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A Study on Ultrasonographic Evaluation of Fetal Sacral Length as a Parameter for Assessment of Gestational Age in a Tertiary Care Center

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Abstract

Background: Gestational age refers to the lengths of pregnancy after the first day of last menstrual period (LMP) and is usually expressed in weeks.This is also known as menstrual age. Conceptional age is the true fetal age and refers to length of pregnancy from time of conception. AIM: To study that ultra-sonographic fetal sacral length measurement is a reliable parameter for assessment of gestational age by correlating fetal sacral length with gestational age.**Material and Methods:**Study Design: Prospective cross-sectional study. Study area: The study was done in the Department of OBGY and Radio diagnosis, Study Period: 1 year. Study population: pregnant women with reliable LMP details attending antenatal clinic and then to radiology. Sample size: 386 pregnant women, between 11-13weeks and 6 days of gestation. Sampling method: Simple Random sampling method. Ethical consideration: Institutional Ethical committee permission was taken prior to the commencement of the study. Study tools and Data collection procedure: This study was carried out on normal pregnant women in department of radio-diagnosis. Details history regarding regularity and duration of menstrual period were taken. Systemic examination for any cardiovascular or respiratory disease, obstetric examination to estimate fundal height, fetal lie, multiple pregnancy, intrauterine growth restriction or polyhydramnios was carried out. Routine blood examination like hemoglobin, blood grouping, urine for albumin and sugar, VDRL, blood urea and blood sugar was carried out to rule out maternal disease.Statistical Analysis: The data was collected, compiled and compared statistically by frequency distribution and percentage proportion. Quantitative data variables were expressed by using Descriptive statistics (Mean ± SD). The effect of gestational age over the biometrical measurement was assessed by liner regression analysis. The statistical analysis was performed using software package SPSS for window version 23.0. P values of <0.05 were considered statistically significant.**Results:**The sacral length in 386 cases ranged from 12 to 39 mm. Average sacral length was 25.79 mm with standard deviation of 6.86 mm. The distribution of sacral length with its 95 % confidence interval. It was observed that sacral length gradually increase from 13.6 at 16 weeks to 39 mm at 40 weeks. The sacral length was lower by 1-3 mm from its corresponding gestational age starting from 16 weeks to 30 weeks.**Conclusion:**The Sacral Length increase in a linear fashion with advancing gestational age.The sacral length is usually lower than gestational age by 1-3 mm up to 30 weeks of gestation. Thereafter it is almost similar to gestational age up to 40 weeks. The relation between the sacral length and gestational age is strong, linear and statistically significant. Hence sacral length can be used as a routine or an alternative parameter for estimation of gestational age.

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Keywords: Gestational age, sacral length, sonographic biometry.

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Introduction

Gestational age refers to the lengths of pregnancy after the first day of last menstrual period (LMP) and is usually expressed in weeks.[1-3]This is also known as menstrual age. Conceptional age is the true fetal age and refers to length of pregnancy from time of conception. Gestational age is conventionally expressed as completed weeks. Therefore, a 25-week, 5 day fetus is considered as 25 week fetus. To round the gestational age of such fetus to 26 weeks is inconsistent with national and international norms.[4]

Gestational age is important to obstetrician because it affects clinical management in a number of important ways, which are as follows: Accurate dating is essential for the proper timing of chorionic villi sampling, nuchal translucency assessment, amniocentesis, and timing for elective caesarean section.[5] Accurate estimation of gestational age prevents unnecessary labor induction. Gestational age is important in evaluating fetal growth. Virtually all important clinical decision requires knowledge of gestational age.

Three basic methods used to help estimate gestational age are menstrual history, clinical examination and ultrasonography. Clinical examination such as uterine fundal height and symphysis fundal height (SFH) can determine the gestational age approximately. Ultrasound biometry of fetus is now the gold standard for assessing the fetal growth and estimation of gestational age.[6] Gestational age calculation according to last menstrual period can be biased for a number of reasons.

The most frequently used ultra-sonographic parameters for estimation of gestational age are biparietal diameter, head circumference and femoral length.[7] Nomogram for other osseous structure, such as the mandible, clavicle, scapula, vertebral arch, iliac bone and foot length, have been established.[8]

Fetal dimensions have been known to depend upon the racial characteristics, genetics, nutrition, and many more environmental factor of a particular population, thus the biometric curves obtained from one population may not accurately estimate the fetal gestational age when used for another population.

