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Evaluation of various foetal biometric parameters by ultrasound in normal pregnant women in local population

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Abstract

Introduction: The accurate knowledge of gestational age is the key for successful planning of appropriate intervention or treatment. Sonographic measurements of the fetus provide information about fetal age and growth. Fetal biometry is a method devoted to the measurement of several parts of fatal anatomy and their growth. But fetal biometric parameters are not standardized in Indian scenario, hence present study is undertaken to determine whether there is any variation.

Objectives

1. To study variation of fetus biometric parameters in normal pregnancies.
2. To evaluate and compare with those of established biometric parameters.

Methods: A Cross-sectional study was conducted among 43 pregnant women attending Radiology department for obstetric examination at Raja Rajeswari Medical College and Hospital, Bangalore. After obtaining informed consent, fetal biometry parameters were measured for each in CMS and gestational age in weeks. The mean of the observations of this study was compared to Hadlock's study parameters. Gestational age given by ultrasound was compared to the gestational age calculated by traditional LMP.

Results: Study included 100 patients with 50 patients belonging to 18-24 weeks and 50 patients to 28-34

weeks. HC (58%) is the most accurate individual parameter, with AC (38%) being the least accurate individual parameter to determine gestational age from 18 to 24 weeks. For 28 to 34 weeks (third trimester) of gestational age, the most accurate individual parameter was HC (40%), with femur as length least accurate. Variations in gestational age by all four parameters increase from -3 to + 4 weeks. The overall trend in both parameters showed that the mean measurement of all four parameters in the present study was lower than western nomograms.

Conclusion: Our study reveals the use of multiple fetal biometric parameters (BPD, HC, FL, AC) to predict the most accurate gestational age and determine EDD. This study reveals that Fetal anthropometric measurements significantly differ among different population groups due to racial, genetic and ethnic factors. Thus, biometric curves of one population varies with other population and may overestimate or underestimate gestational age and EDD when used for other racial or ethnic groups.

Keywords: Ultrasound, fetal biometry, gestational age, obstetric examination, pregnant women

Introduction

Gestational age is the age of an unborn baby[1]. The accurate knowledge of gestational age is the key for successful antepartum care and critical interpretation of antenatal tests and successful planning of appropriate intervention or treatment.[2] In past, gestational age has been established by combination of historical information and physical examination. Predications were based on menstrual history, maternal sensations of fatal movements, assessment of uterine size by bimanual examination in the first trimester, initial detection of fatal heart tones by doppler and uterine fundal height measurement[3,4,5]

Unfortunately, the last menstrual period cannot be used for all patients because 10 to 40% of all patients seen in the antenatal clinics have no knowledge of their LMP or a history of irregular menstrual cycles or have been on oral contraceptives within two months of their LMP. In such situations, Sonographic measurements of the fetus provide information about fetal age and growth. They are used to assign gestation age, EDD, estimated fatal weight, and diagnose growth disturbances.

Fetal biometry is a method devoted to the measurement of several parts of fatal anatomy and their growth.[6] Real time ultrasound scanners are given a number of ultrasound biometric parameters to determine gestational age. The most commonly used biometric parameters are crown rump length (CRL), bi-parietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) to determine gestational age, fatal weight and growth in different trimesters in the absence of known date of LMP or their fundal height does not agree with dates, these parameters are valuable in estimating the gestational age of fetus.[7]

Standard fetal growth charts and tables as given by the previous workers of obstetric ultrasound evaluate whether the dimensions of a particulate parameter are normal for that age.[8] Unfortunately, the obstetric tables used in our country are produced from the data collected in the population of developed countries which may vary from our population. Therefore, the present study was undertaken to assess the gestational age in the second and third trimesters (only from 18 to 24 weeks and 28 to 34 weeks) with help of sonographic measurements of four fatal biometric parameters in local population and to compare these values with western nomograms.

Fetal biometric parameters are not standardized in Indian scenario, hence present study is undertaken to determine whether there is any variation. This study helps for better evaluation of fetal abnormalities.

