Original Research Article

To determine the GA by using sonographic measurement of the (HL) and to confirm that if it is reliable in estimation of GA and comparing with that (FL) in second and third trimesters in normal fetuses

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Abstract
Aim: The purpose of this study was to determine the GA by using sonographic measurement of the (HL) and to confirm that if it is reliable in estimation of GA and comparing with that (FL) in second and third trimesters in normal fetuses.
Methods: This was a descriptive cross-sectional study, consisted of normal pregnant women with singleton fetus during the second trimester and aim to evaluate the reliability of HL and FL in assessing the gestational age. This study included 175 normal pregnant women with singleton fetus, in their second trimester, with known LMP and healthy fetus. This study was conducted at the Ultrasound Department in Rajarajeswari medical college and hospital, in the period from January 2022- January 2023.
Results: In the present study, there were 45 cases in 20 gestational week followed by 29 cases in 21 gestational week. There were 37 cases with age of 21 years followed by 28 cases with age of 20 years. 3 cases were with the age of 29 years. The minimum humerus length was 11 mm at 13 weeks and maximum was 38 mm at 24 weeks. The mean sonographic humerus length at 13 weeks was 7.1 – 10.3mm and at 24 weeks of gestation is 38.6 – 40.5mm. The minimum humerus length was 10 mm at 13 weeks and maximum was 38 mm at 24 weeks. The mean sonographic humerus length at 13 weeks was 7.6 - 10.3 mm and at 24 weeks of gestation is 41.4 – 43.5 mm. There was two-fold increase in humerus length from 13 weeks to 24 weeks. It demonstrates a linear relationship between foetal humerus length and gestational age. There were 37 cases with age of 21 years followed by 28 cases with age of 20 years. 3 cases were with the age of 29 years.
Conclusion: The present study concluded that both femoral and humeral lengths were similar and reliable to estimate the GA. There was strong positive correlation between HL and gestational age done by (LMP). The HL is a basic of fetal biometry in determination of the GA and could be used in combines with FL to detect fetal bone abnormalities.
Keywords: Femur length, gestational age, normal pregnancy, ultrasonography

Introduction
Ultrasound (US) has become an indispensible tool in today's obstetric practice. Foetal biometry with the help of US scanning provides the most reliable and important information about the fetal growth and wellbeing. Appropriately performed obstetric ultrasonography has been shown to accurately determine Foetal gestational age [1]. A good scanning ultrasound machine and an experienced hand are essential for obtaining maximum advantage [2, 3]. It is a safe, non-invasive, convenient, accurate, inexpensive and easily available technique for the antenatal assessment of the foetus [4, 5]. Accurate knowledge of gestational age (GA) of the foetus is vital for timing of appropriate obstetric care; scheduling and interpretation of certain

antepartum tests; determining the appropriateness of foetal growth; and designing interventions to prevent preterm births, post-term births, and related morbidities [1]. determining the first day of the LMP is the first step in establishing the EDD. In women with regular cycles and a certain LMP, the EDD is calculated by adding 7 days to the first day of the LMP and adding 9 months (Nagele Rule) [6]. Measurements of the CRL are more accurate the earlier in the first trimester that ultrasonography is performed [7, 8]. The measurement used for dating should be the mean of three discrete CRL measurements when possible and should be obtained in a true midsagittal plane, with the genital tubercle and foetal spine longitudinally in view and the maximum length from cranium to caudal rump measured as a straight line [7, 9].

Gestational age assessment by ultrasonography in the third trimester (28 0/7 weeks of gestation and beyond) is the least reliable method, with an accuracy of ± 21-30 days [10]. Antenatal measurement of foetal parameters and estimated age and weight vary among different populations, depending on their nutritional status, demographic characters and race. It is therefore important that foetal biometry is performed for local population and local charts of normal biometry be constructed. Foetal biometry with the help of ultrasound scanning provides the most reliable and important information about the foetal growth and well-being [11, 12]. FL, humerus (HL), tibia and ulna were used in combination to allow of good estimation of GA that may be useful when the BPD measurement may be unreliable, unobtainable or abnormal. Because of its size, visibility, ease of measurement and less mobility than distal limb bones, the femur and humerus are preferred over other long bones as a means of predicting menstrual age [13]. The foetal humeral length (HL) is not widely used as biometric parameter for determining the GA although it easy to be imaged with US and measured. In cases where the BPD measurement is not reliable femoral length and humeral length allow reliable estimation of foetal age [4]. Very few studies have been done so far using humerus length to estimate GA so the present study was to determine the GA by using sonographic measurement of the (HL) and to confirm that if it is reliable in estimation of GA and comparing with that (FL) in second and third trimesters in normal fetuses.

