

## ESTIMATION OF GESTATIONAL AGE BY REAL TIME ULTRASONOGRAPHY (BIPARIETAL DIAMETER AND FEMUR LENGTH) TO ESTIMATE THE FOETAL MORPHOMETRY IN II AND III TRIMESTERS

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### ABSTRACT

#### BACKGROUND

The growth of the human fetus is a complex process resulting in an increase in size over time and has been the subject of extensive study. Before the advent of ultrasound evaluation, physicians interested in the growth process of the fetus could only look at the infant at delivery and infer as to what happened in utero. Based on these observations, clinicians were able to categorize fetuses in very general terms on the basis of their age and size. In the second and third trimester of pregnancy the fetus has grown sufficiently in size, so that extreme anatomic details are visualized by ultrasonography. There are a number of structures that can be identified and measured during this time, but the basic foetal measurement we have used to estimate age with ultrasound are- biparietal diameter (BPD) and femur length (FL).

#### MATERIALS AND METHODS

This study was performed in the Department of Anatomy in close association with the Department of Radiodiagnosis, Pt. J.N.M. Medical College, Raipur, Dr. B.R. Ambedkar Memorial Hospital, Raipur (C.G.). The ultrasonographic examination comprised of recording of, Biparietal Diameter (BPD) and Femur Length (FL). The foetal growth parameters i.e. BPD and femur length FL of every patient were measured serially using real time ultrasonographic examination.

#### RESULTS

The means of all measurement were tabulated and were compared individually with western normograms.

#### CONCLUSION

The accuracy of the individual parameter for different weeks of gestation was noted. This accuracy indicated that, the correctly diagnosed gestational age by sonographic parameters are not equally homologous with known menstrual age. The specificity and sensitivity of BPD and FL was found to be more appropriate in predicting gestational age in second trimester and its reliability decreases in third trimester.

#### KEYWORDS

Biparietal Diameter (BPD) and femur Length (FL); Ultrasonography (USG).

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#### BACKGROUND

The growth of the human fetus is a complex process resulting in an increase in size over time, has been the

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subject of extensive study. Before the advent of ultrasound evaluation, physician interested in the growth process of the fetus could only look at the infant at delivery and infer what had happened in utero. Based on these observations, clinicians were able to categorize fetuses in very general terms on the basis of their age and size. Gestation is the period between conception and birth of a baby, during which the fetus grows and develops inside the mother's uterus. Gestational age is the time measured from the first day of the woman's last menstrual cycle to the current date and is measured in weeks. A pregnancy of normal gestation is approximately 40 weeks, with a normal range of 38 to 42 weeks. Strictly speaking, gestational age of the fetus or

infant is a measurement of time in utero (inside of the uterus). Gestational age can be determined prior to birth or at birth. Determination of gestational age and effective foetal weight are an important factor in planning appropriate care for the fetus or infant. It provides important information regarding expected or potential problems and directly affects the medical treatment plan for the baby prior to birth, intrauterine foetal growth can be determined using ultrasound. Our understanding of normal foetal anatomy as seen on sonograms continue to be an area of considerable growth. The ability of sonography to detect intrafoetal structures depends on a balance between spatial resolution and contrast. High resolution, real time scanners with flexible approach to imaging are mandatory.

Foetal sonography, foetal parts of interest fall into three major categories:

1. Structure that generate high-amplitude reflections e.g.: ossified bones.
2. Structure that generate no internal echoes, e.g.: fluid containing viscera.
3. Those that generate mid – range grey echoes e.g.

Parenchymal organs lungs, brain, spleen, liver, kidney and muscles. Real time ultrasonography provides the most appropriate format for imaging foetal bones the resolution and flexibility offered by such systems enables one to rapidly survey the foetal skeleton structures within the fetus, the ossified portion of the skeleton possess the highest level of subject contrast and thus are seen earlier and more consistently than any other organ system. In the second and third trimester of pregnancy the fetus has grown sufficiently in size so that extreme anatomic details is visualized by ultrasonography. There are number of structures that can be identified and measured during this time, but the basic foetal measurement we have used to estimate age with ultrasound are; Biparietal diameter (BPD), Femur length (FL)

## MATERIALS AND METHODS

This study was performed in Department of Anatomy in close association with the Department of Radio diagnosis, Pt. J.N.M. Medical College & Dr. B. R. Ambedkar Memorial Hospital, Raipur (C.G.) from Jan 2013- October 2015. With clearance from Institutional ethics Committee.