Objectives

1. To study variation of fetus biometric parameters in normal pregnancies.
2. To evaluate and compare with those of established biometric parameters.

Methods

A Cross-sectional study was conducted among pregnant women attending Radiology department for obstetric examination at Raja Rajeswari Medical College and Hospital, Bangalore.

Inclusion criteria

all singleton pregnant women with proper menstrual history and known last menstrual period with no maternal complications

Exclusion criteria

1.Twin pregnancy
2. Pregnant women with co morbid conditions
3. Congenital anomalies

Sample size

Hundred normal singleton pregnant women i. e fifty pregnant women with gestational age between 18 to 24 weeks and fifty pregnant women with gestational age between 28 to 34 weeks.

Imaging Protocol

All examinations were performed using a Gray-scale real time sonography machine, SAMSUNG RS80A using a 5 MHz curvilinear transducer. Other materials used are aqua saline jelly and Sony ultrasound thermal paper roll**.**

Method of collection of data

Ethical complete approval was obtained before data collection. Informed consent was collected from the patients and a complete form – F (in compliance to PC&PNDT act) signed by the radiologist as well as the women undergoing sonography was taken prior to examination. Each sonography was done after a complete antenatal check up by obstetrician. Detail personal obstetric and menstrual history was taken. If no anomaly was seen, then the 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 the inner margin of the opposite skull table.[9]
2. Head circumference: the head circumference is imaged in the same plane as BPD. It was traced along the outer perimeter of the calvarium.[9]
3. Abdominal circumference: It is measured in axial view of the fetal abdomen at the level of stomach and intrahepatic portion of the umbilical vein. The measurement were made along the outer edge of the abdomen.[9]
4. Femur length: It was 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.[9]

The gestational age and expected date of delivery were calculated by the traditional LMP method by adding 9 months and 7 days to the first day of last menstrual period. Thereafter, the predictive gestation age was recorded 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.

Figure 1: Abdominal circumference in third trimester.

Figure 2: Femur length in third trimester.

Statistical Method

Data collected was collected, compile and entered into Microsoft excel sheet and was analyzed using SPSS version 26. Descriptive variables like Head circumference, Biparietal diameter, Abdominal circumference and Femur length were presented using mean and standard deviation. Number of cases according to fetal parameters were presented in frequency and percentages. Difference in parameters between present study and Haddock study was presented in Percentage of change. Similarly, difference in parameters between present study and Haddock study was presented in Percentage of change.

Results

Observations of table-1 shows that the HC (58%) is the most accurate individual parameter, followed by FL (46%) and BPD (40%), with AC (38%) being the least accurate individual parameter to determine gestational age from 18 to 24 weeks.

Observations of tables-2 show that from 28 to 34 weeks (third trimester) of gestational age, the most accurate individual parameter as HC (40%), followed by BPD (36%) and AC (32%), with femur length least accurate individual parameter to determine gestational age from 28 to 34 weeks.

Tables 1 & 2 show that the accuracy of each parameter is decreased as the pregnancy advances. Variations in gestational age by all four parameters increase from -3 to + 4 weeks.

Table-3 shows from 18 to 24 weeks gestation, the difference varies from 5.96% to – 5.45% for head circumference, from 3.85% to – 5.93% in biparietal diameter, from 1.02% to – 12.44% in abdominal circumference, from 3.33% to – 11.59% in femur length.

Table-4 shows that for 28 to 34 weeks gestation, the difference varies from 0.30% to – 4.93% for head circumference, from 2.54% to – 5.00% in biparietal diameter, from - 0.96% to – 5.43% in abdominal circumference, from 1.30% to – 5.34% in femur length.

The overall trend in both parameters showed that the mean measurement of all four parameters in the present study was lower than western nomograms.

Table 1: Difference in all parameters according to Gestational age (18-24 weeks) by LMP and USG.

