Estimation of Gestational Age by Real Time Ultrasonography (Biparietal Diameter and Head Circumference) to Estimate the Fetal Morphometry in IInd and IIIrd Trimester

Sangeeta Khare*, Manik Chatterjee**, Bichitrananda Roul***, Hulesh Mandle****

Abstract

The growth of the human fetus is a complex process resulting in an increase in size over time, has been the 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. In the second and third trimester of pregnancy the fetus has grown sufficiently in size so that extreme anatomic details is visualized. There are number of structures that can be identified and measured during this time, but the basic fetal measurement used to estimate age and weight with ultrasound are-Biparietal Diameter (BPD), Head circumference (HC). This study was performed in 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 Diaeter (BPD), Head Circumference (HC). The fetal growth parameters i.e. BPD, HC, of every patient were measured serially using real time ultrasonographic examination. The mean of all measurement were tabulated, and were compared individually with western nomograms. 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 comparisons concludes that, out of the mean value of all parameters, the minimum discrepancy was found in biparietal diameter, for the prediction of gestational age.

Keywords: Biparietal Diaeter (BPD); Head Circumference (HC); Ultrasonography.

Introduction

The growth of the human fetus is a complex process resulting in an increase in size over time, has been the 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 fetal 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 fetal growth can be determined using ultrasound.

Our understanding of normal fetal anatomy as seen on sonograms continue to be an area of considerable growth. The ability of sonography to detect intrafetal structures depends on a balance between spatial

Author's Affiliation: *Demonstrator **Professor & Head ***Assistant Professor, Dept of Anatomy, Pt. Jawahar Lal Nehru Memorial Medical College, Raipur, C.G. ****Senior resident, Dept of Radiology, Ramkrishna Care Hospital, Raipur, C.G.

Corresponding Author: Bichitrananda Roul, Assistant Professor, Dept of Anatomy, Pt. Jawahar Lal Nehru Memorial Medical College, Jail Road, Raipur, Chhattisgarh 492001.
E-mail: bichi4u2000@yahoo.co.in

resolution and contrast. High resolution, real time scanners with flexible approach to imaging are mandatory for.

Modern Fetal Sonography, Fetal Parts of Interest Fall into Three Major Categories:

1. Structure that generate high-amplitude reflections eg: ossified bones.

2. Structure that generate no internal echoes eg: fluid containing viscera.

3. Those that generate mid – range gray echoes eg. Parenchymal organs lungs, brain, spleen, liver, kidney and muscles.

Real time ultrasonography provides the most appropriate format for imaging fetal bones the resolution and flexibility offered by such systems enables one to rapidly survey the fetal 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. There are number of structures that can be identified and measured during this time, but the basic fetal measurement used to estimate age and weight with ultrasound are-

♦   Biparietal Diameter (BPD)

♦   Head circumference (HC)

Material and Method

This study was performed in 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.) from Jan2013- october 2015.

Material Required for The Study

Material Required are:

1.   Ultrasonographyc (USG) machine (PHILIPS USG MACHINE) (Figure-1 A+B).

2. Transducers (3.5 MHz convex transducer).

3. Ultra sonic jelly.

4. A comfortable bed for the patient.

5. Bedsheets 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.

Criteria for Selection of Cases

Inclusion Criteria

1. The patients attending the A.N.C. in the department of Radiology Pt. J.N.M. Medical College and Dr. BRAM Hospital Raipur C.G. should be taken as subject.

2. A history of regular menses.

3. The last menstrual period (LMP) of the patient should be 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 melitus, etc… in mother and congenital disorders of fetus will be excluded from the study.

2. Twins pregnancy excluded.

Method

The record and detailed history of the patient was obtained from the department of Obstetrics and Gynecology, 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 Diaeter (BPD), Head Circumference (HC) .

Technique of Scanning

All examinations were performed by using a Gray scale 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 fetal parameters was obtained by placing the transducer over abdomen in the middle sagital section. The fetal head was then looked for the lie of the fetus then placing the transducer over parasaggital plane to define other fetal parts.

After asserting the position of the fetal head, serial scan were made in the plane transducer to the fetal 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 fetal BPD was the outer margin of the proximal skull interface to the inner margin of the distal skull interface (Fig. 2). The Head circumference can be calculated by using the shortest and longest axis of the fetal head measured outer to outer table (Fig. 2).

Observations

Table 1: Distribution of cases according to age groups

S. 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: 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.

Table 2: Distribution of cases according to age parity

S. 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: Showed maximum no. of cases i.e. 97 cases in primipara and minimum no. of case i.e.0 case was found in 4th parity. By this we can say that the awareness of Ultrasonography examination is more in primipara.