### Materials

1. Ultrasonography (USG) machine (Philips USG Machine)
2. Transducers (3.5 MHz convex transducer).
3. Ultrasonic jelly.
4. A comfortable bed for the patient.
5. Bed sheets to maintain dignity of the patient.
6. Well trained staff- nurse for USG Procedures.

This study consists of 200 pregnant females, between 20 weeks to 36 weeks' gestation with their age ranging from 17-35 years. After obtaining consent from them.

### Inclusion Criteria

1. The patients attending the A.N.C. in the department of Radiology Pt. J.N.M. Medical College & Dr. BRAM Hospital Raipur C.G. were taken as subject.
2. A history of regular menses prior to LMP.
3. The last menstrual period (LMP) of the patient were well known or with previous sonography report (prior to 20 weeks).
4. Pregnancy was single and viable.

### Exclusion Criteria

1. Pregnancy complicated by medical disorder such as anaemia, Diabetes mellitus, etc., in mother and
2. Congenital disorders of fetus will be excluded from the study.
3. Twin pregnancy excluded.

## RESULTS

The record and detailed history of the patient was obtained from the department of Obstetrics and Gynaecology, Pt. J.N.M. Medical College and Dr. B. R. Ambedkar Memorial Hospital, Raipur (C.G.). Maternal investigations like Hb, TLC, Sickling, VDRL, Blood sugar, Blood grouping, Rh Typing, and urine for routine and microscopic examination. The ultrasonographic examination comprised of recording of, Biparietal Diameter (BPD), Femur Length.

### Technique of Scanning

All examinations were performed by using a Grayscale real time machine (Philips USG Machine) employing a 3.5 MHz convex transducer. Each examination was performed after the routine antenatal check-up by the obstetrician prior to the scan. The patients were explained the procedure and its purposes, prior to scanning. Patient is placed supine and the area between the pubic symphysis and umbilicus is exposed, the ultrasonic jelly is applied to the skin and transducer's head. The jelly serves to make better contact between the skin surface and the transducer, making the passage of ultrasonic wave easier. The anatomical plane chosen for measurement of various foetal parameters was obtained by placing the transducer over abdomen in the middle sagittal section. The foetal head was then looked for the lie of the fetus then placing the transducer over para sagittal plane to define other foetal parts.

After asserting the position of the foetal head, serial scans were made in the plane transducer to the foetal head. The BPD was measured in the scan which shows the widest diameter at the level showing a midline falx echo, two lateral ventricles and the thalami. The reference point for foetal BPD was the outer margin of the proximal skull interface to the inner margin of the distal skull interface.

For the measurement of femur length, the transducer was placed at right angle to the foetal spine and passed down the fetus, maintain this angle to the caudal end because the distal femur was visualized. After a clear image of the femur was obtained, the freeze frame was employed and with multidirectional electronic callipers the femur length was measured.

**Observations**

Sl. No.	Age Group in yr.	No. of Cases	Percentage
1	18-20	33	16.5
2	21-23	81	40.5
3	24-26	61	30.5
4	27-29	13	6.5
5	30-32	9	4.5
6	33-35	1	0.5
7	>35	2	1
	Total	200	100
	Mean ±SD	23.53±3.20	

**Table 1. Distribution of Cases According to Age Groups**

Table No. 1 showed the maximum no. of cases found between the age group of 21-23 years i.e. 81 cases. Minimum no. of cases found in the age group of 33-35 years is only 1 case.