Difference	Head Circumference in Cm		BiparietalDiameter		Abdominal Circumference		FemurLength		Ultrasound	
	No.	%	No.	%	No.	%	No.	%	No.	%
-3	1	2%	-	-	-	-	-	-	-	-
-2	-	-	2	4%	2	4%	3	6%	1	2%
-1	7	14%	9	19%	10	20%	8	18%	5	10%
0	29	58%	20	40%	19	38%	23	46%	28	56%
1	9	18%	14	28%	12	24%	11	22%	12	24%
2	4	8%	5	10%	5	10%	5	10%	4	8%
3	-	-	-	-	1	2%	1	2%	-	-
4	-	-	-	-	1	2%	-	-	-	-

Table 2: Difference in all parameters according to Gestational age (28-34 weeks) by LMP and USG.

Difference	Head Circumferencee in Cm		BiparietalDiameter		Abdominal Circumference		FemurLength		Ultrasound	
	No.	%	No.	%	No.	%	No.	%	No.	%
-3	1	2%	-	-	1	2%	-	-	-	-
-2	2	4%	2	4%	1	2%	1	2%	-	-
-1	8	16%	13	26%	2	4%	11	22%	4	8%
0	20	40%	18	36%	16	32%	15	30%	22	44%
1	11	22%	14	28%	14	28%	14	28%	18	36%
2	5	10%	3	6%	10	20%	8	16%	4	8%
3	3	6%	-	-	6	12%	1	2%	1	2%
4	-	-	-	--	-	-	-	-	1	2%

Table 3: Comparison of mean parameters between (P-Present study, H- Hadlock study) for 18-24 weeks GA

GA	HC		% Diff.	BPD		% Diff.	AC		% Diff.	FL		% Diff.
	P	H		P	H		P	H		P	H	
18	16	15.1	5.96%	4.05	3.9	3.85%	12.1	12.5	3.20%	2.79	2.7	3.33%
19	16.54	16.4	0.85%	4.34	4.3	0.93%	13.84	13.7	1.02%	2.92	3.0	-2.67%
20	17.22	17.7	-2.71%	4.53	4.6	-1.52%	14.38	15.0	-4.13%	3.22	3.3	-2.42%
21	18.75	18.9	-0.79%	4.95	5.0	-1.00%	15.98	16.2	-1.36%	3.45	3.5	-1.43%
22	19.54	20.1	-2.79%	5.21	5.3	-1.70%	16.78	17.4	-3.56%	3.69	3.8	-2.89%
23	20.63	21.3	-3.15%	5.38	5.6	-3.93%	17.33	18.5	-6.32%	3.91	4.1	-4.63%
24	21.18	22.4	-5.45%	5.55	5.9	-5.93%	17.25	19.7	-12.44%	3.89	4.4	-11.59%

P – Present Study H- Hadlock

Table 4: Comparison of mean parameters between (P-Present study, H- Haddock study) for 28-34 weeks GA

GA	HC		% Diff.	BPD		% Diff.	AC		% Diff.	FL		% Diff.
	P	H		P	H		P	H		P	H	
28	26.68	26.6	0.30%	71.28	7.1	2.54%	24.0	24.0	0%	5.47	5.4	1.30%
29	26.68	27.5	-2.98%	7.23	7.3	-0.96%	24.8	25.1	-0.96%	5.41	5.6	-3.39%
30	27.0	28.4	-4.93%	7.22	7.6	-5.00%	25.4	26.1	-2.57%	5.49	5.8	-5.34%
31	28.2	29.3	-3.75%	7.67	7.8	-1.67%	25.7	27.1	-5.09%	5.82	6.0	-3.00%
32	28.63	30.1	-4.88%	7.95	8.1	-1.85%	27.0	28.1	-3.91%	5.99	6.2	-3.39%
33	29.22	30.4	-3.88%	8.19	8.3	-1.33%	27.5	29.1	-5.43%	6.24	6.4	-2.50%
34	30.08	30.8	-2.34%	8.29	8.5	-2.47%	28.6	30.0	-4.37%	6.50	6.6	-1.52%

Discussion

Many researchers in the past worked on the correct estimation of gestational age by measuring different biometric parameters by ultrasound. By using four parameters to determine gestational age in the present study, we found that the accuracy of each parameter decreases as gestational age increases.

