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Fetal humerus Length for Prediction of Gestational Age: An Ultrasonographic Study

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Abstract
Introduction: *An accurate determination of gestational age is must for Obstetricians and Gynecologists to make appropriate decisions, for identifying and counseling of women who are at risk of a preterm delivery. It is also essential to evaluate fetal growth and the detection of intrauterine growth restriction (IUGR). In our present study, we worked on fetal humerus length and found that in normal growing fetus, fetal it increase with advancing gestational age and regression analysis showed a strongly significant relationship between gestational age and fetal humerus length. The purpose of this study is to find out the other parameters such as foot length and tibial length which can be used to determine the gestational age or can be used in other conditions where the previous parameters are unreliable and can also be used as supplement in the diagnosis of many genetic defects.*
Methods: *100 pregnant women underwent ultrasonographic measurements of humerus Length from 13 to 40 weeks of gestation during routine ANC, in the Radio diagnosis Department.*
Results: *In our study, we 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.*
Conclusion: *Humerus length can be considered as one of the good parameter for the determination of gestational age.*
Keywords: *Fetal humerus length.*

Introduction

The accurate dating of pregnancy is critically important for pregnancy management from the first trimester to delivery, and is particularly necessary for determining viability in premature labour and in post-dates deliveries.[1]

Prior to the widespread use of ultrasound, caregivers relied on a combination of history and physical examination to clinically determine gestational age. Ultrasound gave clinicians a method to measure the fetus and therefore to estimate gestational age. Much of our current clinical practice is based on studies from the

1980s and 1990s. As new information emerges in fields, such as reproductive biology, perinatal epidemiology, and medical imaging, our current clinical practice is being challenged. "Certain" menstrual dating, for example, is less certain than previously thought. When ultrasound is performed with quality and precision, there is evidence to suggest that dating a pregnancy using ultrasound measurements is clinically superior to using menstrual dating with or without ultrasound, and this has been advocated and adopted in other jurisdictions.[2–6]

The clinical estimate of gestational age typically relies on clinical history (menstrual cycle length, regularity, and recall of the first day of the last menstrual period), followed by confirmation by physical examination or other signs and symptoms.[7–10]

All of the limb bone lengths correlate with gestational age and may serve as indicators of skeletal dysplasia.[11]

Extensive study has been done in Indian population for the assessment of gestational age by femur length, biparietal diameter and abdominal circumference. But the data regarding the tibial length in Indian population is meagre. Fetal tibial length measurement in ultrasound can be utilised as an accurate parameter to determine gestational age.

If the head is unusually rounded (brachycephalic) or unusually elongated (dolicocephalic), BPD measurements would overestimate or underestimate gestational age.

Similarly variation in AC measurements in macrosomic and growth-retarded fetuses is due to differences in liver size and width of subcutaneous tissue was observed.

So, the purpose of this study is to find out the other parameters which can be used to determine the gestational age either more accurately or can be used in other conditions where the previous parameters are unreliable such as foot length which can also be used as an adjunct in the diagnosis of many karyotypic defects and syndromes.

In the second and third trimesters, estimation of gestational age is accomplished by measuring the biparietal diameter, head circumference, abdominal circumference, and femur length. These measurements are only as good as the quality of the images. Optimal imaging can be difficult in some clinical situations, such as in a late pregnancy abnormal lie when the head is deep in the maternal pelvis, maternal obesity, or multiple gestation. Normal biological variation appears to have more influence on measurements in the second and third trimester.[11]

Material and Methods

100 fetuses were studied retrospectively. Ultrasonographic measurements were done by skilled radiologist. Women with multiple gestation, diabetes, or growth disorders like (IUGR) were excluded. Cross-sectional data for each case were used to assess the GA. Humerus length, FL, BPD, AC, HC were measured.

Five independent and variables and dependent parameter GA were bio-mathemetically modeled and graphed to determined best fitted curves by SPSS. Linear correlation is obtained.