Materials and Methods

This was a descriptive cross-sectional study, consisted of normal pregnant women with singleton fetus during the second trimester and aim to evaluate the reliability of HL and FL in assessing the gestational age. This study included 175 normal pregnant women with singleton fetus, in their second trimester, with known LMP and healthy fetus. This study was conducted at the Ultrasound Department in Rajarajeswari medical college and hospital, in the period from January 2022- January 2023.

Inclusion criteria

- Healthy pregnant women and fetus verified by clinical and US scanning.
- GA verified clinically & by (LMP) of 12 weeks up to 24 weeks.
- Singleton fetus.

Exclusion criteria: Pregnant women which were not fulfill the inclusion criteria.

Sonographic Technique

These pregnant women between 12 to 24 weeks of GA are examined by US while lying comfortably on her back (supine); apply coupling agent to lower abdomen, using 3.5 MHz transducer (Samsung RS80A machine), when full HL and FL were measured.

Humerus scanning

Slide the transducer until the fetal heart is identified within the fetal chest scanning through

fetal rib/thorax and shoulder girdle leading to adjacent humerus, then rotate the transducer until the full length of the humerus is obtained, measurement of length is determined from a sagittal line measurement between 2 points at each end of the bone shaft, three or more measurements were taken in each examination; to obtain accurate measurement the value more repeated is selected as an accurate value, one humerus is examined only (18).

Femur scanning

By scanning through transverse section of the fetal lower abdomen until the iliac bones visualized, cross-section of the femur is seen at these points. Rotation of the transducer is then performed until the full length of the femur is visualized. The measurement of the femur is made from the centre of each end of the bone; which represent the length of metaphysis. Three or more measurements were taken in each examination, to obtain an accurate measurement. The accurate ones should be within the 1mm of each other and one femur is only examined (18).

Ethical clearance

The procedures of the scanning with US were being explained to the pregnant women came to obstetric examination and the purpose of incorporating their data in the study, were acquired in case of agreement. Verbally permission from the hospital and the department were being granted.

Data analysis

Data were analyzed and initially summarized as mean $\pm$ SD in a form of comparison tables and figures. Statistical analysis was performed using the standard statistical methods. Statistical tests used were correlation and T-test. The statistically significant p-value was 5%, values less than 5% were considered to be significant.

Results

Table 1: Age wise distribution

Age in years	Number of cases
19	22
20	28
21	37
22	12
23	21
24	14
25	16
26	9
27	6
28	7
29	3
Total number of cases	175

There were 37 cases with age of 21 years followed by 28 cases with age of 20 years. 3 cases were with the age of 29 years.

Table 2: Gestation week wise distribution

Gestation age in weeks	Number of cases
13	3
14	6
15	2

16	9
17	3
18	8
19	14
20	45
21	29
22	22
23	9
24	25

In the present study, there were 45 cases in 20 gestational week followed by 29 cases in 21 gestational week.

Table 3: Gestation age in weeks and corresponding humerus length

Gestation age in weeks	Mean humerus length in mm	Standard measurement in mm
13	11	7.1 – 10.3
14	14	10.7 – 13.8
15	17	14.1 – 17.0
16	19	17.3 – 20.1
17	23	20.4 – 23.1
18	25	23.4 – 25.9
19	27	26.2 – 28.6
20	31	28.9 – 31.2
21	32	31.5 – 33.7
22	34	34 – 36.1
23	36.5	36.3 – 38.4
24	38	38.6 – 40.5

The minimum humerus length was 11 mm at 13 weeks and maximum was 38 mm at 24 weeks. The mean sonographic humerus length at 13 weeks was 7.1 – 10.3 mm and at 24 weeks of gestation is 38.6 – 40.5 mm. There was two-fold increase in humerus length from 13 weeks to 24 weeks. It demonstrates a linear relationship between foetal humerus length and gestational age.

