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ULTRASONOGRAPHIC EVALUATION OF FETAL HUMERUS LENGTH FOR ASSESSMENT OF GESTATIONAL AGE AND ITS COMPARISON WITH OTHER CONVENTIONAL PARAMETERS

Radiology

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ABSTRACT

Introduction: Ultrasonography is being a painless, non-invasive, non-ionizing,portable, redoable and relatively inexpensive modality used to evaluate fetal growth parameter many times during pregnancy.

Aim: To assess relationship between sonographic gestational age and fetal HUMERUS length between 16 and 39 weeks of gestation and to compare its accuracy with other biometric parameters.

Materials and Methods: Prospective cross sectional study was performed on 500 normal singleton pregnancies at second and third trimesters between 16-39 weeks The study was conducted on a gray scale real-time ultrasound scanner using linear and sector transducers to measure the standard fetal biometrics and fetal humeral length.

Results: Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC), and Femur length (FL) were compared with standard charts and scatter graphs were plotted. Coefficient of correlation were calculated which were for BPD, HC, AC, and FL, respectively, proving them reliable indicators. HL measured in the present study was compared with standard nomogram. A statistically significant curvilinear correlation was found between the HL and GA indicating it to be a reliable indicator of GA. Significant coefficient of correlation (0.16) was observed between HL and GA indicating it to be a reliable parameter.

Conclusion: The HL was most accurate parameter next to FL in assessing GA. The study also indicates that combination of BPD, HC, AC, FL, HL is more accurate in predicting GA than any single parameter, particularly in the third trimester of pregnancy. HL would contribute to maximum accuracy next to FL amongst all the parameters.

KEYWORDS

Gestational age=GA. Kidney length=KL, Ultrasonographic=USG, BPD=biparietal diameter. HC=head circumference.AC=abdominal circu, ference.FL=femur length,HL=Humerus length.

INTRODUCTION:

Ultrasonography is being a painless, non-invasive, non-ionizing,portable, redoable and relatively inexpensive modality[1,2]. Foetal biometry with the help of US scanning provides the most reliable and important information about the fetal growth and wellbeing. 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. EDD is calculated by adding 7 days to the first day of the LMP and adding 9 months (Nagele Rule)[12].

Mean sac diameter measurements are not recommended for estimating the due date.

CRL are more accurate in the first trimester. It 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[8].

Nontraditional sonographic parameters for estimating GA are being studied like transverse cerebellar diameter[4,5], foot length[7], clavicular length, epiphyseal ossification centers (Goldstein Ipubmed.DOI10.10.16./0002-9378(88)90793-4) , amniotic fluid volume(DOI: 10.1046/j.1469-0705.2001.00264.x · Source: PubMed). Placental grading, (DOI: http://dx.doi.org/10.18203/2349-3933.ijam20175181) colonic echogenicity, (DOI: http://dx.doi.org/10.18203/2320-1770.ijrcog20161328). Some authors have found a strong correlation of fetal sacral length (Divya J Tekani www.medplus.in), hard palate width (Ultrasound in Obstetrics and Gynecology 24(1):35-41), length, and area with gestational age in 2nd and 3rd trimesters[13]

Second trimmester Biparietal diameter and head circumference (measured in transverse section of the head at the level of the thalami and cavum septi pellucidi; the cerebellar hemispheres should not be visible in this scanning plane). The femur length (measured with full length of the bone perpendicular to the ultrasound beam, excluding the distal femoral epiphysis). The abdominal circumference (measured in symmetrical, transverse round section at the skin line, with visualization of the vertebrae and in a plane with visualization of the stomach, umbilical vein, and portal sinus)[7].

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. . (**Methods for estimating the due date. Committee Opinion No. 700. American College of Obstetricians and Gynecologists. Obstet Gynecol. 2017;129:e150-4).** The above cited parameters reliably predict gestational age and are used routinely and helpful to estimate GA when history and clinical examination are unreliable. 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 however the Femur and Humerus length are preferred over other long bones as a means of predicting menstrual age[9,10].

