Assessment of Gestational Age in the First and Third Trimester by Real Time Ultrasound Measurement of the Fetal Crown-Rump-Length, Bi-Parietal Diameter, Femur Length, Abdominal Circumference and Head Circumference'

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<u>**Original Research Article**</u>

Abstract: Accurate knowledge of gestational age is an essential prerequisite in an obstetrician ability to successfully manage the prenatal care of a patient and planning of appropriate therapy or intervention. The prospective observational study was done to evaluate gestational age by ultrasound measurement of CRL in the first trimester and HC, AC, and FL in the third trimester of pregnancy. A study population of 200 female pregnant women in the age range of 19 to 33 years of any gravid in the first and third trimester of pregnancy. The ultrasonographic examination comprised recording CRL in the 1st trimester and HC, AC and FL in the 3rd trimester of pregnancy and in the follow-up visits. The accuracy of CRL between 9 to 12 weeks of known menstrual age was 99%. While in the 3rd trimester, the accuracy of HC and FL from 34 to 37 weeks known menstrual age was 92%, while accuracy of AC from 34-37 weeks of known menstrual age was found to be 90% in the present study. So, it was found that CRL in the 1st trimester and HC and FL in the 3rd trimester found to be accurate for assessment of gestational age. The AC was found to be relatively less accurate in the prediction of gestational age by using real-time USG in the 3rd trimester.
Keywords: Gestational age, first and third trimester, real time ultrasound, fetal crown-rump-length, biparietal diameter, femur length, abdominal circumference, head circumference

INTRODUCTION

The first method of gestational dating was the calculation of an estimated date of confinement (EDC) from the patient's last normal menstrual period (LMP). Using the Nagele's rule (first day of the last LNMP + seven days (-) three months= EDC). The EDC can be established and the parent's current gestational age can be calculated from the LNMP. The accuracy of this method of gestational dating has been evaluated by a number of investigators who have found that 95% of obstetric patients with a normal LMP will deliver within 14 days of this calculated EDC. Accurate determination of gestational age is fundamental to obstetric care and is important in a variety of situations [1]. For example, antenatal test interpretation may be dependent on gestational age. Unfortunately, this method cannot be

used for all patients because 10-40% cases seen in prenatal clinics either have no knowledge of this LNMP or have a history of irregular menstrual cycles or have conceived while on oral contraceptives. In this group, 10-20% of the patients belong to upper socioeconomic group.

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[2]. 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 [3-7].

In the first and third trimester of pregnancy, the basic fetal measurements by ultrasound to estimate gestational age are: crown rump length (CRL), Biparietal diameter (BPD), femur length (FL), abdominal circumference (AC) and head circumference (HC) [8-15]. This study was carried out in the Department of Obstetrics & Gynaecology, MGM Medical College, and Indore in close association with Parakh Radiodiagnostic Centre, Indore. The study was done to evaluate gestational age by ultrasound measurement of CRL in the first trimester and HC, AC, and FL in the third trimester of pregnancy.

AIMS & OBJECTIVES
The present study was done with the following aims and objectives:
- To the study the role of sonography in the evaluation of gestational age
- To assess gestational age by ultrasound measurement of CRL in the first trimester and HC, AC and FL in the third trimester of pregnancy
- To assess the sensitivity and specificity of CRL in the first trimester of pregnancy as an reliable index of predicting gestational age by real-time ultrasonography
- To assess the sensitivity and specificity of HC, AC and FL in the third trimester of pregnancy as an reliable index of predicting gestational age by real-time ultrasonography
- To evaluate the fetal parameters against know menstrual age
- For better management of fetal growth in antenatal period during delivery and in postnatal period

MATERIALS & METHODS
This prospective observational study was carried out in the Department of Obstetrics & Gynaecology, MGM Medical College, and Indore in close association with Parakh Radiodiagnostic Centre, Indore. A study population of 200 female pregnant women in the age range of 19 to 33 years of any gravid in the first and third trimester of pregnancy. Same patient was examined sonographically in the first trimester and in the follow-up visit in the 3rd trimester of pregnancy. Institutional ethics committee approval was taken before enrolment of study participants and individual written informed consent was sought before data capture.

