

Original research article**Evaluation of fetal growth based on biparietal diameter and femur length using ultrasonography**

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Abstract

The prenatal assessment is essential during pregnancy for the determination of growth and development of fetus. Ultrasonography has been an accessible screening procedure to monitor prenatal growth using fetal parameters and gestational age. Femur length (FL) and biparietal diameter (BPD) are commonly used in the second trimester to assess the growth of the fetus and to determine an accurate gestational age (GA). As per studies, variations were noted in the reliability of FL and BPD in estimating the GA and fetal growth using ultrasonography. Hence, the present study was conducted to understand the growth patterns of both femur length and biparietal diameter from second trimester using ultrasonography and also to compare their relative accuracy in assessing the fetal growth.

The study involved local antenatal mothers with no medical and obstetric complications and the ultrasonography was performed using ESAOTE-MY LAB 60 Machine equipped with 3.5 MHZ curvilinear transducer. Statistical Package for Social Sciences (SPSS) software was used to analyze the collected data. Mean and standard deviations for the two parameters were estimated from the derived measurements and the linear regression analysis was performed to understand the accuracy of FL and BPD in estimating GA from second trimester. The results had revealed the mean and standard deviation of femur length and biparietal diameter as 51.39 ± 19.17 and 66.66 ± 20.91 respectively with a strong correlation coefficient of 0.986 and significant P values (<0.001). Based on these findings, we may affirm that the fetal femur length could be a reliable parameter in assessing fetal growth than BPD regardless of growth rate in the last week of 3rd trimester. Therefore, fetal femur length would be a preferable parameter to assess fetal growth which not only enables the detection of fetal maturity but also aid to minimize preterm deliveries.

Keywords: Gestational age, femur length, biparietal diameter, ultrasonography

Introduction

Ultrasonography is a preliminary and routine investigation carried out during early pregnancy for the estimation of fetal growth, gestational age and associated anomalies ^[1]. Clinically, parameters like gestational sac mean diameter and Crown- rump length are commonly used in the first trimester at different weeks to determine the gestational age of the fetus ^[2]. In the subsequent trimesters, due to the continuous growth of the fetal head and FL at a specific rate throughout gestation, ultrasonographic assessment of FL and BPD became highly accessible for the estimation of gestational age and fetal growth ^[3,4,5].

However, fetal age estimated in the last weeks of pregnancy invalidate the age of fetus due to different ranges of the BPD values and distortion of cranial shape due to fetal position ^[6,7]. Hence, early second trimester scanning is necessary to know the gestational age and rate of fetal growth. Even so, BPD measurement remained as a challenging factor due to diverse anomalies like microcephaly, anencephaly, deformed cranial shape and deeply engaged fetal head. Hence, due to apparent femur visibility during ultrasonographic imaging at early weeks of second trimester, estimation of fetal femur length gained importance to assess gestational age and fetal growth. This eventually would aid to interpret conditions like dwarfism and congenital limb anomalies of fetus ^[8, 9, 10].

As per documented studies, both femur length and biparietal diameter were used to assess gestational age and fetal growth ^[11, 12]. Hence, the present study was aimed to understand growth patterns of femur length and biparietal diameter using sonography which may not only helps to assess an accurate

gestational age but also aid to determine an exact date of delivery by estimating fetal growth. Thus, it eventually helps health care provider to guide with a suitable prenatal care and management.

Materials and Methods

The study involves ultrasonograms collected from local pregnant women who were scanned using ultrasonography as a part of their routine antenatal checkups at Radiology Department of S.V.R.R.G.G. Hospital and few other radio-diagnostic centers in and around Tirupati, Andhra Pradesh, India. The study was initiated after obtaining Ethical committee approval and consent of the antenatal mother participants.

Inclusion and exclusion criteria

The antenatal mothers included in the study were clinically well aware of the date of last menstrual period and reported with regular menstrual cycles, absence of alcohol and oral contraception intake with no other medical and pregnancy associated complications. A total of 521 scans were performed on 472 antenatal mothers, where 17 sonograms were excluded from the study due to fetal anomalies like polydactyly, Intra Uterine Deaths (IUD) and asymmetrical intrauterine growth retardation (IUGR). In the present study, the number of scans exceeds the number of patients indicating that some patients were scanned more than once in their antenatal period. The consecutive scans of these antenatal mothers were utilized to observe the growth rate of femur length (FL) and biparietal diameter (BPD) of fetuses from second trimester.

