



ESTIMATION OF GESTATIONAL AGE BY MEASURING THE FEMUR LENGTH: A SONOGRAPHY STUDY

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ABSTRACT

Introduction: Sonography is a useful tool for estimating gestational age in cases where the pregnancy cannot be dated accurately by clinical evaluation. The present work was undertaken with a view to study the relationship between the femur length and gestational age. Attempt has been made to estimate gestational age more reliably by taking measurement of foetal femur length. **Materials & Methods:** This study was conducted at T.N Medical College and B.Y.L.Nair Hospital for a period of two years. Patients referred for ultrasound examinations were studied. A real time ultrasound was performed on 215 pregnant women with history of regular menses and knew unequivocally the beginning day of the last menstrual period. The measurements of the biparietal diameter and femur length were made using electronic calipers. **Observation:** The results of present study are shown in tabulated form in table no. 1,2,3,4 & 5. **Conclusion:** Predictions of gestational age by sonography have been shown to be more accurate than predictions from the date of last menstrual period even if the women are certain of their dates. Estimation of gestational age is more reliable using femur length because variability is more in biparietal diameter in second and third trimester as compared to length of femur. Finally the femur length is a useful substitute when head measurements are unobtainable and can be confirmative when they are available.

KEYWORDS: Gestational age, Femur length, Sonography



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INTRODUCTION

Sonographic measurements of the foetus provide information about foetal age, estimate foetal weight and diagnose growth disturbances. Another use of foetal measurements is their contribution to the diagnosis of a number of foetal anomalies such as skeletal dysplasia and microcephaly. Gestational age, the term commonly used to date the pregnancy, is thus defined as conceptual age plus two weeks and is based on reliable LMP.(last menstrual period) Accurate knowledge of gestational age is important for a number of reasons. The timing for chorionic villous sampling in the first trimester, genetic amniocentesis in the second trimester and elective induction of caesarean delivery in the third trimester are all based on the gestational age. Clinical dating of a pregnancy is usually based on the patient's recollection of the first day of her last menstrual period and on physical examination of uterine size. Unfortunately, both these methods are subject to imprecision, leading to inaccuracies in gestational age assignment, dating by LMP may be inaccurate because of variability in length of menstrual cycle, faulty memory, or bleeding during early pregnancy. Determination of the uterus may be affected by the uterine fibroids and maternal body habits ¹.

The present work has been undertaken with a view to study the relation between the femur length and gestational age. In our country a large section of women do not accurately recall their L.M.P. In cases where the pregnancy cannot be dated accurately by clinical evaluation, sonography is a useful and accurate tool for estimating gestational age. This has urged a necessity for the use of sonography for estimating the gestational age. The foetal femur can be identified in utero using real time sonography by the 10th gestational week and normal values have been reported both as a function of gestational age and biparietal diameter ². Predictions of gestational age by USG have been shown .to be more accurate than

predictions from the LMP, even if the woman is certain of her dates ^{1 & 3}. In this study attempt has been made to estimate gestational age more reliably by taking measurement of foetal femur length. Gestational age is based on measurement of BPD were also recorded for comparison. These studies indicate that the variability in predicating gestational age from femur length is actually less than that of biparietal diameter.

MATERIALS & METHODS

This study was conducted in the Department of Ultrasound at the B.Y.L Nair Hospital. The study group consisted of 215 women who were referred to the ultrasound department for ultrasonography. Patients selected had a history of regular menses and knew unequivocally the beginning day of the last menstrual period. In case there was a doubt regarding LMP then only those patients were selected who at least one sonography had performed in the first trimester. In all cases the first trimester clinical findings were in agreement with the last menstrual period. Patients with maternal disease that adversely affect foetal growth (e.g.: diabetes mellitus) were not included. In keeping with proper design of a cross-sectional study, each foetus was measured only once in gestational age. All examinations were performed by radiologists using a commercially available linear array real-time ultrasound system with a TOSHIBA ECOCEE USG SYSTEM with a 3.75 MHz convex probe and 7.5 MHz linear probe. Measurements of the BPD and femur length were made using electronic calipers. A freeze-frame for electronic caliper measurement of the femur was made. BPD was measured in each case by standard landmarks. Caliper dots were placed on the outer and inner aspects of the proximal and distal parietal bone reflections respectively. To facilitate comparisons of the observed variability associated with determining menstrual age from femur length with previous studies the data were divided into two groups. Group 1 comprised

foetuses of 12-26 weeks and Group 2 comprised foetuses 27-40 weeks. Statistical analysis is done by using the test, Standard

Error of Difference between two means. The formula used is

$$Z = \frac{X_1 - X_2}{\text{Standard Error}}$$

Where Z is standard normal variate.