Results

The present study was conducted in 100 pregnant women between 13 to 40 weeks of gestation, attending the OPD for 2nd and 3rd trimester routine checkups, in the department of Radio- diagnosis, L.L.R.M. Medical College and associated S.V.B.P. Hospital Meerut U.P.

Gestational age estimated in between 13th to 40th week in present study. Mean humerus length in 13th week was found 13.1mm and in 40th week 69 mm.

Humerus length was correlated with GA and we observed strong correlation. (Table-3)

The correlation coefficient of fetal Humerus length verses femur length is 0.996 with $p<0.0001$.

The correlation coefficient of fetal Humerus length verses abdominal circumference is 0.973 with $p<0.0001$.

The correlation coefficient of fetal Humerus length verses Head circumference is 0.960 with p<0.0001.

The correlation coefficient of fetal Humerus length verses Biparietal diameter is 0.973 with p<0.0001.

Table 1: This table shows the relationship of mean HUMERUS length (FL) versus gestational age (GA). Fetal Humerus length increases as pregnancy progresses from 13 to 40 weeks of gestation.

GA	No. of Cases	Mean HL ± SD
13	6	13.12±00
14	3	14.33 ±1.15
15	5	18.40 ± 0.54
16	4	20.50 ±1.00
17	7	23.42 ±1.27
18	4	25.75 ±.50
19	5	28.40 ± 0.54
20	7	30.28 ±2.13
21	5	33.00 ±00
22	5	35.58 ±.53
23	5	38.00 ±00
24	7	39.71 ±.48
25	4	42.77 ±1.55
26	8	44.12 ±.64
27	3	46.00 ±00
28	8	46.75 ±1.66
29	9	49.91 ±1.83
30	9	51.63 ±1.30
31	10	52.69 ±1.94
32	8	54.50 ±1.77
33	7	56.31 ±1.81
34	8	58.62 ±0.51
35	7	60.71 ±0.75
36	4	62.50 ±.57
37	2	64.00 ±00
38	4	65.50 ±.57
39	2	67.00 ±00
40	2	69.00 ±00

Table 2: Association between Gestational age and HL, BPD, HC, AC

GA (Weeks)	Mean HL (mm ± SD)	Mean FL (mm ± SD)	Mean BPD (mm ± SD)	Mean HC (mm ± SD)	Mean AC (mm ± SD)
13	13.12±00	13.40 ± 00	23.90±00	68.00±00	65.00±00
14	14.33 ±1.15	15.00 ± 00	30.00 ±1.73	98.33±2.30	81.00±1.73
15	18.40 ± 0.54	18.20 ± 0.83	34.80±0.83	111.60±1.67	89.80±1.64
16	20.50 ±1.00	21.25 ± 0.50	37.37±0.47	121.75±1.25	103.50±2.38
17	23.42 ±1.27	24.58 ±1.30	40.85±1.77	138.00±4.39	114.28±5.05
18	25.75 ±.50	26.50 ±1.00	43.85±0.59	151.750±1.25	126.00±2.00
19	28.40 ± 0.54	30.00 ±00	46.60±.5477	165.80±2.04	136.20±2.04
20	30.28 ±2.13	32.67 ±1.78	49.38±1.56	180.21±4.77	143.21±4.77
21	33.00 ±00	35.20 ±.44	53.40±0.89	189.00±1.87	161.80±2.04
22	35.58 ±.53	37.98 ±.70	54.18±15.72	200.40±1.51	173.80±4.14
23	38.00 ±00	40.60 ±.54	59.20±0.44	211.00±1.22	183.20±1.64
24	39.71 ±.48	43.28 ± .75	62.28±2.05	223.85±3.97	194.28±2.28
25	42.77 ±1.55	44.40 ± 1.20	65.67±0.65	235.15±1.05	209.82±9.30
26	44.12 ±.64	47.75 ± 1.16	68.12±0.99	243.62±3.70	222.87±19.93
27	46.00 ±00	50.66 ±.57	71.66±0.57	250.00±1.73	228.33± 1.15
28	46.75 ±1.66	53.12 ±.35	73.37± 1.84	261.00±3.29	243.87±18.58
29	49.91 ±1.83	54.77 ± 1.48	77.44±1.81	269.66±2.17	247.77±14.54
30	51.63 ±1.30	57.12 ±1.21	78.98±2.09	278.25±3.37	234.75±78.43