These findings were supported by Hadlock et al, they stated that a combination of multiple fetal parameters provided better age estimation than individual parameter. Also, Hohler etal.,[6] found that the measurement of more than one fetal parameter, in a sense, prevents over reliance of any single measurement.

Hadlock et al[6] stated that the regression equations developed from white middle class populations is applicable to the population of different socio-economic and racial characteristics. Ruvolo et al[10] found no statistically significant difference in FL vs gestational age in a racially mixed population of blacks, Asians and Caucasians. However, the sample size for each group was small and the chart used was not specified. In this study, findings suggest that the means of all four fetal biometric parameters are lower than western nomograms.

Yeo et al[11] conducted a study on Chinese, Malaysian and Indian population and showed that fetal FL are apparently shorter than the Indian FL therefore proving the existence of differences in ultrasound measurements of FL in different ethnic groups. Lai and Yeo etal.,[11] demonstrated slightly smaller BPD, HC, AC and FL, more pronounced over the course of gestation in Asians compared to white fetuses.

Lachman and Shen[12] conducted a study on 128 cases of Chinese fetuses and found a statistically significant difference in fetal FL between Chinese population and established nomograms and the Chinese FL was shorter by 0.56 mm which ultra sono graphically manifest as 0.3-week difference in gestational age determination. Thomas et al[13] demonstrated that the use of growth curves that do not take race and gender into consideration may lead to inaccurate diagnosis of infants as small or large for gestational age.

Various studies have determined that Indian fetal measurements are smaller than the Caucasian fetal measurements. Madan et al[14] conducted a study on 1539 infants of different races as white, Asian Indians, Chinese, Hispanic and other Asian and others at northern California and those Asian Hispanic and other babies

had lower mean birth weights, shorter mean lengths and smaller mean HC than white male babies.

Shipp et al[15] found a significant difference in the mean variance from the expected FL and BPD among the fetuses of women in the second trimester with respect to racial group. Jeswar et al[16] found a discrepancy of 1.09 – 2.39 cm between HC at term in Caucasian and Indian population.

Kinare et al[17] described fetal size on sonography in rural Indian population and compared it with those in European and urban Indian populations. The results showed that sonography at 18 weeks underestimated gestational age compared with the LMP date by a median of – 1.4 days. Fetal AC and BPD were markedly smaller than the western references at 18 weeks, whereas FL and HC were comparable. In late pregnancy (28 to 36 weeks), all measurements were smaller than the European references. The deficit was greatest foe AC and BPD.

In this study, we observed that there is variation of fetal biometric parameters measurements in local pregnant women when compared with measurements of exiting standard nomograms (Hadlock). The most accurate single parameter in evaluating gestational age is head circumference, 56% in 18 to 24 weeks of gestation and 40 % in 28 to 34 weeks of gestation. The accuracy of each parameter decreases as the pregnancy advances. We also observed that the mean gestational age is most accurate in determining gestational age in both groups.

As the growth trend of our fetuses is slower than western fetuses, all fetal biometric parameters predict imprecise gestational age and fetal weight, more so as pregnancy advances. We still don't have our own population specific tables for determination of gestational age of our own population. Therefore, if we use western nomograms for gestational age determination, there are chances of significant error in gestational age estimation and the fetus may appear small for date even when it is not.

Conclusion

Our study reveals the use of multiple fetal biometric parameters (BPD, HC, FL, AC) to predict the most accurate gestational age and determine EDD. Our study shows that fetal anthropometric measurements significantly differ among different population groups due to racial, genetic and ethnic factors. Thus, biometric curves of one population varies with other population and may overestimate or underestimate gestational age and EDD when used for other racial or ethnic groups.

Recommendation

Our study suggests that the need for construction and use of fetal biometric nomograms that are specific for individual population and ethnic group to determine gestational age and EDD by sonogram on basis of various fetal biometric parameters for better clinical guidelines for antepartum care and fetal growth interpretation.

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