Table 4: Estimation of age in weeks and corresponding femur length

Gestational age in weeks	Mean length of femur in mm	Standard measurement in mm
13	10	7.6 - 10.3
14	12	11 – 13.7
15	14	14.3 – 17.0
16	17	17.6 – 20.2
17	22	20.8 – 23.4
18	24	24.0 – 26.4
19	24.5	26.7 – 29.5
20	29	30.1 – 32.4
21	32.5	33.0 – 35.3
22	35	35.9 – 38.1
23	38	38.7 – 40.9
24	40	41.4 – 43.5

The minimum humerus length was 10 mm at 13 weeks and maximum was 38 mm at 24 weeks. The mean sonographic humerus length at 13 weeks was 7.6 - 10.3 mm and at 24 weeks of gestation is 41.4 – 43.5 mm. There was two-fold increase in humerus length from 13 weeks to 24 weeks. It demonstrates a linear relationship between foetal humerus length

and gestational age.

Discussion

This study was done on 175 women with normal singleton gestations having regular menstrual cycles and known LMP to find accuracy of ultrasound in estimation of gestational age by humeral length and to compare it with other parameters used routinely. 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 because humerus is difficult to define accurately, because of its proximity to the chest wall and its apparent continuity with the scapula and clavicle.

In another study (Moawia Gameraddin *et al*, 2015) revealed no significant difference in HL and FL in the estimation of gestational age. The study confirmed that accuracy of HL in estimating gestational age is equivalent to FL. Finally this study have positive finding to confirm the main objective of the study by demonstrate strong correlation between FL and GA(LMP), HL and GA (LMP) that lead me to say that the US has more accurate in estimation of GA by using HL and FL in second trimester. This study has been done on participants with known LMP and healthy fetuses, there is scope to estimate the importance of HL in unknown LMP and skeletal disorders, wherein along with FL, HL can be of utmost important tool [14].

In another study (Sachin Kumar *et al*, 2018) they found the earliest age at which humerus length could be seen by ultrasound was 13 weeks of gestation and mean humerus length 13.12±0.50, while at 40 weeks of gestation 69.00±00 respectively. A strongly significant relationship has been observed between fetal humerus length and gestational age by regression analysis [15]. In another cross-sectional study (Premlata Mital *et al*, 2019) found the mean humerus length at 18 weeks was 25.27±1.16 mm and at 36 weeks of gestation was 57.11±1.58 mm. Simple linear regression analysis shows a strongly significant linear relationship between humerus length and gestational age. Where, gestational age (weeks) $Y= 0.5213$ x humerus length $(X) + 4.905$; with high degree of correlation coefficient ($R2=0.9785$ and $p\leq0.0001$). When Compared with BPD, HC, AC and FL, humerus length also shows a linear correlation [16]. The measurement of the humerus length can be an important additional parameter for estimating gestational age along with other parameters and can be used to predict the gestational age of fetuses in special circumstances.

In a descriptive study (Ibrahim *et al*, 2021) carried out at ultrasound department in dream hospital in the period from June – august (2019), in which 70 pregnant women were examined in their late second and third trimesters, with singleton pregnancy, healthy mother and fetus, were examined in their gestational age group (26 Ws up to full term verified clinically by last menstrual period (LMP). The study aimed to assess the reliability of the femoral and humeral length measurement to estimate the gestational age. The study revealed that there was a strong positive correlation between gestational age (LMP) and humeral length. Also strong correlation was found between the gestational age and femoral length, there was no significant difference between humeral length and femoral length. 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 using femoral length alone. The study recommended that using of Humerus Length measurement in estimating gestational age. Also to give more attention for practicing &training the students, medical staff and technologists about humerus measurement technique of taking Gestational Age from HL in hospital practicing [17]. My finding agree with (Vivek Patre *et al*, 2015) who measured the HL for assessment of gestational age and compared it with other conventional parameters in order to confirm the role of fetal HL as biometric parameter which could be used to determine the GA, concluded that both FL and HL were similar and reliable to estimate the GA. There was strong positive correlation between HL and GA and linear relationship of

BPD, HC, FL with gestational age. The HL is a basic fetal bone biometry in determination of the GA and could be used in accompanied with FL to detect fetal bone abnormalities [18].