Sl. No.	Pregnancy No.	No. of Cases	Percentage
1	1	97	48.5
2	2	87	43.5
3	3	16	8
4	4	0	0
	Total	200	100

**Table 2. Distribution of Cases According to Age Parity**

Table 2 showed maximum no. of cases i.e. 97 cases in primipara and minimum no. of case i.e. 0 case was found in 4<sup>th</sup> parity. By this we can say that the awareness of Ultrasonography examination is more in primipara.

Sl. No.	Weeks of Gestation	BPD in mm	FL in mm
1	20	46.54	32.67
2	21	51.36	35.36
3	22	54.53	38.42
4	23	56.23	41.75
5	24	60.85	43.10
6	25	65.43	44.60
7	26	64.81	49.92
8	27	68.25	50.58
9	28	72.41	53.17
10	29	73.39	51.24
11	30	73.64	56.93
12	31	80.12	58.79
13	32	79.55	61.83
14	33	81.55	63.14
15	34	82.00	65.40
16	35	87.70	67.86
17	36	89.82	69.56
	Mean	69.93	52.06
	SD	12.75	11.37

**Table 3. Mean of Various Parameters Observed in Present Study**

The study includes the sonographic recording of BPD, and FL. The mean of present study is tabulated in Table 3.

Sl. No.	Gestational Age in Weeks	Standard BPD chart by (Wexler S, et al, 1986) <sup>1</sup>	Mean BPD in Present Study	R	P
1	20	46	46.54	0.9763	0.0094
2	21	49	51.36		
3	22	53	54.53		
4	23	55	56.23		
5	24	59	60.85	0.9674	0.012
6	25	63	65.43		
7	26	64	64.81		
8	27	66	68.25		
9	28	72	72.41	0.9653	0.0077
10	29	73	73.39		
11	30	74	73.64		
12	31	78	80.12		
13	32	81	79.55	0.9866	0.114
14	33	82	81.55		
15	34	84	82.00		
16	35	86	87.70		
17	36	88	89.82		
	Mean	69	69.93		
	SD	13.39	12.75		

**Table 4. Comparison of BPD Measurement with Western Nomogram**

Table No 4. Shows the comparison of present study values of BPD measurement with Western Nomogram (chart formulated by Wexler S. et al 1986),<sup>1</sup> it was found that in values of present study there is maximum difference of ± 2.4 mm in 2<sup>nd</sup> and ±2 mm in 3<sup>rd</sup> trimester.

Sl. No.	Gestational Age in Weeks	Western Nomogram (Jeanty P, Coussaert E et al 1984)	Mean FL in Present Study	R	P
1	20	31	32.67	0.9644	0.0072
2	21	34	35.36		
3	22	36	38.42		
4	23	39	41.75		
5	24	42	43.10	0.9244	0.0021
6	25	44	44.60		
7	26	47	49.92		
8	27	49	50.58		
9	28	52	53.17	0.9848	0.0022
10	29	54	51.24		
11	30	56	56.93		
12	31	59	58.79		
13	32	61	61.83	0.9843	0.11
14	33	63	63.14		
15	34	65	65.40		
16	35	67	67.86		
17	36	68	69.56		
	Mean	51	52.06		
	SD	11.96	11.37		

**Table 5. Comparison of FL Measurement with Western Nomogram**

Table No. 5 showed the comparison of present study values of FL measurement with Western Nomogram, we noted the maximum difference of  $\pm 2.9$  mm in 2<sup>nd</sup> and  $\pm 2.7$  mm in 3<sup>rd</sup> trimester. (The maximum difference of  $\pm 2.9$  mm was found in 26 weeks.)