MATERIALS AND METHODS:

Our prospective study has been done was conducted in the Department of Radio-Diagnosis, PES Institute of Medical Sciences and Research Kuppam. Andhra Pradesh. India, with voluson 736 , from jan 2019 to aug 2019, 500 of singleton pregnant mothers, using humerus length to estimate GA between 16 to 39 weeks of normal singleton pregnancies and to compare Humerus length with routine parameters BPD, HC, AC and FL. Transabdominal ultrasound was performed in supine position as part of antenatal assessment by using 3.5 MHz transducer. Humerus Scanning Technique- after visualizing the heart, the transducer is moved to image the scapular spine which is dorsal to the humerus head. The full length of the humerus was then obtained in a plane as close as possible to right angles of the ultrasound beam. A straight measurement was made from the center of one end of the diaphysis to the other, disregarding any curvature.

Inclusion criteria - Healthy women who were certain of their LMP and

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had prior regular menstrual cycles with uncomplicated pregnancy between 16 to 39 weeks of gestation were selected for the study.

Exclusion criteria- Unknown or inaccurate date of last menstrual period. Before 16 weeks of gestational age. Oligohydramnios. Polyhydramnios. Diabetic mother. Pregnancy induced hypertension. Pre-eclampsia.multiple gestations.

Each parameter was obtained as described in standard texts, compared with its respective standard chart. The graph was plotted between GA with individual parameters and the accuracy of each parameter evaluated and compared amongst each other. For a given gestational age, predicted values of Humerus length was obtained for the 5 th, 10th, 25th, 50th, 75th, 90th and 95th percentiles to develop a nomogram. Correlation of foetal Humerus length with BPD, HC, AC and femur length was also determined by using linear regression analysis. P value of less than 0.05 was considered as significant.

RESULTS:

Table .1. Age-wise details.

Age of pregnant patients	No of patients n=500
<20 yrs	92(18.4%)
21-25 years	91(18.2%)
26 -30 years	97(19.4%)
31 to35 years	136(27.2%)
36 years	84(16.8%)

Table 2 shows 27 % of our pts were between 31-35 weeks followed by 19.4% between26-30 weeks of gestation.

Table.2. Gravid wise details

gravid	No of cases	percentages
1	205	41%
2	176	35.2%
3	86	17.2%
4	33	6.6%

Table. 3. Mean value of fetal BPD, HC, AC, FL and HL from 18 to 39 weeks of gestation.

