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Fetal humerus length as a Gestational Age parameter – A nomogram for local Indian population.

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ABSTRACT
Background: Precise understanding of the fetus's gestational age is necessary to achieve a logical and accurate conclusion. Gestational age can be accurately predicted by biparietal diameter, head circumference, abdomen circumference, and femur length. The current study was conducted to estimate fetal gestational age by measuring humerus length between 18 and 36 weeks period of gestation of normal singleton pregnancies and to compare humerus length with conventional measurements as an additional tool to improve accuracy because the humerus is not commonly employed as a biometric parameter for calculating the GA.
Materials and methods: In this cross-sectional study conducted in Department of Radiology, SMS&R, Sharda Hospital, Greater Noida, Uttar Pradesh, India, 150 women between the gestational ages of 18 and 36 weeks gestation who had a viable singleton pregnancy and a low miscarriage risk were included. Using electronic calipers on ultrasonography, fetal measurements were taken which include femur length, humerus length, head circumference, abdomen circumference and biparietal diameter. The gestational age obtained from the four conventional parameters was confirmed with the gestational age obtained from date of last menstrual period to maintain standard and to rule out any growth restriction which would affect the nomogram. Statistics were used to analyze the data.
Results: The average humerus length in this study was 26.63±0.67 mm at 18 weeks and 48.51±0.59 mm at 28 weeks. Univariate linear regression was used to find out relationship of HL and gestation age by LMP and shows a strongly significant linear relationship between humerus length and gestational age. The present study revealed coefficient of correlation of humerus length with gestational age of r = 0.994 demonstrating a strong linear association.
Conclusion: In this study, the measurement of the fetal humerus length was used to develop a nomogram for the local Indian population between 18 to 36 week of gestation.

Keywords: Femur length, Gestational age, Normal pregnancy, Ultrasonography, Nomogram

INTRODUCTION

High-frequency sound waves are used in ultrasound to produce real-time ultrasound images of the fetus. Fetal gestational age and growth abnormalities are revealed by sonographic measurements of the fetus[(1)]. It is essential to use lengths of two or more bones to forecast gestational age, and it is better to use the mean gestational age derived from such combinations [(2)].
The cornerstones of the current effort are the significance of fetal humerus length in identifying gestational age and the establishment of the HL (Humerus length) nomogram in the local community[(3,4)]. Diverse population of women are referred for prenatal diagnostics. The different scoring methods may be significantly impacted by variations in individual biometric parameters among different ethnic groups.in the prior research undertaken, the following prenatal sonographic measurements have not been found to differ: femur length, head circumference, abdominal circumference, and biparietal diameter[(5)].

MATERIALS AND METHODS

A prospective study was carried out on female outpatients and inpatients who were sent to the Department of Radiodiagnosis, SMS&R, Sharda Hospital, Greater Noida, Uttar Pradesh, India, for an antenatal scan at 18 to 36 weeks gestation. The research was conducted using a 5 MHz curvilinear transducer on a greyscale real-time sonography and imaging system (Philips Epiq 7G). Measuring tools were electronic calipers. Fetal humerus length and other four conventional fetal biometric parameters i.e. femur length, biparietal diameter, head circumference and abdominal circumference were recorded as part of the study.

The patients were evaluated while lying supine, exposed from xiphisternum to the pubic symphysis exposed from the xiphisternum. The transducer was then positioned over the abdomen, and the position of the fetal head was determined in order to determine the fetus's lie, confirm viability, and exclude multiple pregnancies. The routine procedure for evaluating other parameters was used. The following protocol was followed to measure fetal humerus length. After localizing the fetal heart, the transducer was shifted to scan the scapular spine, which is dorsal to the humerus head. After that, the entire humerus was measured in a plane that was as near to the ultrasound beam's right angles as achievable. Without taking into account any curvature, a straight measurement was taken from the center of one diaphyseal end to the other.

FIGURE 1

FIGURE 1 shows humerus length. The images also shows adjacent thorax with ribs and vertebral spine.