**DISCUSSION**

In present study we have recorded the conventional ultrasonic parameters of the fetus for assessment and correlation of gestational age. In previous studies the accuracy of prediction of gestational age in the 2<sup>nd</sup> and 3<sup>rd</sup> trimesters have, in general, relied on gold standard, and based on last normal menstrual period in women with regular cycle lengths. To assess the accuracy of method for determination of gestational age, we examined total of 200 pregnant females between 18 -40 years of age, with the gestational age of 20 weeks to 36 weeks. The parity included in the study is from 1st - 4th number of pregnancies. The maximum number of cases out of total 200 normal pregnant female were found in the maternal ages between 21 – 23 years i.e. 81 cases, and minimum in case of age group of 33 – 35 years i.e. 1 case. In our study 97 cases belongs to primipara i.e. maximum number of cases out of 200 cases, and minimum number of cases i.e. 16 cases found in 3<sup>rd</sup> parity and no case found in 4th parity. This study shows the maximum number of cases in primipara because of the fact that, the awareness for the sonographic examination is more in primipara to confirm the intrauterine pregnancy, secondly to avoid birth complications and to detect foetal malformations. Various conventional parameters of the fetuses i.e. Biparietal diameter, Femur length, was studied sonographically to assess the gestational age by real-time sonography. Mean of every parameter was recorded weekly, i.e. from 20th weeks of gestation to 36th weeks of gestation. Equal numbers of cases were not available for every week. Second trimester the variability is found to be  $\pm 14$  days.

**Biparietal Diameter (BPD)**

It is seen that as the pregnancy advance the variability also increases. In last trimester it reaches up to  $\pm 3$  weeks. The mean BPD of the present study was compared by the standard BPD chart formulated by Wexlers S. et al (1986)<sup>1</sup> in table No. 4. The coefficient correlation(r) of BPD with gestational age in present study in 20–23 weeks was found to be (r =0.9763) and P value was (p = 0.0094), in 32-36 weeks (r= 0.9866) and (p=0.114). That means with advancing gestational age significance of assessment of gestational age decreases. In early second trimester it is highly significant and in 3<sup>rd</sup> trimester it is highly insignificant. (If p value is less than  $<0.05$  that means it is significant). The BPD, and FL shows a linear relationship with gestational age in sensitivity parameters, indicated that these parameters are reliable predictor of gestational age. BPD (Biparietal Diameter) in present study the mean BPD in each week of gestation from 20-36 weeks shown in Table no. 3. The BPD is measured from the outer surface of skull table of one side, to the inner margin of the skull table on opposite side (outer to inner). In the present study the accuracy of the mean BPD in 20-36 weeks of known menstrual age is 69.93% with the variability of  $\pm 12$  days. Mongelli M et al (2003)<sup>2</sup> they compared the accuracy of ultrasound dating formulae in late second trimester of pregnancy results were marginally less accurate than the early second trimester. Similar results have been reported by Person P et al<sup>3</sup> in a large series of patients whose dates were confirmed by CRL in the first trimester of pregnancy.

The mean BPD value of present study between 20 to 36 weeks of pregnancy was compared with the chart formulated by Wexler S et al (1986)<sup>1</sup> the discrepancy of 3 mm was found, which may be due to the variability of the lifestyle and the environment. The accuracy of the BPD value from known menstrual age ranging between 20-23 weeks was 62% and the accuracy of BPD value in 24-27 weeks of pregnancy was found 44% the variability estimate is  $\pm 7$  days. In 28-31 weeks of pregnancy the accuracy of BPD values was found 28%. The variability estimate is  $\pm 14$  days. In 32-36 weeks of pregnancy the accuracy of BPD value is found to be 26% with variability estimate of  $\pm 3$  weeks. In the present study it was found that in early second trimester the accuracy of BPD value is most reliable with variability of  $\pm 7$  days. In later half of the second trimester the variability is found to be  $\pm 14$  days. It is seen that as the pregnancy advance the variability also increases. In last trimester it reaches up to  $\pm 3$  weeks. The mean BPD of the present study was compared by the standard BPD chart formulated by Wexler's S. et al (1986)<sup>1</sup> in table No. 4. The coefficient correlation (r) of BPD with gestational age in present study in 20-23 weeks was found to be ( $r = 0.9763$ ) and P value was ( $p = 0.0094$ ), in 32-36 weeks ( $r = 0.9866$ ) and ( $p = 0.114$ ). That means with advancing gestational age significance of assessment of gestational age decreases. In early second trimester it is highly significant and in 3rd trimester it is highly insignificant. (If p value is less than  $< 0.05$  that means it is significant). The BPD, and FL shows a linear relationship with gestational age in sensitivity parameters, indicated that these parameters are reliable predictor of gestational age. The BPD, HC and FL shows a linear relationship with gestational age in sensitivity parameters, indicated that these parameters are reliable predictor of gestational age.