Conclusion

The ultrasound is accurate diagnostic technique in evaluation of gestational age. It is noninvasive, reliable and widely available. It plays a great role to asses fetal bone biometrics as it is sensitive and accurate. Many studies have already proven the efficacy of BPD, HC, FL, AC lengths in determining the gestational age. The present study concluded that both femoral and humeral lengths were similar and reliable to estimate the GA. There was strong positive correlation between HL and gestational age done by (LMP). The HL is a basic of fetal biometry in determination of the GA and could be used in combines with FL to detect fetal bone abnormalities.

References

1. Reddy UM, Abuhamad AZ, Levine D, Saade GR, Participants FIWI. Fetal imaging: Executive summary of a joint Eunice Kennedy Shriver National Institute of child health and human development, Society for Maternal-Fetal medicine, American Institute of ultrasound in medicine, American College of obstetricians and Gynecologists, American College of radiology, Society for pediatric radiology, and society of radiologists in ultrasound fetal imaging workshop. American journal of obstetrics and gynecology. 2014;210(5):387-397.
2. Tan JK. Health management information systems: Methods and practical applications. Jones & Bartlett Learning; c2001.
3. Rihab MA, Bushra HA, Salah MA, Mohamed TI. The accuracy of gestational age predicted from femur and humerus length in Saanen goats using ultrasonography. Acta Vet Brno. 2012;81:295-9.
4. 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.
5. 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);4040-4.
6. Gaharwar A, Tiwari V. Correlation between Crown Rump Length of Fetus and Gestational Age in First Trimester of Pregnancy in North Indian Population. Int J Med Res Prof. 2019 May;5(3):102-4.
7. Robinson HP, Fleming JE. A critical evaluation of sonar "crown–rump length" measurements. Br J Obstet Gynaecol. 1975;82:702-10.
8. Pexsters A, Daemen A, Bottomley C, Schoubroeck VD, Catte L, Moor B, *et al*. New crown–rump length curve based on over 3500 pregnancies. Ultrasound Obstet Gynecol. 2010;35:650-5.
9. Verburg BO, Steegers EA, Ridder M, Snijders RJ, Smith E, Hofman A. New charts for ultrasound dating of pregnancy and assessment of fetal growth: longitudinal data from a population-based cohort study. Ultrasound Obstet Gynecol. 2008;31:388-96.
10. Methods for estimating the due date. Committee Opinion No. 700. American College of Obstetricians and Gynecologists. Obstet Gynecol. 2017;129:e150-4.
11. Shehzad K, Ali M, Zaid S. Fetal Biometry. Pak J Med Sci. 2006;22(4):503-8.
12. 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.
13. Rao CBR, Sreepadma S, Kalghatgi RN. The study of relation between the gestational age of human fetuses and the diaphyseal length of femur using ultrasonography. Int. J Anat Res. 2017;5(1):3342-9.

14. Hadlock FP, Harrist RB, Deter RL, Park SK. Fetal femur length as a predictor of menstrual age: sonographically measured. American Journal of Roentgenology. 1982 May 1;138(5):875-8.

15. Sachin Kumar, Vishnu Datt Pandey, Yogesh Yadav, Dr Vishnu Datt Pandey. Fetal humerus Length for Prediction of Gestational Age: An Ultrasonographic Study. Journal of Medical Science And Clinical Research, v6i12.27.

16. Mital P, Ainani R, Hooja N, Sonkhya P, Pradodh V, Chaudhary K, *et al*. A cross-sectional study to evaluate sonographic foetal humerus length for estimation of gestational age in normal singleton pregnancies at a tertiary care centre. International Journal of Reproduction, Contraception, Obstetrics and Gynecology. 2019 Sep 1;8(9):3622-9.

17. Ibrahim OH. Estimation ofGestational Age by Measuring Humerus Length using Ultrasonography (Doctoral dissertation, Sudan University of Science & Technology).

18. 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. International Journal of Scientific Study. 2014;2(7):58-64.