Inclusion criteria –

Every patient with a singleton pregnancy between the gestational ages of 18 and 36 (second and third trimester). Women who are certain of the dates of their LMP. Women which regular menstrual cycles. Regular prenatal patients who don't have any related risk factors.

Exclusion criteria –

- Multiple or twin pregnancies.
- Pregnancies with birth defects such hydrocephalus, anencephaly, or dysplasia of the short limbs.
- Intrauterine growth retardation.
- Gestational diabetes mellitus.
- Oligohydramnios and polyhydramnios.

RESULTS

Every measurement was gathered in accordance with the standard texts and cross-referenced with the corresponding standard chart. Predicted Humerus length values for the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles were acquired for a specific gestational age in order to create a nomogram.

Table 1:- Age distribution of women under study

Age(years)	Frequency	Percentage
18 to 20 years	19	12.67%
21 to 30 years	105	70.00%
31 to 40 years	26	17.33%
Mean ± SD	25.94 ± 4.3	
Median(25th-75th percentile)	26(23-29)	
Range	18-36	

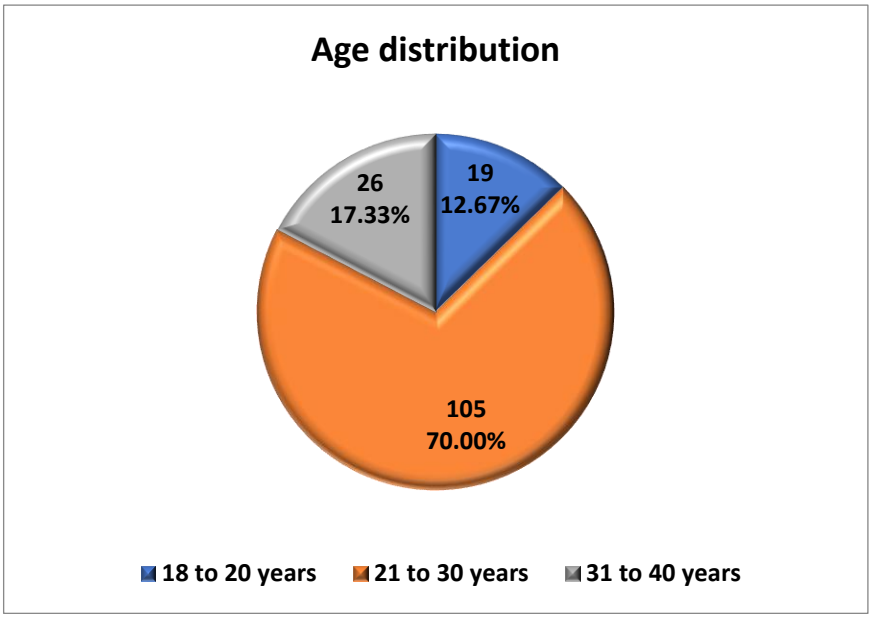

Figure 2 :- Age distribution.

Table 2:- Distribution of period of gestation by LMP(weeks) under study.

Period of gestation by LMP(weeks)	Frequency	Percentage
18	9	6.00%
19	16	10.67%
20	7	4.67%
21	9	6.00%
22	9	6.00%
23	5	3.33%
24	4	2.67%
25	5	3.33%
26	6	4.00%
27	5	3.33%
28	7	4.67%
29	5	3.33%
30	6	4.00%
31	9	6.00%
32	9	6.00%
33	16	10.67%
34	13	8.67%
35	4	2.67%
36	6	4.00%

Table 2 displays the distribution of gestational periods by Last Menstrual Period (LMP) in weeks, presenting both frequencies and percentages. Notably, 10.67% of pregnancies have a gestational age of 19 weeks and another 10.67% at 33 weeks, making these two weeks the most prevalent in the dataset. The distribution further indicates that 6.00% of

pregnancies have a gestational age of 18, 21, 22, 31, and 32 weeks. Additionally, other weeks show varying percentages, with 4.67% at 20 and 28 weeks, 4.00% at 26 and 30 weeks, 3.33% at 23, 25, 27, and 29 weeks, 2.67% at 24 and 35 weeks, and 8.67% at 34 weeks. The data provides a comprehensive overview of the distribution of gestational periods, aiding in the understanding of the prevalence of different weeks based on LMP in the studied population.