31	52.69 ±1.94	59.82 ±1.64	81.03±2.65	287.30±4.64	269.20±3.67
32	54.50 ±1.77	61.87 ± 1.35	83.62±2.06	293.50±3.66	279.62±6.54
33	56.31 ±1.81	63.68 ± 1.77	86.66±0.51	300.66±3.14	254.28±9.78
34	58.62 ±0.51	66.75 ±.46	88.37±1.40	306.75±2.54	302.25±2.05
35	60.71 ±0.75	68.37 ±.46	90.21±1.14	313.45±10.63	312.82±10.54
36	62.50 ±.57	70.50 ±.57	92.00±00	321.00±1.15	324.00±1.15
37	64.00 ±00	73.33 ±.57	93.00±00	328.00±00	331.00±1.73
38	65.50 ±.57	74.00 ± 00	95.00±00	334.00±1.15	344.50±2.88
39	67.00 ±00	76.00 ± 00	97.00±00	340.00±00	352.00±00
40	69.00 ±00	79.00 ± 00	102.00± 00	349.00±00	366.00±00

Table 2: This table shows the mean values and standard deviation of Humerus length (HL), biparietal diameter (BPD) and abdominal circumference (AC) and Head circumference (HC) at weekly intervals from 13 to 40 weeks of gestation.

Table 3: Predicted Values of Various Parameters (FL, HL, BPD, HC, AC.)

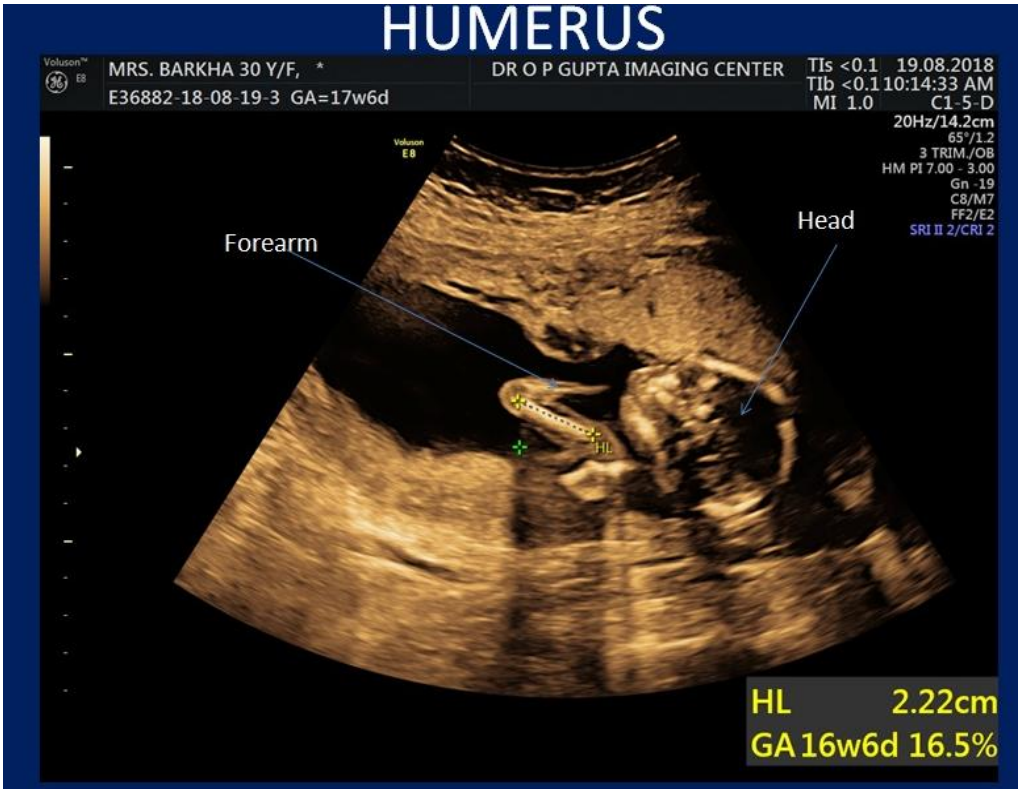
Parameters	Intercept		Slope		R Square	Adjusted R Square	P Value
	Estimate	Standard Error	Estimate	Standard Error			
Femur Length	6.936	0.253	0.409	0.005	0.996	0.996	<0.001
Humerus Length	5.299	0.397	0.489	0.008	0.993	0.993	<0.001
Biparietal Diameter	2.817	0.674	0.355	0.010	0.981	0.981	<0.001
Head Circumference	2.561	1.020	0.103	0.004	0.962	0.960	<0.001
Abdominal Circumference	6.728	0.707	0.092	0.003	0.974	0.973	<0.001