Femur length and biparietal diameter were measured using ESAOTE-MY LAB 60 Machine equipped with 3.5 MHZ curvilinear transducer. To measure biparietal diameter, initially the position of fetal head should be determined and then it was measured at the widest part of fetal head with electronic calipers by applying freeze-frame. The biparietal diameter measurements were obtained in the trans-axial plane at the level of thalamus, with septum pellucidum anteriorly^[1] (Fig.1). The measurements were taken from the outer margin of skull to the inner margin of skull and it was considered as the best method to assess BPD as measuring BPD from outer table to outer table of skull was noted to have limited value in clinical practice^[13].

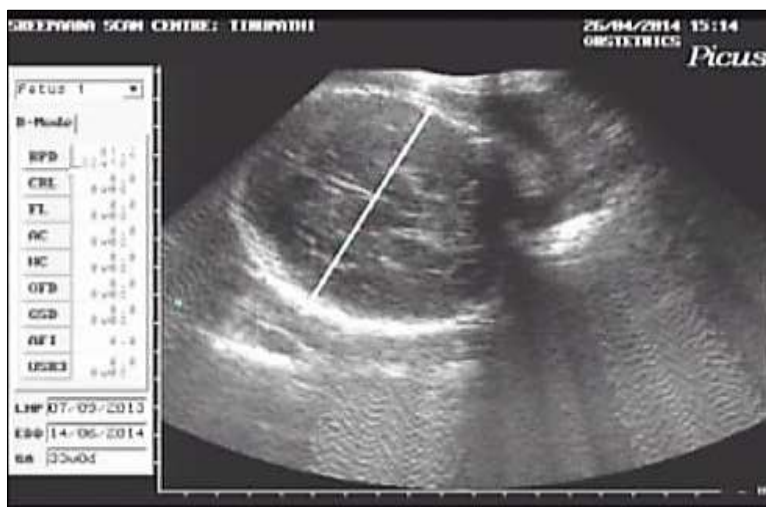


Fig 1: Measurement of biparietal diameter from outer to inner table of skull

Fetal femur length was measured with multidirectional electronic calipers along its long axis from one end to the other end excluding femoral neck and epiphyseal cartilages of both ends using Mahoney and Hobbins technique as shown in Figure 2. The largest measurement of FL was recorded for the study as suggested^[14].



Fig 2: Measurement of osseous portion of femur length with electronic calipers

The data of the current study was analyzed and calculated mean and standard deviation values for femur length and biparietal diameter using Statistical Package for Social Sciences (SPSS). Further linear regression was also performed to determine their correlation coefficient.

Results

The data was statistically analyzed and the calculated mean and standard deviation of fetal femur length (FL) and biparietal diameter (BPD) from second trimester of gestation were shown in the Table 1. From the given tabular values, the standard deviation of femur length is comparatively less than biparietal diameter indicating, fetal femur length is more precise than biparietal diameter in estimating the gestational age and this was further substantiated by its correlation coefficient value 0.986 with significant P values (<0.001) as given in the Table 1.

Table 1: Mean, Standard deviation and Pearson’s Correlation for FL and BPD

S. No.	Variable (mm) (N=521)	Mean	Standard Deviation (SD)	Correlation Coefficient (r)	P value
1.	FL	51.39	19.17	0.986	<0.001
2.	BPD	66.66	20.91		

Where N = Number of ultrasonograms, FL = Femur length and BPD = Biparietal Diameter.

The means of femur length and biparietal diameter were calculated based on ultrasonography measurements at an interval of two weeks from 12 to 40 weeks as shown in the Table 2. From these results, the mean of FL and BPD were found to be gradually increasing with the progress of gestation. This clearly suggest that FL and BPD were found to be proportional to gestational age, and this was quiet evidenced through a linear relation in the graph plotted for these parameters against gestational age (USG) as shown in figure 3.