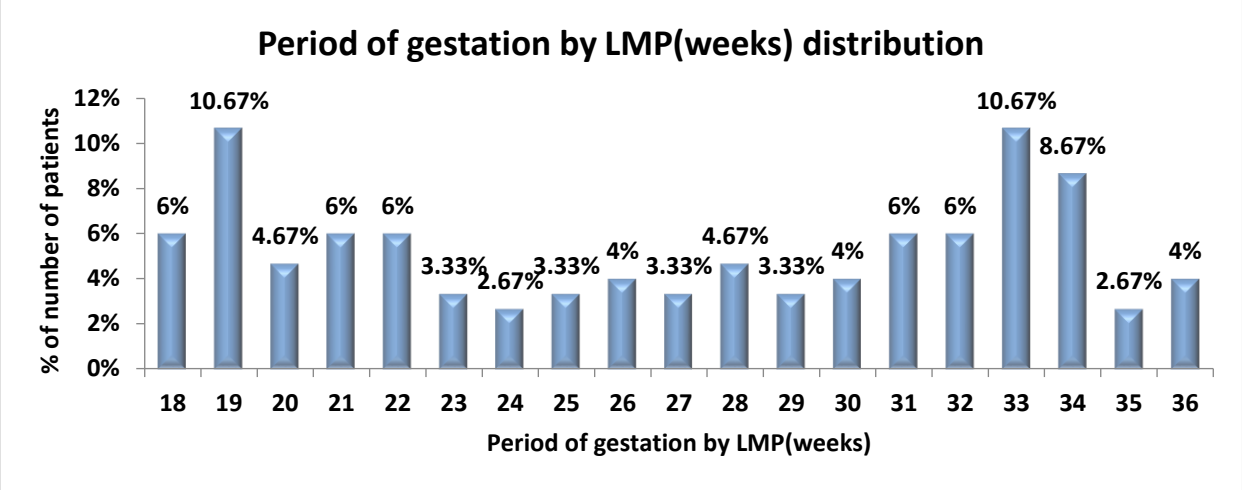

Table 3 :- Nomogram of HL(mm) in period of gestation by LMP(weeks)

GA (weeks)	Humerus Length (mm)						
	5th percentile	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile	95th percentile
18(n=9)	25.800	25.990	26.3	26.7	26.9	27.620	28.100
19(n=16)	27.900	27.940	28.825	29.2	29.55	29.980	30.630
20(n=7)	30.200	30.300	30.8	31.3	31.5	32.080	32.200
21(n=9)	31.400	31.960	33.1	34.1	34.3	35.200	35.400
22(n=9)	34.700	34.820	35.2	35.6	36.5	37.060	37.100
23(n=5)	36.600	36.800	37.2	37.5	38.6	40.700	41.700
24(n=4)	39.000	39.000	39.225	39.7	40.15	42.300	42.900
25(n=5)	42.200	42.200	42.4	42.7	42.9	43.400	44.400
26(n=6)	43.500	43.570	44.3	44.6	44.75	44.980	45.000
27(n=5)	45.600	45.800	46.4	46.8	47	47.300	47.900
28(n=7)	47.700	47.740	48.15	48.4	48.95	49.260	49.300
29(n=5)	48.500	49.500	49.6	50.8	50.9	51.000	51.600
30(n=6)	50.600	50.710	51.775	52.15	52.45	52.590	52.600
31(n=9)	53.500	53.800	53.6	54	54.6	54.960	55.200
32(n=9)	54.900	54.940	55.2	55.6	56.2	56.460	56.500
33(n=16)	55.620	55.950	56.775	57.1	57.7	58.290	58.440
34(n=13)	55.145	57.940	58.9	59.3	59.5	60.100	60.400
35(n=4)	60.200	60.600	61.010	61.200	61.410	61.500	62.000
36(n=6)	62.800	62.810	62.925	63	63.075	63.190	63.200