CGA WEEKS	N0	PERCENTAGE %	MEAN BPD length+SD	MEAN HC length+SD	MEAN AC length+SD	MEAN FL length+SD	MEAN HL length+SD
16 WEEKS	3	0.6%	3.1± 0.66	11.15± 2.9	10.0± 2.54	3.0 2±.89	2.1±o.17
17 WEEKS	8	1.6%	3.8± 0.10	14.2± 0.51	13.0± 2.17	2.4± 0.16	2.4±o.13
18 WEEKS	10	2%	4.1± 0.28	15.7± 0.95	14.6± 2.48	3. 0± 0.30	2.6 ±o.36
19 WEEKS	32	6.4%	4.4± 0.24	16.3± 1.95	14.2± 1.38	3.7± 4.42	2.9± o.55
20 WEEKS	36	7.2%	4.7± 0.53	17.9± 2.07	15.6± 1.70	3.3± 0.46	3.1± o.39
21 WEEKS	24	4.8%	5.0± 0.25	19.0± 0.10	16.3± 0.9	3.5±±0.23	3.4± o.29
22 WEEKS	23	4.6%	5.3± 0.22	20.0± 1.25	17.2± 0.89	3.7 0.22	3.4± o.40
23 WEEKS	15	3%	5.7± o.48	20.5± 0.3.17	18.9± 1.75	4.2± 0.54	3.7± 0.17
24 WEEKS	17	3.4%	5.9± 0.99	22.5± 0.86	19.7 ±1.41	4.3±0.19	4.0± 0.23
25 WEEKS	12	2.4%	6.0± 0.39	23.0 ±1.08	20.7± 0.64	4.5± 0.30	4.1± 0.30
26 WEEKS	12	2.4%	6.5± 0.18	24.4± 0.81	21.4± 1.34	4.8± 0.18	4.2 ±0.17
27 WEEKS	15	3%	6.8 0.45	25.9 1.1	23.16 1.29	5.0 0.30	4.4± 0.±54
28 WEEKS	25	5%	7.1± 0.28	27.6± 5.9	23.6± 1.62	5.3± 0.22	4.7± 0.27
29 WEEKS	15	3%%	6.8± 0.87	25.7± 3.07	23.5± 3.55	5.2± 0.78	4.8±± 0.67
30 WEEKS	30	6%	7.5 ±0.29	27.3± 4.74	24.9± 3.63	6.4± 4.1	4.8 0.70
31 WEEKS	22	4.4%0	7.9± 0.24	27.5± 5.75	26.8 ±1.09	5.9± 1.15	4.9± 0.78
32 WEEKS	23	4.6%	8.1± 0.38	29.8± 2.66	27.9± 1.16	7.1± 4.37	5.2± 0±.88
33 WEEKS	35	7%	8.3± 0.38	30.8± 2.85	28.6± 1.79	6.4± 0.35	5.4± 0.61
34 WEEKS	17	3.4%	8.5± 0.27	31.2± 0.75	29.8± 0.90	6.6± 0.54	5.7± 0.±29
35 WEEKS	39	7.8%	8.6± 0.27	32.08± 1.49	30.2± 2.11	6.7± 0.32	5.8± 0.61
36 WEEKS	46	9.2%	9.3± 0.3	32.2± 3.3	31.6± 1.56	7.1± 0.27	5.8± 0.73
37 WEEKS	25	5%%	8.7± 1.0	32.8 ±1.4	32.5± 1.56	7.1± 0.51	5.7± 0.73
38 WEEKS	09	1.8%	9.2± 0.32	34.0± 1.91	34.2± 1.26	7.5± 0.19	6.3± 0.36
39 WEEKS	07	1.4%	8.4± 1.2	31.7± 4.6	30.0± 5.35	6.7 ±1.22	6.0±1.17

Table 4: Nomogram of foetal humerus length (mm) according to percentile distribution.

CGA WEEKS	N0	PERCENTAGE %	5TH	10TH	25TH	50TH	75TH	90TH	95TH
16 WEEKS	3	0.6%	1.8	1.8	1.9	2	2.1	2.3	2.3
17 WEEKS	8	1.6%	2.3	2.3	2.3	2.45	2.55	2.6	2.6
18 WEEKS	10	2%	2.1	2.15	2.4	2.65	2.9	3.15	3.2
19 WEEKS	32	6.4%	2.6	2.6	2.7	2.9	3.1	3.31	3.8
20 WEEKS	36	7.2%	2.8	2.9	3.0	3.1	3.4	3.55	4.1
21 WEEKS	24	4.8%	3.0	3.1	3.3	3.4	3.55	3.8	3.9
22 WEEKS	23	4.6%	2.6	3.0	3.3	3.6	3.7	3.8	3.9
23 WEEKS	15	3%	3.4	3.5	3.5	3.7	3.9	3.9	4.0
24 WEEKS	17	3.4%	3.6	3.9	3.9	4.1	4.3	4.3	4.6
25 WEEKS	12	2.4%	3.4	3.9	4.05	4.15	4.25	4.3	4.7
26 WEEKS	12	2.4%	4	4.1	4.1	4.25	4.4	4.5	4.5
27 WEEKS	15	3%	4.0	4.1	4.1	4.25	4.4	4.5	4.5
28 WEEKS	25	5%	4.4	4.5	4.6	4.7	4.9	5.3	5.4
29 WEEKS	15	3%%	3.8	3.9	4.8	4.7	4.9	5.3	5.4
30 WEEKS	30	6%	3.1	4.4	4.6	4.95	5.2	5.4	5.5
31 WEEKS	22	4.4%	3.1	3.5	5.1	5.2	5.3	5.5	5.7
32 WEEKS	23	4.6%	3	4.8	5.1	5.4	5.7	5.7	6.0
33 WEEKS	35	7%	3.8	5	5.2	5.5	5.8	6.0	6.1
34 WEEKS	17	3.4%	5.1	5.3	5.5	5.7	5.9	6.1	6.2
35 WEEKS	39	7.8%	5	5.3	5.7	5.9	6.2	6.3	6.4
36 WEEKS	46	9.2%	5.4	5.5	5.8	5.9	6.2	6.4	6.6
37 WEEKS	25	5%%	4.3	5.0	5.6	5.9	6.2	6.4	6.6
38 WEEKS	09	1.8%	5.4	5.4	6.4	6.4	6.5	6.6	6.6
39 WEEKS	07	1.4%	3.7	3.7	4.1	5.2	6.05	6.2	6.2