\bar{X}_1 is mean for Group 1

\bar{X}_2 is mean for Group 2

OBSERVATION AND RESULTS

The results of present study were shown in tabulated form in table no. 1,2,3,4 & 5.

TABLE NO.I
Showing various parameters in II trimester.

Variable	Mean	S.D	η	Z
Length of femur (In cm)	3.33	1.09	108	9.73
Biparietal diameter (In cm)	4.79	1.19	108	

$P < 0.001$: Variability is more in BPD in the II trimester as compared to the femur length and that variability is highly significant.

TABLE NO.II

Variable	Mean	S.D	η	Z
Average foetus By USG	143.77	24.93	108	1.35
Average foetus by LMP	13935	23.10	108	

$P > 0.05$: There is no significant difference in average foetus by USG and LMP.

TABLE NO III
Showing various parameters in III trimester.

Variable	Mean	S.D	η	Z
Length of femur (In cm)	5.81	0.62	106	19.22
Biparietal diameter (In cm)	7.54	0.67	106	

$P < 0.001$: Variability is more in BPD in the III trimester as compared to the femur length and that variability is highly significant

TABLE NO IV

Variable	Mean	S.D	π	Z
Average foetus by USG	214.53	22.59	106	1.36
Average foetus by LMP	210.53	20.3	106	

P > 0.05: There is no significant difference in average foetus by USG and LMP.

TABLE NO. V

Menstrual Age (weeks)	Filly etal ¹ 1981	Jaenty etal ² 1981+	Hadlock etal ³ 1982*	Hadlock etal ³ 1982+	This Study
12		09	14	08	
13		12	16	11	10
14	16	16	19	15	14
15	19	19	21	18	18
16	22	23	23	21	21
17	25	26	26	24	24
18	28	30	28	27	28
19	32	33	30	30	31
20	35	36	33	33	34
21	38	39	35	36	37
22	41	42	38	39	40
23	44	45	40	42	43
24	47	48	42	44	44
25	50	51	45	47	46
26	53	54	47	49	50
27	55	57	49	52	52
28	57	59	52	54	53
29	61	62	54	56	55
30	63	65	57	58	58
31		67	59	61	61
32		70	61	63	62
33		72	64	65	63
34		74	66	66	66
35		77	69	68	67
36		79	71	70	69
37		81	73	72	71
38		83	76	73	72
39		85	78	75	73
40		87	80	76	

Linear function+Linear quadratic function



DISCUSSION

The gestational age of a pregnancy can only be a reliable estimate if the date of conception is known. This is rarely known in spontaneous conceptions but is accurately known in assisted conception cycle. In most cases the gestational age is estimated by assuming that the date of conception occurs 2 weeks after the date of last period, but this only holds if the following conditions apply:

- The date of the last period is accurately known.
- The menstrual cycle is regular 28 days.
- There is no history of bleeding in early pregnancy.
- The woman has not been taking the oral contraceptive pill for 2mths prior to the last period. Unfortunately some 25% to 40% of patients will not have fulfilled the above criteria and therefore the length of pregnancy based upon the date of the last period is usually known as post-menstrual age⁴. If pregnancy is incorrectly assumed to be more advanced, a premature foetus may be inappropriately delivered because of wrong diagnosis of IUGR (intrauterine growth retardation). Conversely, a truly compromised IUGR foetus may be subjected to prolonged asphyxia in a hostile uterine environment because pregnancy is assumed to be early⁵.