Sometimes, routine ultra-sonographic parameters like BPD and HC could not be measured accurately in the condition like third trimester deeply engaged head or multiple pregnancies. It is very difficult to estimate gestational age in conditions of femur length deformities along with skull deformity like achondroplasia etc.[9]Associated congenital anomaly such as sacral agenesis or sacrococcygeal teratoma can be detected simultaneously with sacral length measurement.[6] So estimation of gestational age by measuring sacral length may be helpful in these conditions.

So the present study was undertaken to study the relation of fetal sacral length with gestational age and comparison of other sonographic biometry (BPD, HC, FL and AC) with standard Nomogram of fetus in local Indian population.

Aim: To study that ultra-sonographic fetal sacral length measurement is a reliable parameter for assessment of gestational age by correlating fetal sacral length with gestational age.

Materials and Methods

Study Design: Prospective cross-sectional study.

Study area: The study was done in the Department of OBGY and Radio diagnosis,

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Study Period: 1 year.
Study population: pregnant women with reliable LMP details attending antenatal clinic and then to radiology.
Sample size: 386 pregnant women, between 11-13weeks and 6 days of gestation.
Sampling method: Simple Random sampling method.

Inclusion Criteria: All routine ANC patients between 16 to 40 wks of gestation referred to the dept of radio-diagnosis, for ultra-sonographic evaluation of fetal biometry and having following criteria:

- Single live pregnancy with no known abnormality
- The patient having regular menstrual period 26-30 day and is define for her first date of last menstrual period.
- Fundal height on examination corresponded with LMP

Exclusion Criteria: Pregnancy with congenital malformation, multiple pregnancies, intrauterine death of fetus, suspected IUGR, patient with unknown and unreliable LMP, and abnormal maternal and fetal health that require immediate intervention were excluded from study.
Ethical consideration: Institutional Ethical committee permission was taken prior to the commencement of the study.

Study tools and Data collection procedure:
This study was carried out on normal pregnant women in department of radio-diagnosis. Details history regarding regularity and duration of menstrual period were taken. Systemic examination for any cardiovascular or respiratory disease, obstetric examination to estimate fundal height, fetal lie, multiple pregnancy, intrauterine growth restriction or polyhydramnios was carried out. Routine blood examination like hemoglobin, blood grouping, urine for albumin and sugar, VDRL, blood urea and blood sugar was carried out to rule out maternal disease. All relevant information was recorded in specified proforma for data collection.
All subjects were properly informed about the study and written consent was taken from them. Ultrasound was performed after filling of 'F' form. The undertaking form for non-disclosure of sex of fetus was duly signed. The grey scale real time ultrasonographic examination was performed using GE LOGIC F8 USG machine.The transducer used was a 2.5-6 MHz curved array transducer.

Statistical Analysis:
The data was collected, compiled and compared statistically by frequency distribution and percentage proportion. Quantitative data variables were expressed by using Descriptive statistics (Mean ± SD). Qualitative data variables were expressed by using frequency and Percentage (%). Each parameter compared with its standards nomogram. Mean and correlation test applied for analysis and interpretation of the results. The effect of gestational age over the biometrical measurement was assessed by liner regression analysis. The statistical analysis was performed using software package SPSS for window version 23.0. P values of <0.05 were considered statistically significant.

Results

In the total study group of 386 normal antenatal women, the age ranged from 17-38 years. The Mean ± SD age was 26.02 + 4.38 years. Majority of antenatal women were in the age group between 20 to 30 years.

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Table 1: Age distribution of the study population (in years)

Age in years	Number of subjects	Percentage %
17-20	44	11.3
21-25	142	36.7
26-30	145	37.5
>30	55	14.2
Total	386	100

Table 2: Distribution of gravida and parity in the study population

Gravida	Number	%	parity	Number	%
1	161	41.7	0	164	42.4
2	154	39.8	1	162	41.9
3	54	13.9	2	51	13.2
4	12	3.1	3	6	1.5
> 5	5	1.2	> 4	3	0.7
Total	386	100	total	386	100

In the study out of 386 subjects, the gravida ranges from 1-6 and para ranges from 0-4. Most of the cases were primi gravida and second gravid.