Inclusion criteria
The selection of cases as based on the following criteria:
- The last normal menstrual period (LNMP) of the pregnant woman was well known
- Pregnancy was single and viable
- The ability of the subject to come for follow-up at regular intervals
- Willing to participate in the study and was ready to give written informed consent

Exclusion criteria
Pregnancy complicated by medical disorders like HTN, anaemia and DM, etc were excluded from the study. The ultrasonic examination performed by using real-time ultrasonography machine, color Doppler (Toshiba SSH 140 A) employing a 3.5 MHz sector and 7.5 MHz linear transducer. The ultrasonographic examination comprised recording CRL in the 1st trimester and HC, AC and FL in the 3rd trimester of pregnancy and in the follow-up visits. The patients were instructed not to evacuate their bladder for at least 3 hrs prior to the examinations. If needed they were advised to drink 4 to 5 glasses of water, one to half hr prior to examination. Each examination was performed after the routine antenatal check up by the obstetrician prior to the scan. Patient was placed supine, area between the symphysis pubis and umbilicus was exposed and a coupling gel i.e. ultrasonic jelly was applied to the skin or transducer head.

After six and half weeks of gestational sac can still be measured, but now there is an alternative measurement, the CRL i.e. crown-rump- length [Figure 1]. The embryo is yet too small to have the individual parts measured, but length can be estimated. Longest CRL is most accurate, since no anatomic marker exists at the tip of the crown or the rump.

Biparietal Diameter (BPD)[8]
In making BPD measurements the fetal head should be imaged in a transverse axial section. The BPD was measured from the outer surface of the skull table nearest the transducer to the inner margin of the opposite skull table (outer to inner) [Figure 2].

Head Circumference (HC)
The measurement was made from the same axial image used to measure BPD. Reliable estimates of the head circumference can be calculated by using the shortest and longest axes of the fetal head measured outer to outer [Figure 4].

Abdominal Circumference [14]

Measurement of the fetal abdominal circumference was made from the transverse axial image of the fetal abdomen at the level of the liver [Figure 3].

Femur Length [11]

Because of size of the femur and ease of measurement, the FL is generally preferred over the other long bones as a measure of predicting menstrual age. The FL measurement was made with the transducer aligned along the long axis of bone [Figure

5]. The measured ends of the bone should be blunt than pointed. R-value or coefficient between USG parameters and gestational age were analyzed to determine the degree of association.

RESULTS

In the present study 200 healthy pregnant women between 19 to 33 years of any gravid coming for antenatal check up were selected who fulfilled inclusion and exclusion criteria for clinical and ultrasonic evaluation.

Table-1: Distribution of study participants according to age group

Age group in years	No. of Cases	Percentage
19-21	49	24.5
22-24	50	25
25-27	51	25.5
28-33	50	25
Total	200	100

Table 1 illustrates that equal number of the cases were found in all age groups in the present study.

Table 2 shows maximum number of cases i.e. 111 (55%) in primipara.

Table-2: Distribution of study participants according to parity

Parity/ Gravidity	No. of Cases	Percentage
Nullipara (P0)	38	19
Primipara (P1)	111	55
Multipara (≥P2)	51	25
Total	200	100

Table-3: Mean of CRL observed in the present study

Weeks of Gestation	Mean CRL in mm
5	8.22
6	9.24
7	10.96
8	13.58
9	16.36
10	29.50
11	41.00
12	53.00

Fig−1: Fetal Crown Rump Length estimation in study participant under real-time USG

Table−4: Specificity in the 1st trimester by CRL i.e. correctly diagnosed cases by USG by CRL in 1st trimester

No. of Cases	Known menstrual age in weeks	Percentage
75	5-8	85.33
115	9-12	99.13
10	13-19	80.00

Table−5: Mean of various parameters observed in the present study

Weeks of Gestation	Mean HC in mm	Mean AC in mm	Mean FL in mm
26	243	209	45
27	251	215	50
28	258	228	57
29	266	243	55
30	275	236	57
31	273	261	57
32	290	265	59
33	288	274	61
34	307	289	67
35	308	287	67
37	317	306	69
38	326	322	72
39	328	319	74
40	322	310	73
41	309	276	69

Table 5 shows the mean HC, mean AC, and mean FL of the present study in the third trimester from 26th to 41st week of gestation.