### FL (Femur Length)

Femur length is easy to measure, and it is preferred over other long bones. It is measured along the long axis of the bone, and the measured ends of the bone should be blunt rather than pointed.

In the present study, the accuracy of Femur Length value from known menstrual age ranging 20 – 23 weeks was found 61% and coefficient correlation (r) is found to be ( $r = 0.9644$ ) and p value is ( $p = 0.0072$ ). From 24-27 weeks accuracy was 49% and (r) is ( $r = 0.9244$ ) and ( $p = 0.0021$ ) from 28-31 weeks accuracy was again 46%, from 32 -36 weeks accuracy was 22%, and ( $r = 0.9843$ ) and ( $p = 0.11$ ). This study shows accuracy of the correctly diagnosed cases and P value decreases as pregnancy advance.

In present study the mean Femur Length in each week of gestation was compared with the western nomogram (Jeanty P et al 1984)<sup>4</sup> in table No. 5. The maximum difference of 2 mm was found in both the 2<sup>nd</sup> and 3 mm was in the 3<sup>rd</sup> trimester.

O'Brien G. D et al<sup>5</sup> in 1981 proposed a new method for the prediction of gestational age in early 2<sup>nd</sup> trimester by ultrasound measurement of femur length.

Hadlock F. P et al<sup>6</sup> 1982 studied the relationship between FL and menstrual age by using cross-sectional analysis of 338 normal fetuses between 12 to 40 weeks. The prediction of menstrual age from FL showed variability of  $\pm 9.5$  days between 12 to 23 weeks. Beyond 23 weeks variability increased up to  $\pm 22$  days.

Yeh M.N et al<sup>7</sup> in 1982 studied 145 uncomplicated gravid patients with 16-42 weeks of gestation. The result of analysis showed the variability in estimation of gestational age by FL, between 25-35 weeks of gestation was less than 5 days. Beyond 35 weeks measurement of femur length is less précised with more variability. The correlation coefficient of gestational age versus foetal FL is statistically greater than that of the gestation age versus foetal biparietal diameter.

In our study the results are similar with above mentioned studies, where accuracy of the correctly diagnosed cases and P value decreases as pregnancy advance.

### CONCLUSION

The present study comprised of sonographic examination of 200 uncomplicated pregnancies between 20-36 weeks of gestation. The age of the gravidas ranged from 18 years to 40 years. These patients came for sonographic examination in Department of Radiodiagnosis after attending the antenatal clinic of Department of Obstetrics and Gynecology, Dr. B. R. Ambedkar Memorial Hospital, Raipur (C.G.).

The foetal growth parameters i.e. BPD, and FL of every patient were measured serially using real time ultrasonographic examination. The mean of all measurements were tabulated, and were compared individually with western normograms.

We found that the coefficient of correlation (r) of BPD, varying between ( $r = 0.96$  to  $0.98$ ), FL, varying between ( $r = 0.92$  to  $0.98$ ), showed a high degree of linear relationship with gestational age.

The mean BPD value for each gestational age was compared with the western standard (Wexler S et al, 1986),<sup>1</sup> showed the difference of  $\pm 2.4$  mm in 2<sup>nd</sup> trimester and  $\pm 2$  mm in 3<sup>rd</sup> trimester.

The mean FL value for each gestational age was compared with western nomogram (Jeanty P et al 1984),<sup>4</sup> and the difference was noted  $\pm 2.9$  mm in 2<sup>nd</sup> and 2.7 mm in 3<sup>rd</sup> trimester.

The accuracy of the individual parameter for different weeks of gestation was noted. This accuracy indicated that, the correctly diagnosed gestational age by sonographic parameters are not equally homologous with known menstrual age. The specificity and sensitivity of BPD and FL was found to be more appropriate in predicting gestational age in second trimester and its reliability decreases in third trimester.

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