Independent variables: Femur length (FL), Humerus length (HL), Radius length (RL), Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC), in mm.

Dependent variable: Gestational age in weeks.

SE=Standard error.

P value should be less than 0.0001.



Ultra sonogram 1: This ultrasonogram shows the measurement of Humours length at 16 weeks of gestation

Discussion

Juozas Kurmanavicius et al did a prospective cross sectional study on 6557 pregnant women between 12 to 42 weeks of gestational age. They obtained R value 0.999 for limb length[12]

Taner Ziylan et al in their study concluded the R value for limb length in foetuses between 20 to 30 weeks 0.905 [13].

The values in our study are lower or higher because there is a significant racial and socioeconomic difference between individuals of the present study and those of studies done by C.Exacoustos and Lyn S.Chitty.

Table 4: Comparison of mean Humerus length of present study with that of C.Exacoustos, Lyn S, Chitty

Gestational age (weeks)	Mean Humerus length in mm		
	Present study	C.Exacoustos[14]	Lyn S.Chitty[15]
13	13.12±00	11.7	13.1
14	14.33 ±1.15	13.0	16.5
15	18.40 ± 0.54	17.0	19.8
16	20.50 ±1.00	21.0	23.0
17	23.42 ±1.27	24.0	26.0
18	25.75 ±.50	27.0	28.9
19	28.40 ± 0.54	29.0	31.6
20	30.28 ±2.13	31.0	34.2
21	33.00 ±00	33.0	36.8
22	35.58 ±.53	36.5	39.2
23	38.00 ±00	38.5	41.5
24	39.71 ±.48	41.5	43.7
25	42.77 ±1.55	44.0	45.8
26	44.12 ±.64	46.5	47.9
27	46.00 ±00	48.0	49.8
28	46.75 ±1.66	50.0	51.7
29	49.91 ±1.83	51.5	53.5
30	51.63 ±1.30	54.0	55.2
31	52.69 ±1.94	56.0	56.8
32	54.50 ±1.77	57.0	58.4
33	56.31 ±1.81	58.5	59.8
34	58.62 ±0.51	60.5	61.3
35	60.71 ±0.75	62.0	62.6
36	62.50 ±.57	63.0	63.9
37	64.00 ±00	65.0	65.1
38	65.50 ±.57	65.5	66.3
39	67.00 ±00	66.0	67.4
40	69.00 ±00	69.0	68.5

On comparing the results of the present study with that of previous researches we concluded that the present study is concordant with that of previous studies. Nevertheless high correlation coefficient (0.993) and comparatively lesser standard error (0.397) make this study more reliable.

Conclusion

In normally developing fetus the fetal Humerus length increases with an advancing gestational age. The findings of present study deduce that the fetal humeral length may also be used as one of the standard markers for the determination of gestational age. Further it may be a good tool for evaluation of gestational age in cases of femur achondroplasia, gastroschisis, Omphalocele, dolichocephaly or brachycephaly especially in the late second and third trimesters of pregnancy.

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