Table 3: Distribution of gestational age in the study population

GA (in weeks)	Number of subject	%
16-20	68	17.6
21-25	88	22.7
26-30	111	28.7
31-35	81	20.9
36-40	38	9.8
Total	386	100

In this study, gestational age of the study subject ranges from 16 to 40 weeks. The average gestational age is 27.1 weeks with standard deviation of 6.1 weeks.

Table 4: Measurement value and correlation of sacral length with corresponding gestational age

GA	Frequency	Percentage	Mean	Sd	I	
16	5	1.3	13.60	1.140	12.18	15.02
17	12	3.1	14.92	.669	14.49	15.34
18	14	3.6	15.93	.730	15.51	16.35
19	15	3.9	17.67	.816	17.21	18.12
20	22	5.7	18.05	1.838	17.23	18.86
21	24	6.2	19.04	.751	18.72	19.36
22	14	3.6	19.64	1.550	18.75	20.54
23	16	4.1	21.19	1.276	20.51	21.87
24	14	3.6	21.64	1.447	20.81	22.48
25	20	5.2	22.95	1.356	22.32	23.58
26	27	7.0	23.93	1.238	23.44	24.42
27	18	4.7	25.28	1.447	24.56	26.00
28	14	3.6	26.57	2.209	25.30	27.85

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29	27	7.0	27.33	1.664	26.68	27.99
30	25	6.5	28.56	1.781	27.82	29.30
31	15	3.9	30.40	.632	30.05	30.75
32	13	3.4	31.46	.660	31.06	31.86
33	17	4.4	32.47	.624	32.15	32.79
34	18	4.7	34.00	.840	33.58	34.42
35	18	4.7	35.33	.686	34.99	35.67
36	13	3.4	36.23	.927	35.67	36.79
37	9	2.3	36.67	.500	36.28	37.05
38	7	1.8	37.43	1.718	35.84	39.02
39	7	1.8	37.00	1.732	35.40	38.60
40	2	.5	39.00	.000	-	-

Mean + SD: 25.7+6.8

The sacral length in 386 cases ranged from 12 to 39 mm. Average sacral length was 25.79 mm with standard deviation of 6.86 mm. The distribution of sacral length with its 95 % confidence interval. It was observed that sacral length gradually increases from 13.6 at 16 weeks to 39 mm at 40 weeks. The sacral length was lower by 1-3 mm from its corresponding gestational age starting from 16 weeks to 30 weeks. Thereafter the sacral length almost matched the gestational age. It was observed from 95% confidence interval that gestational age can be accurately predicted from the sacral length measurement. Slight increased variations were observed in 16-, 39- and 40-weeks gestation as seen from relatively wide 95% confidence interval limits. Sacral length in individual from 16 to 40 weeks of gestation was plotted with gestational age and observed that there was liner positive correlation between gestational age and sacral length(r-0.980).The p value was <0.001 which is statistically significant.

The data show that fetal sacral length directly related to gestational age with liner regression model yielding the following equation:

For gestational age 16 to 30 weeks: $y = 1.033x - 2.679$

For gestational age 30 to 40 weeks: $y = 0.962x + 0.979$

y =sacral length (in mm)

x =gestational age

r =Pearson correlation coefficient

Gestational age =0.871 x sacral length (in mm) + 4.699

Table 5: Coefficient of correlation and error in predicting gestational age with various parameters

Independent variable	Dependant variable	Coefficient of correlation(r)	Maximum error	Mean error
Gestational age	BPD	0.977	1.16 wks	0.47wks
Gestational age	HC	0.984	1.48 wks	0.69wks
Gestational age	FL	0.991	1.55 wks	0.52wks
Gestational age	AC	0.972	3.97 wks	1.06wks
Gestational age	SL	0.980	2.6 wks	0.83ks

The BPD in current study almost matched the standard nomogram in all gestational age except in late third trimester gestational age (34- 40 weeks) where BPD was lower by 2-3 mm from its standard value. The maximum difference between measured BPD and standard was 2.9 mm, on gestational age of 36 weeks.