Table 2: Mean of FL and BPD in two week interval from 2nd trimester

GA by LMP (weeks)	GA by USG (weeks)	N	FL (mm)	BPD (mm)
12-13.9	14.1	22	12.6	25.3
14-15.9	15.3	18	16.7	30.0
16-17.9	17.9	34	26.2	38.7
18-19.9	19.3	48	30.6	43.3
20-21.9	21.7	31	38.1	51.3
22-23.9	23.2	36	42.1	56.0
24-25.9	25.7	22	47.2	63.5
26-27.9	27.8	48	53.0	68.7
28-29.9	29.8	27	57.1	74.0
30-31.9	31.2	25	60.6	76.7
32-33.9	33.7	25	65.6	83.0
34-35.9	35.0	77	69.8	86.5
36-37.9	37.4	65	72.0	89.0
38-39.9	39.0	26	73.6	90.0

Where GA = Gestational age, USG = Ultrasonography, N = Number of ultrasonograms, FL = Femur length, BPD

= Biparietal diameter and LMP = Last Menstrual Period.

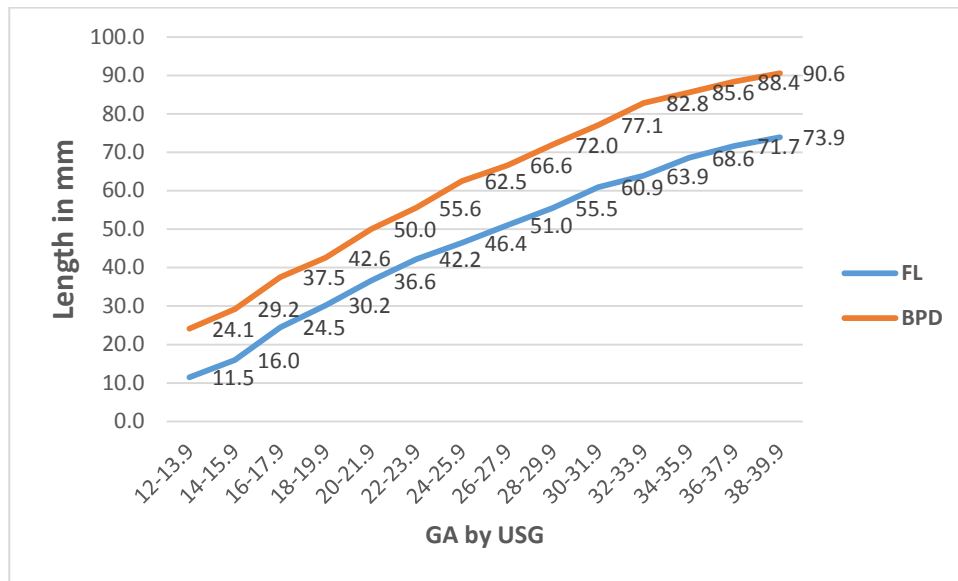


Fig 3: Correlation graph between FL and BPD with GA

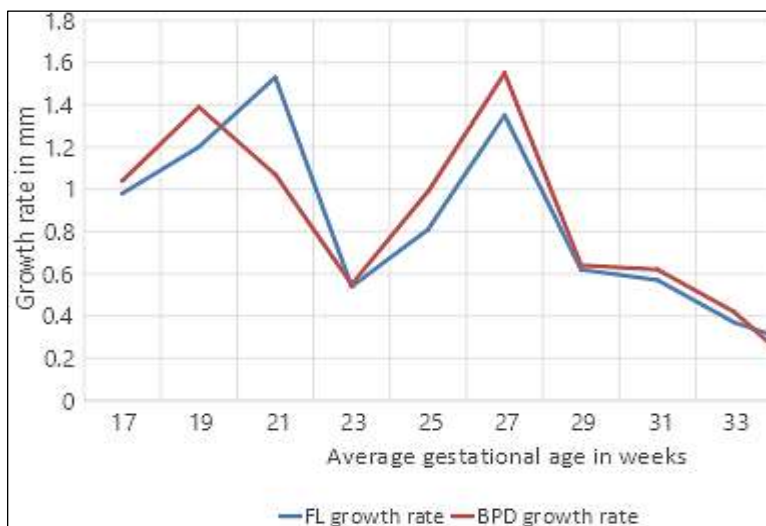
During 2nd trimester the difference in the mean of femur length was found to be 4 to 10 mm whereas BPD ranging from 5 to 8 mm at 2 week intervals. Similarly, in 3rd trimester, femur length and BPD mean difference were noted as 1 to 6 mm and 1 to 7 mm respectively. This indicates that the growth of the femur length and biparietal diameter were found to be more in 2nd trimester, less in the 3rd trimester and least in the last week of gestation comparatively. This gives a hint that femur length and BPD growth in the last week of gestation was less compared to early weeks of 2nd trimester as shown in Table 2. An increase in the biparietal diameter and femur length was exhibited with gestational age, with a variation of 2 days to one week during 2nd trimester till 24th week. However, a variation of one to nine days was noticed after 24th week which specifies a slow growth of FL and BPD during last weeks of pregnancy (Table 2).

Further to understand the growth rate of femur length and biparietal diameter from second trimester, serial measurements of these parameters were recorded and their means were given in Table 3. Using these means, a graph was plotted to observe the growth pattern from second trimester (Fig. 4). As evidenced in the graph, the growth of femur length reached maximum at 21 and 27 weeks, whereas the maximum growth of BPD was noted at 19 and 27 weeks which subsequently reduced after 27th week confirming decreased growth rate in the last weeks of gestation (Fig. 4).

Table 3: Growth rate of FL and BPD using sonography

GA (weeks)	FL growth rate (mm)	BPD growth rate (mm)
17	0.98	1.04
19	1.2	1.39
21	1.53	1.07
23	0.54	0.55
25	0.81	0.99
27	1.35	1.55
29	0.62	0.64
31	0.57	0.62
33	0.37	0.42

GA = Gestational age, FL = Femur length, BPD = Biparietal diameter

**Fig 4:** Line graph showing growth rate of BPD and FL

Discussion