Table 3 presents the humerus length (HL) in millimeters at various percentiles during different weeks of gestation based on the last menstrual period (LMP). The table provides percentile values, ranging from the 5th to the 95th percentile, for each week of gestation. For example, at 18 weeks (n=9), the 50th percentile HL is 26.7 mm, while the 90th percentile is

27.620 mm. As gestational weeks progress, there is an increase in HL across the percentiles. Notably, at 35 weeks (n=4), the 50th percentile HL is 61.2 mm. This table serves as a reference for assessing fetal humerus length during various stages of pregnancy, aiding in monitoring fetal growth and development in local population.

DISCUSSION

The gestational age obtained by LMP was confirmed with the mean gestational age obtained from the four conventional fetal parameters i.e. biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL). Hadlock et al. [6.7] suggested this method, stating that combining several fetal characteristics produced a more accurate age estimate than using just one or two parameters. Hohler et al. and numerous other researchers that have argued that measuring multiple fetal parameters yields a more accurate gestational age estimate than measuring just one have also supported this[8].

As per the findings of previous writers, our research also demonstrated a substantial association (R = 0.994) between gestational age and humerus length in our local community. When evaluating skeletal dysplasia, estimation of the humerus and femur lengths are also useful. Even though it is an uncommon disorder, we can rule out skeletal dysplasia in the fetus if the humerus or femur are shorter than the fifth centile. A nomogram was also acquired through my research, which was helpful in providing a reliable estimate of fetal gestational age in our sample when other data proved inconclusive. Therefore, in many specific scenarios, estimating the humerus length in addition to other factors is useful. The average humerus length in this study was 26.63±0.67 mm at 18 weeks and 48.51±0.59 mm at 28 weeks.

The humerus and femur mean lengths in this investigation were slightly greater than those found in Tahmasebpour AR et al.'s 2012 study [9]. In a research by Moawia Gameraddin et al., a descriptive cross-sectional study was carried out in Khartoum State's Dream Specialized Hospital between August and October 2015. The investigation found that in estimating the GA, FL and HL were comparable and trustworthy. A robust positive connection was observed between HL and GA. In addition to FL, the HL is a fundamental fetal bone biometry that may be used to determine gestational age and identify anomalies in the fetal bone [10].

In their study, Nagesh R et al. used the Pearson coefficient correlation to observe the relationship between GA and FL and HL and concluded that it is significant and positively connected. They came to the conclusion that there is little difference between FL and HL in determining fetal gestational age, and that humerus length is a trustworthy criterion for estimate of fetal gestational age [11]. Vivek Patre et al. showed that the correlation coefficient (0.9704) for HL and GA was a reliable measurement in another investigation. HL and GA showed a statistically significant curvilinear association, suggesting that HL is a trustworthy predictor of fetal GA.

Multiple biometric measures were collected for every patient, ranging from 18 to 36 weeks of gestation, including BPD, HC, AC, FL, and HL. The present study's BPD (r = 0.992), HC (r = 0.991), AC (r = 0.986), FL (r = 0.995), and HL (r = 0.994) coefficients of correlation with GA demonstrated a strong linear association. The outcomes aligned with the findings reported by V Patre and colleagues [12].

CONCLUSION

According to our research, all fetal humerus lengths exhibit a typical linear growth trend from 18 to 36 weeks. The humerus's growth pattern resembled the length growth of the femur. Fetal humerus length measurement is a reliable indicator of gestational age. In fetal anamolies where conventional criteria are not detectable, such as anencephaly, hydrocephalus, hydrops, exophthalmos, gastrochesis and isolated skeletal abnormalities, it is extremely beneficial. There is a linear relationship between gestational duration and humerus length. The study also produced a nomogram for fetal humerus length at various gestational ages in our local community.

ETHICAL CONSIDERATION

This study has been carried out with formal institutional ethical committee permission. The study was conducted after taking proper patient consent and with total confidentiality about the subject's details at all times.

CONFLICT OF INTEREST

No conflicts of interest to be disclosed

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