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The HC in current study almost matched the standard head circumference except in late 3rd trimester from 36 to 40 weeks. The value of difference between HC from its standard in late trimester ranged maximum up to 14 mm. the maximum difference of HC value was on gestational age of 39 weeks.
The abdominal circumference in current study almost matched the standard nomogram up to 30 weeks of gestational age. Beyond 30 weeks, the values were lower than standard. The maximum difference between measured AC and its standard nomogram was 38.6 mm, on gestational age of 39 weeks.
The femur length in current study almost matched the standard nomogram up to 25 weeks of gestation. Beyond 25 weeks the values were lower than standard maximum of 3.5 mm in 40 weeks.
There was liner positive correlation of all parameter showing in the table. The coefficient of correlation for femur length was higher (r=0.991). The value of this coefficient was lowest for abdominal circumference. Maximum mean error in predicting gestational age was found with abdominal circumference of 1.06 weeks.

Discussion

Definitive knowledge of fetal growth and accurate estimation of gestational age have been shown to be crucial in the management of both normal and high-risk pregnancies. The assessment of gestational age is one of the most important aims of ultrasonography in obstetrics.
Fetal dimensions have been known to depend upon the racial characteristics, genetics, nutrition, and many more environmental factor of a particular population, thus the biometric curves obtained from one population may not accurately estimate the fetal gestational age when used for another population.
This current study found strong liner positive correlation between gestational age and fetal sacral length measured in mm. The values of Pearson's correlation coefficient(r) was 0.980, which was significant ($p<0.001$). The coefficient of determination (R2) was found 0.961.
The BPD, HC, and AC obtained in the study almost matched the standard nomogram except in third trimester. The 3rdtrimester biometric values in local population were lower than standard nomogram. The reduction of value may be due to influence of race, genetics and environmental factors of local population. Besides this, deeply engaged head and variability of abdominal shape, fetal breathing etc further reduce the reliability of these parameters in 3rd trimester. The femur length obtained from this study almost matched the standard nomogram starting from 16 weeks to 40 weeks gestational age. Thus femur length is more accurate than other parameter in third trimester, when other parameter measured lower than standard in our local population. Maximum mean error in predicting gestational age was found with abdominal circumference of 1.06 weeks.
Biasio de p et al,[9] worked on ossification timing of sacral vertebra by ultrasound in the second trimester of pregnancy. They found that S1 ossification nuclei were visualised in all fetus at 5 weeks and S2 nucleus was found in all fetus within 17 weeks. S3 nucleus was found in 45% of fetus by the beginning of the 16 week. S4 was visualised in 55% of the case at 18 weeks and progressively in a higher percentage of cases during the following weeks of gestation. The presence of five sacral ossification centers is seen by 16 weeks in the present study.
Sherer et al,[10] demonstrated the presence of sacral ossification centres by at least 16 weeks of gestation. Karabulut et al,[11] Observed sacral ossification centres as early as the 14 Th gestational weeks. The aforementioned discrepancies can be attributed to the difference in the resolution power of the ultrasound machine and variability in the personal experience of the sonographers.

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Sherer et al,[10] found strong positive liner correlation between sacral length and gestational age in both normal and abnormal pregnancy. Pajak et al,[12] also found strong and significant correlation between sacral length and gestational age. but they found more variability in measurement especially in term reaching up to 7 weeks of error.
Karabulut et al,[11] also found strong and significant correlation between sacral length and gestational age. But they claimed that sacrum length does not change throughout pregnancy. The relationship between gestational age and sacrum length was weaker in the third trimester of pregnancy in their study.
Vigno et al,[13] studied on spontaneously aborted fetus aged from 13 to 39 weeks. They dissected the fetus and measured the length of sacrum. They found significant positive liner correlation between sacral length and gestational age.
Agrawal et al,[14] studied on Indian population. They found the biometry in Indian fetus almost matches the western fetus except in late 3rd trimester, where our population shows a slightly lower range of mean values. HC and AC fall below the lower range of Hadlock as early as 24 weeks of pregnancy. They conclude that fetal biometric parameters in Indian population are at the lower range of established nomograms by Hadlock on white fetuses, more so with the progression of pregnancy. The current study almost matched the above mention study.
It was quite difficult to acquire the measurement in correct plane when the fetus was in sacrum-posterior position especially in late third trimester. Complete visualisation of sacrum was not possible in few cases of early second trimester. These were the few limitation of the current study.

Conclusion

The Sacral Length increase in a linear fashion with advancing gestational age. The sacral length is usually lower than gestational age by 1-3 mm up to 30 weeks of gestation. Thereafter it is almost similar to gestational age up to 40 weeks. The relation between the sacral length and gestational age is strong, linear and statistically significant. Hence sacral length can be used as a routine or an alternative parameter for estimation of gestational age.

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