Figure‑2: Fetal Biparietal Diameter estimation in study participant under real-time USG

Fig‑3: Fetal Abdominal Circumference estimation in study participant under real-time USG

Table‑6: Specificity i.e. correctly diagnosed cases by USG parameter in the third trimester

Known menstrual age in weeks	Percentage of correctly diagnosed cases		
	HC	AC	FL
26-29	75	83.33	83.33
30-33	80	87.5	87.5
34-37	92.30	90.38	92.30
38-43	90.90	81.87	88.63

Fig‒4: Fetal head circumference estimation in study participant under real-time USG

Fig‒5: Fetal femur length estimation in study participant under real-time USG

DISCUSSION

The present study recorded the conventional ultrasonic parameters of the fetus in utero in 200 uncomplicated pregnancies. The maternal age ranged from 19 to 33 years. In the 1st and 3rd trimester of pregnancy of any number gravid. The study shows that maximum number of cases in primipara i.e. 111 cases (55%). This may be because that the awareness for the sonographic examination is more in primi to confirm the intrauterine pregnancy and to avoid birth complications and to detect fetal malformations.

The conventional parameters of the foetuses i.e. CRL in the 1st trimester and HC, AC and FL in the 3rd trimester of pregnancy of the same subject which comes for follow-up in the 3rd trimester. In the present study, the accuracy of the CRL between 9 to 12 weeks of known menstrual age was 99%. We believed that the optimal time for prediction of gestational age from CRL measurement was between 9 to 12 weeks using high resolution USG. The coefficient of CRL with gestational age in present study was found to be r=0.927. r values determines the degree of association between CRL and gestational age. Specificity is the accuracy of CRL in assessing gestational age. It is expressed in percentage.

Head circumference is an important measurement of neonatal head growth [8]. It is more shaped independent that the BPD. So the neonatal HC has gained importance as in-utero ultrasound measurement. Several authors had documented that HC is one of the most reliable individual parameter for estimation of gestational age due to its shaped independence. HC can be calculated by using the shortest and longest axes of the fetal head measured outer to the outer [16].

In the present study it was observed that 34 to 37 weeks in the 3rd trimester of pregnancy specificity

was found to be 92% as shown in Table 6. Mean HC in the present study in the 3rd trimester i.e. 26 to 41 weeks of gestation is shown in Table 5. The coefficient of HC with gestational age in the present study was found to be r=0.936.

The measurement of the fetal abdominal circumference was made from a transverse axial image of the fetal abdomen at the level of the umbilical portion of the left portal vein deep in the liver, with the fetal stomach representing a secondary landmark. Abdominal circumference was measured anteroposterior and transverse axial image from outer to outer [14]. In the present study the specificity of the AC value in the third trimester was found to be 90% accurate between 34 to 37 weeks of gestation as shown in Table 6. Mean AC of the present study in the 3rd trimester from 26 to 41 weeks of gestation is shown in Table 5. The coefficient of correlation of AC with gestational age in the present study was found to be r=0.903.

FL is easy to measure thus it is preferred over the outer long bones. It was measured along the long axis of the bone and measured ends of the bone should be blunt rather than pointed.[11] In the present study, the specificity of the FL value was found to be 92% in the 3rd trimester of pregnancy between 34 to 37 weeks of gestation as shown in Table 6. The co-efficient of correlation of FL with the gestational age in the present study was found to be r=0.953.

The correctly diagnosed cases i.e. specificity by real time ultrasound measurement of various parameters in the 1st trimester. The accuracy of CRL between 9 to 12 weeks of known menstrual age was 99%. While in the 3rd trimester, the accuracy of HC and FL from 34 to 37 weeks known menstrual age was 92%, while accuracy of AC from 34-37 weeks of known menstrual age was found to be 90% in the present study.

CONCLUSION

The present prospective observational study was conducted to check fetal growth parameters through ultrasonic examination among 200 uncomplicated pregnancies during the 1st and 3rd trimester of pregnancy. The coefficient of correlation between the CRL and gestational age (1st trimester) positive and r value was found to be 0.927. In the same way the coefficient of correlation of HC, AC, and FL with gestational age was obtained statistically in the 3rd trimester of pregnancy and were found to be: for HC it was r=0.936, for AC it was r=0.903 and for FL it was r=0.953. the coefficient of correlation or 'r' value is defined as 'it determines of association between the USG parameters and gestational age'.