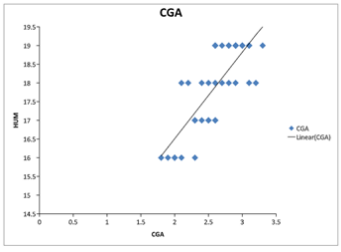
Table 3 shows ultrasonographic measurement of foetal humerus length in mm (mean±SD) for a given gestational age between 16 to 39 weeks. The Humerus length increased from 2.3 mm to 60.2 mm along with the increasing foetal GA from 16 to 39 weeks.

All parameters showed a linear relationship with gestational age (Table 3).

Table.5.Summary of relationship of humerus length with GA, BPD, HC, AC and FL.

X axis	Y axis	Regression formula	Correlation coefficient	P value
Humerus length	**GA**	**Y=2.314x+11.87**	**0.16**	<0.0001
Humerus length	**BPD**	**Y=1.267x+1.181**	**0.47**	<0.0001
Humerus length	**HC**	**Y=4.619x+4.507**	**0.157**	<0.0001
Humerus length	**AC**	**Y=4.746x+2.016**	**0.16**	<0.0001
Humerus length	**FL**	**Y=1.117x+0.264**	**0.37**	<0.0001

Figure 1.scatter plot of sonographic gestational age vs Fetal mean humerus length in our study.



A significant linear statistical correlation was found between sonographic gestational age and fetal HL with p-value of < 0.001 and R2 value of 95%. The p value of0.001 indicates that the relationship between fetal HL and gestational age has a strong statistical significance

The correlation was the highest with HC, with the adjusted R2 being 0.16, followed by AC (4.619), and was the least with BPD (1.267).

Simple linear regression analysis shows a strongly significant positive linear relationship between Humerus length and Gestational age.

Gestational age wise, Femur and Humerus lengths were compared. The association between HL and FL for GA was also positively correlated and are strongly significant (p 0,001) scatter graph.

BPD, HC and AC, Humerus length also showed a linear correlation scatter graph.

DISCUSSION:

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.So our study was done on 500 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.

The results of our study reflect the validity of HL and FL in determining the gestational age.Hence the HL is a basic foetal bone biometry in determination of the gestational age and could be used in accompany with FL to detect foetal bone abnormalities.

Vivek Patre[9] study of for HL and GA, **Pramila**[10] SVV study of association of GA with FL and HL revealed that HL would contribute to maximum accuracy next to FL among all the other parameters.

Tahmasebpour AR[9], **Yeo GS**[11], et al. study of linear relationship between menstrual age and both femur diaphysis length (R 2 = 0.957) and humerus diaphysis length (R 2 = 0.941) showed lenear relationship.

CONCLUSION:

1. Ultrasound is a non-invasive, sensitive, simple and cost effective tool.
2. A strong positive correlation between HL and GA was observed hence HL,FL can be used/added ito fetal biometry to enhance the accuracy of GA.
3. Humerus length can be an important additional parameter for estimating gestational age along with other parameters in certain conditions like hydrocephalous, anencephaly breech presentation, multiple gestations, and uterine anomalies .
4. Sonologists should take up HL also in practice as a parameter for assessing GA in future.

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