG by Femur Length. I.e., with increase in Humerus length there was increase in and POG by Head Circumference, POG by Biparietal Diameter, POG by Abdominal Circumference and POG by Femur Length and vice versa. In the study mean age of subjects was 25.76 ± 4.04 years and mean POG in Weeks by LMP was 27.93 ± 7.47 weeks. In the study mean Humerus length with respect to POG by Femur length was highest at 37 to 40 weeks (60.91 ± 2.69 mm) and lowest at <20 weeks (25.27 ± 5.76 mm).

In the study POG by femur length was <20 weeks in 21%, 21 to 24 weeks in 17%, 25 to 28 weeks in 13%, 29 to 32 weeks in 16%, 33 to 36 weeks in 20% and 37 to 40 weeks in 13%.

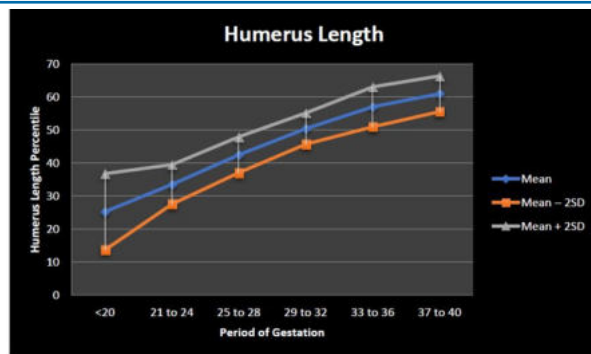
At POG <20 weeks, Humerus length was 15 to 20 mm in 6%, at 21 to 24 weeks, Humerus length was 21 to 30 mm in 15%, at 25 to 28 weeks, Humerus length was 31 to 40 mm in 20%, at 29 to 32 weeks, Humerus length was 41 to 50 mm in 19%, at 33 to 36 weeks, Humerus length was 51 to 60 mm in 30% and at 37 to 40 weeks, Humerus length was 61 to 70 mm in 10%.



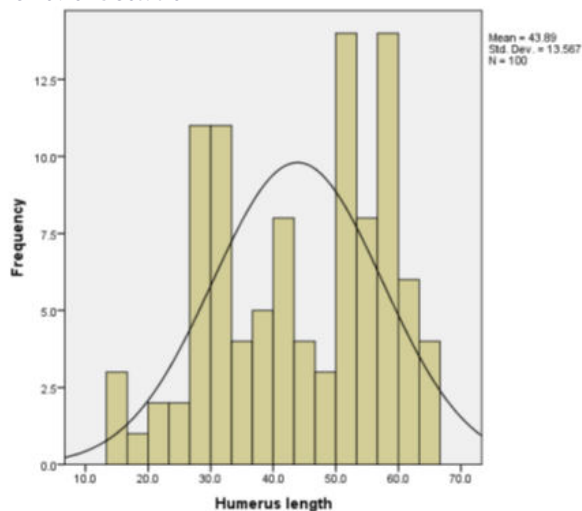
**FIG 1: Technique of Fetal humerus length**



**Figure 02: Scatter plot showing positive correlation between Humerus length and POG by Head circumference**



**Figure 03: Humerus Length with respect to Femur Length Period of Gestation**



**Figure 04: Histogram showing Normal distribution of Humerus Length**

**SUMMARY AND CONCLUSION:**

Ultrasound is very important in management of obstetric patients as it helps in accurate assessment of fetal gestational age. Ultrasound helps to distinguish pre-term from term infants, antepartum care, critical interpretation of antenatal tests and successful planning of appropriate intervention or treatment.

Measurement of four reliable parameters i.e., Biparietal diameter (BPD), Head circumference (HC), Abdominal Circumference (AC) and femur length (FL) is used for estimation of fetal gestational age as recommended by Hadlock et al 17, 27, who stated that a combination of multiple fetal parameters provided better age estimation than individual parameters. This has also been corroborated by Hohler et al and many others who have advocated that measurement of more than one fetal parameter provides a better gestational age estimation than any single parameter.

However, conditions such as hydrocephalus, anencephaly and hydrops where BPD, HC and AC parameters cannot be precisely acquired, development of another reliable parameters to assess fetal gestational age becomes a necessity. Fetal humerus length can also be an important indicator when other parameters are not available.

In our study, findings suggest that fetal humerus length can be used as reliable parameter in assessing fetal gestational age since it shows a linear growth pattern with gestational age.

We can further use this to establish Fetal humerus length (HL) as a standard parameter and not just as an adjunct to FL, BPD, HC and AC.

Our study showed that in our local population, there is a strong correlation between humerus length and gestational age with an R2 value of 0.969 in our local population, similar to the result of other authors.

Through my study, a nomogram was also obtained which helped in contributing to a well founded estimation of fetal gestational age in our population in situation where other parameters were not conclusive. Thus, humerus length estimation in addition to other parameters is valuable in many given situations.