Interestingly Dewhurst, Beazley and Campbell reported a four-fold increase in prenatal mortality when gestational age was unknown. Data from a number of clinical studies indicate that LMP may be uncertain in 20 to 40 % of gravidas. Furthermore, in approximately 15% of pregnancies, although the menstrual dates are reported with certainty, they still turn out to be inaccurate by as much as 3-4wks. These findings suggest that objective definition of gestational age is desirable not only in women with uncertain dates, but also in those who believe their LMP are accurate. Ultrasound has gained wide acceptance as the preferred method for assessment of gestational age because of its relative simplicity, safety, accuracy and applicability⁶. Several ultrasound parameters have been used estimate gestational age. The most commonly used are: gestational sac volume, crown rump length, biparietal diameter, femur length, head circumference and abdominal circumference⁷. Biparietal diameter in the most reliable method of estimating gestational age is between the 12th and 26th weeks. After that, its accuracy may be lessened by pathological disorder and biological variations that affect foetal growth. Biparietal diameter measurement must be considered together

with other ultrasound measurements such as femoral length & abdominal circumference to arrive at an accurate gestational age^{8 & 9}. O'Brien and co-workers first evaluated sonographic measurement of foetal limb bones as an indicator of menstrual age and subsequently several authors have evaluated the foetal femur length as a predictor of menstrual age. These studies have demonstrated that measurements of the foetal femur with ultrasound are very reproducible probably because of sharp bony margins^{4 & 10}. Measurement of long bone length is a relatively uncomplicated procedure especially with real-time equipment charts of femur length and gestational age. Such charts show a linear relationship of a fairly narrow standard deviation comparable to the BPD. Measurement of femur length is of particular value where there is a problem in visualizing the foetal head or in other cranial anomalies, such as anencephaly, hydrocephalus or iniencephaly^{8, 11, 12 & 13}. The femur can be measured from 12 weeks gestational age to term. Estimation of gestational age on the basis of femur length is as accurate as the BPD. As the examination of intracranial anatomy is an important part of all ultrasound examinations; measurement of the femur should not replace that of the BPD as the sole predictor of gestational age, but should provide additional confidence¹⁴. The estimation of gestational age obtained from measurements of femur length should agree with that obtained from the measurement of the BPD. If the gestational age based on femur length is small compared to that based on the BPD, then all the long bones should be carefully measured to exclude dwarfism.

CONCLUSION

The foetal femur length can be identified in-utero using real time sonography by the 10th gestational week and values reported as a function of gestational age and biparietal diameter. Predictions of gestational age by sonography have been shown to be more accurate than predictions from LMP even if the woman is certain of her dates. Recent studies have confirmed that estimation of gestational age is more reliable using femur length. The

Sonographic measurement of the foetal biparietal diameter (BPD) can provide a good estimate of foetal age in the first half of pregnancy (2SD±7-10 days) but there is a progressive increase in the variability as pregnancy progresses, with a maximum variability of approximately ±3.6 weeks in the last six weeks of pregnancy. For this reason, efforts have been made to predict foetal age from the other foetal growth parameters such as the head circumference (HC), abdominal circumference (AC) and femur length (FL). However, variability patterns in predicting age from these parameters used individually are similar to those obtained when BPD is used alone². Previous authors have demonstrated statistically significant improvement in estimation of foetal age in the third trimester of pregnancy when two or more types of these measurements are used in combination, resulting in reduction in the variability of approximately 25-30% as well as a reduction in the maximum errors that are observed when an individual parameter such as the BPD is used alone^{2 & 15}. In the setting of a routine ultrasound clinic, it is recommended that the minimum measurements used to establish gestational age are those of BPD and femur length^{4 & 16}. Hadlock, have examined the use of BPD, head circumference, abdominal circumference and femur length and demonstrated that prior to 18 weeks post menstrual age the use of multiple variables does not improve the prediction of gestational age obtained by use of the BPD alone. In later pregnancy however, multiple variables do reduce the uncertainty of the prediction, especially when measurements are made for the first time in the third trimester².

predicted femur length at various points in gestation agreed relatively well with values reported by other researchers and this study, as shown in table noV. We felt that the foetal femur length would prove to be an accurate indicator of foetal age. This was confirmed since statistical analysis proved that variability is more in BPD in the II and III trimester as compared to length of femur and that is highly significant ($P < 0.001$). In view of linear

relationship between femur and BPD growth, it is to be expected that femur length could be used as an alternative to BPD measurement for gestational age assessment in normal pregnancies after 22 weeks. Hence it can be concluded that femur length is a useful substitute when head measurements are unobtainable and it can be confirmative when they are available. However, because of the potentially serious consequences of a false

positive diagnosis, the sonographer should develop expertise in making these measurements before using any data. As the examination of intracranial anatomy is an important part of all ultrasound examinations, measurements of femur length should not replace that of the BPD as the sole predictor of gestational age, but should provide additional confidence.

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