To assess fetal growth, serial measurements of fetal parameters at regular intervals were recommended. As per earlier studies, growth rate of the fetus was calculated from two successive measurement differences divided by intervening time interval^[15, 16]. Hence in this study, 41 antenatal mothers were consecutively scanned during their routine checkups and observed the growth rate of fetus using femur length and BPD. According to the studies, FL and BPD had shown a gradual increase in growth with progression of gestational age^[17]. Similarly, in the present study also, it had exhibited a gradual increase in femur length and biparietal diameter till term from second trimester which was potentiated through positive growth correlation between USG estimated gestational age and measured parameters.

As per earlier studies, fetal parameters like BPD, HC and FL were conventionally employed during early prenatal period to assess an accurate fetal growth till 34 weeks, with reduced accuracy after 34 weeks^[18, 19, 20]. In the present study also the analysis of data indicates that growth rate is less in the last weeks though the growth of fetus is known to increase progressively throughout the gestation, substantiating the earlier reports.

According to the available literature, femur length is superior in estimating the accuracy of gestational age than biparietal diameter^[3, 6, 15]. The results of the present study also affirm that femur length is precise and reliable parameter in estimating gestational age and growth of fetus based on its low standard deviation compared with BPD values. Further, combination of multiple parameters like crown rump length (CRL), femur length (FL), head circumference (HC) and abdominal circumference (AC), with appropriate selection of landmarks along with excluding congenital skeletal abnormalities would certainly able to improve the accuracy of fetal growth and gestational age estimation.

Conclusion

The findings of the present study have evidenced increasing femur length and biparietal diameter measurements throughout gestation. Further, the femur length was also suggested to be more precise than biparietal diameter in estimating gestational age. In addition, excluding skeletal anomalies, the ultrasonographic estimation of femur length and biparietal diameter regularly at weekly intervals may aid to assess accurate growth rate. Thus, the regular estimations of both FL and BPD would not only help to diagnose congenital anomalies of fetus but also assist to interpret an exact gestational age providing effective prenatal interventions.

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