Our study shows that fetal humerus length has characteristic linear growth pattern from 14 week to 40 weeks in all pregnant women. Growth pattern of humerus was similar to femur length growth. Fetal humerus length can be used as reliable parameter for assessment of gestational age. It is particularly useful when other parameters cannot not be measured in conditions like anencephaly, hydrocephalus, hydrops and isolated skeletal anomalies. There is a linear relationship between humerus length and period of gestation. The study also developed a nomogram for fetal humerus length at various gestational ages in our local population.

**REFERENCES**

1. Seeds JW. The routine screening obstetrical ultrasound examination. Clin Obstet Gynaecol. 1996;34:825-26
2. Giorgia Buscicchio, et al. Analysis of foetal biometric measurements in the last 30 years. Journal of Prenatal Medicine 2008; 2 (1): 11-13 11
3. Hadlock FP, Deter RL, Harrist RB, Park SK. Computer assisted analysis of fetal age in the third trimester using multiple fetal growth parameters. J Clin Ultrasound 1983;11:313-316
4. Gruenwald P. Growth of the human fetus. I. Normal growth and its variation. Am J Obstet Gynecol 1966;94:1112-1119
5. Doubilet PM, Benson CB. Improved prediction of gestational age in the late third trimester. J Ultrasound Med 1993;12:647-653
6. Goldstein RB, Filly RA, Simpson G. Pitfalls in femur length measurements. J Ultrasound Med 1987;6:203-207
7. Warsof SL, Gohari P, Berkowitz RL, Hobbins JC. The estimation of fetal weight by computer-assisted analysis. Am J Obstet Gynecol 1977;128:881-892
8. Bree RL, Edwards M, Bohm-Velez M, et al. Transvaginal sonography in the evaluation of normal early pregnancy: correlation with HCG level. AJR Am J Roentgenol 1989;153:75-79
9. Prashanth acharya, et al. Evaluation of applicability of standard growth curves to indian pregnant women by foetal biometry. South Asian federation of obstetrics and gynaecology, sept-dec 2009;1(3):55-61
10. Jeanty P. A simple reporting system for obstetrical ultrasonography. J Ultrasound Med 1985;4:591-593
11. Campbell S, Warsof SL, Little D, Cooper DJ. Routine ultrasound screening for the prediction of gestational age. Obstet Gynecol 1985;65:613-620
12. Hadlock FP, Deter RL, Harrist RB, Park SK. Computer assisted analysis of fetal age in the third trimester using multiple fetal growth parameters. J Clin Ultrasound 1983;11:313-316
13. M. W. Pang, et al. Customizing foetal biometric charts .Ultrasound Obstet Gynecol wiley 2003 271-276.
14. Hadlock FP, Deter RL, Harrist RB, Park SK. Fetal abdominal circumference as a predictor of menstrual age. AJR Am J Roentgenol 1982;139:367-370
15. Hadlock FP, Harrist RB, Deter RL, Park SK. Fetal femur length as a predictor of menstrual age: sonographically measured. AJR 1982;138(5):857-8
16. Jeanty P, Rodesch F, Delbeke D, Dumont JE. Estimation of gestational age from measurements of fetal long bones. J Ultrasound Med 1984;3:75-79
17. Honarvar M, Allahyari M, Dehbashi S. Assessment of gestational age based on ultrasonic femur length after the first trimester: a simple mathematical correlation between gestational age (GA) and femur length (FL). Int J Gynaecol Obstet 2000;70:335-340
18. Hadlock FP, Deter RL, Harrist RB, Park SK. Estimating fetal age: computer-assisted analysis of multiple fetal growth parameters. Radiology 1984;152:497-501
19. Khan. Z, Faruqi. N. A. Determination of gestational age of human fetuses from diaphyseal lengths of long bones- A radiological study. J. Anat. Soc. India 2006 June;55(1):67-71
20. Patre V, Aryan AK, Sahu P, Patre V. Ultrasonographic Evaluation of Fetal Humerus Length for Assessment of Gestational Age and Its Comparison with Other Conventional Parameters. Int J Sci Stud 2015;3(7):58-64.
21. Moawia Gameraddin, Suzan Abdelmaboud, Sultan Al shoabi, Mona Fadol. The Role of Fetal Humeral length in Gestational Age compared with Femoral length Using Ultrasonography. IOSR-JDMS 2015; 14(5):65-68.
22. Nagesh R, Pramila SVV, Shukla AK. Ultrasonographic estimation of foetal gestational age by humerus length and its comparison with femur length. J. Evid. Based Med. Healthc. 2016; 3(74), 4040-4044.
23. Rao CBR, Sreepadma S. The study of the humerus and femur length as combined predictors of the gestational age of human fetuses using ultrasonography. Int J Res Med Sci 2017;5:2701-5.
24. Tahmasebpour A.R, Pirjani R, Rahimi-Foroushani A, Chaffari S R, Rahimi-Sharbat F and Masrouf F F. Normal Ranges for Fetal Femur and Humerus Diaphysis Length During the Second Trimester in an Iranian Population. J Ultrasound Med. 2012;31(7):991-5.
25. Tsuzaki T, Iwamoto K, Maeda K. Significance in ultrasonographic measurement of fetal limb bones. Nihon Sanka Fujinka Gakkai Zasshi. 1982;34(3):315-20.