The accuracy of CRL between 9 to 12 weeks of known menstrual age was 99%. While in the 3rd trimester, the accuracy of HC and FL from 34 to 37 weeks known menstrual age was 92%, while accuracy of AC from 34-37 weeks of known menstrual age was found to be 90% in the present study.

So, it was found that CRL in the 1st trimester and HC and FL in the 3rd trimester found to be accurate for assessment of gestational age. The AC was found to be relatively less accurate in the prediction of gestational age by using real-time USG in the 3rd trimester.

REFERENCES
1. Kalish RB, Chervenak FA. Sonographic determination of gestational age. Ultrasound Rev Obstet Gynecol 2005; 5:254–8.
2. BensonCB, Doubilet PM. Sonographic prediction of gestational age: accuracy of second and third trimester fetal measurements. AJR Am J Roentgenol. 1991 Dec; 157(6):1275-7.
3. Hughes R, Aitken E, Anderson J, Barry C, Benton M, Elliot J; National Institute for Health and Clinical Excellence. Antenatal care. Routine care for the healthy pregnant woman. NICE clinical guideline 62. London: RCOG Press; 2008.
4. Bottomley C, Bourne T. Dating and growth in the first trimester. Best Pract Res Clin Obstet Gynaecol 2009; 23:439–52.
5. Gardosi J. Dating of pregnancy: time to forget the last menstrual period. Ultrasound Obstet Gynecol 1997; 9:367–8.
6. Gardosi J, Geirsson RT. Routine ultrasound is the method of choice for dating pregnancy. Br J Obstet Gynaecol 1998; 105:933–6.
7. Salomon LJ, Alfirevic Z, Bilardo CM, Chalouhi GE, Ghi T, Kagan KO, Lau TK, Papageorghiou AT, Raine-Fenning NJ, Stirnemann J, Suresh S. ISUOG practice guidelines: performance of first-trimester fetal ultrasound scan. Ultrasound in obstetrics & gynecology: the official journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2013 Jan;41(1):102.
8. Adam AH, Robinson HP, Fleming JE, Hall AJ. A comparison of biparietal diameter measurements using a real time scanner and a conventional scanner equuiped with a coded cephalometry system. Br J Obstet Gynaecol. 1978 Jul; 85(7):487-91.
9. Osinusi BO, Hall AJ, Adam AH, Fleming JE. Reproducibility of biparietal diameter measurements obtained with a real-time scanner. Br J Obstet Gynaecol. 1980 Jun; 87(6):467-70.
10. Cooperberg PL, Chow T, Kite V, Austin S. Biparietal diameter: a comparison of real time and conventional B scan techniques. J Clin Ultrasound. 1976 Dec; 4(6):421-3.

11. Warda AH, Deter RL, Rossavik IK, Carpenter RJ, Hadlock FP. Fetal femur length: a critical reevaluation of the relationship to menstrual age. Obstet Gynecol. 1985 Jul; 66(1):69-75.
12. Selbing A. Gestational age and ultrasonic measurement of gestational sac, crown-rump length and biparietal diameter during first 15 weeks of pregnancy. Acta Obstet Gynecol Scand. 1982; 61(3):233-5.
13. Campbell S. The prediction of fetal maturity by ultrasonic measurement of the biparietal diameter. J Obstet Gynaecol Br Commonw. 1969 Jul; 76(7):603-9.
14. Weiner CP, Sabbagha RE, Tamura RK, DalCompo S. Sonographic abdominal circumference: dynamic versus static imaging. Am J Obstet Gynecol. 1981 Apr 15; 139(8):953-5.
15. O'Keeffe DF, Garite TJ, Elliott JP, Burns PE. The accuracy of estimated gestational age based on ultrasound measurement of biparietal diameter in preterm premature rupture of the membranes. Am J Obstet Gynecol. 1985 Feb 1; 151(3):309-12.
16. Hohler CW. Ultrasound estimation of gestational age. Clin Obstet Gynecol. 1984 Jun; 27(2):314-26.