Table 3: Mean of various parameters observed in present study

S. No.	Weeks of Gestation	BPD in mm	HC in Mm
1	20	46.54	173.23
2	21	51.36	187.48
3	22	54.53	202.98
4	23	56.23	210.18
5	24	60.85	224.97
6	25	65.43	232.18
7	26	64.81	240.94
8	27	68.25	248.25
9	28	72.41	257.02
10	29	73.39	272.01
11	30	73.64	275.06
12	31	80.12	281.37
13	32	79.55	288.47
14	33	81.55	296.63
15	34	82.00	305.18
16	35	87.70	316.12
17	36	89.82	319.33
	Mean	69.93	255.04
	SD	12.75	43.56

The study includes the sonographic recording of BPD, HC,
The mean of present study is tabulated in Table No.3.

Table 4: Comparison of bpd measurement with western nomogram

S. No.	Gestational Age in Weeks	Standard BPD chart by (Wexler S et al,1986)	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		
6	25	63	65.43	0.9674	0.012
7	26	64	64.81		
8	27	66	68.25		
9	28	72	72.41		
10	29	73	73.39	0.9653	0.0077
11	30	74	73.64		
12	31	78	80.12		
13	32	81	79.55		
14	33	82	81.55	0.9866	0.114
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 showed the comparison of present study values of BPD measurement with Western Nomogram (chart formulated by Wexler S. et al 1986), it was found that in values of present study there is maximum difference of ± 2.4mm in 2nd and ±2mm in 3rd trimester.

Table 5: Comparison of hc measurement with western nomogram

S. No.	Gestational Age in Weeks	Western Nomogram (Hadlock F.P.1984)	Mean HC in Present study	r	p
1	20	175	173.23		
2	21	187	187.48	0.9837	0.006
3	22	199	202.98		
4	23	210	210.18		
5	24	221	224.97		
6	25	232	232.18		
7	26	242	240.94	0.9735	0.04
8	27	252	248.25		
9	28	262	257.02		
10	29	271	272.01		
11	30	280	275.06	0.9650	0.011
12	31	289	281.37		
13	32	297	288.47		
14	33	304	296.63		
15	34	312	305.18	0.9758	0.17
16	35	318	316.12		
17	36	325	319.33		
	Mean	257.41	255.04		
	SD	47.64	43.56		

Table 5 showed the comparison of present study values of HC measurement with Western Nomogram (chart formulated by Hadlock F.P.1984),we noted the maximum difference of ±3.7 mm in 2nd and ± 9mm in 3rd trimester.(The maximum difference of ± 9 mm was found in 32 week.)

Discussion

In present study we have recorded the Amniotic Fluid Index and other 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 2nd and 3rd 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 cases.

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 3rd 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 fetal malformations.

various conventional parameters of the fetuses i.e. Biparietal diameter, Head circumference, 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.

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 ± 12 days. Mongelli M et al (2003) 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 Persson P et al 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) 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 ±7 days.

In 28 – 31 weeks of pregnancy the accuracy of BPD values was found 28%. The variability estimate is ± 14 days.

In 32-36 weeks of pregnancy the accuracy of BPD value is found to be 26% with variability estimate of ± 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 ± 7days. In later half of the second trimester the variability is found to be ± 14 days. It is seen that as the pregnancy advance the variability also increases. In last trimester it reaches up to ± 3 weeks.

The mean BPD of the present study was compared by the standard BPD chart formulated by Wexlers S. et al (1986) in table No.6. 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, HC and FL shows a linear relationship with gestational age in sensitivity parameters, indicated that these parameters are reliable predictor of gestational age.

HC (Head Circumference)

Head circumference is an important measurement of neonatal head growth and maturity, but the value of this parameter over BPD and FL for prediction of gestational age is not very reliable, however it is a sensitive index of fetal head and maturity which can be affected by variation in fetal head shape. The reliable estimates of head circumference can be calculated by using the shortest and longest axis of the fetal head measured outer to outer.

In present study the accuracy of Head Circumference value from known menstrual age ranging 20 – 23 weeks is 53% and the accuracy of Head Circumference value in 24 – 27 weeks of pregnancy was found 26%. and in 28 – 31 weeks of pregnancy was found 28% and accuracy of Head Circumference in case of more than 32-36 weeks found 30%.

This data shows that the percentage of correctly diagnosed cases decreases as the pregnancy advance. Callen P et al have demonstrated that the head circumference can predict menstrual age within ± 1 week, at 20 weeks of gestation, while Bensen C.B et al have demonstrated that the variability in prediction of age from head circumference reaches to a peak approximately at ± 3.8 weeks in the late 3rd trimester of pregnancy.

Mean Head Circumference value of the present study was compared with the standard chart of Hadlock F.P (1984) In table No.7. In 32th weeks of pregnancy there is maximum discrepancy i.e. ± 1mm. The graph of AC is nonlinear in sensitivity parameter indicate that these.

In second trimester HC value with the standard has got the discrepancy of about ± 5 mm. In the third

trimester the mean variability is of about ± 10 mm comparing with the standard chart. The coefficient correlation (r) of HC with gestational age in present study in 20 – 23 weeks was found to be (r = 0.9837) and P value was (p = 0.006), and in 32 – 36 weeks   (r= 0.9758) and (p= 0.17). That means HC is significant for assessment of gestational age in second trimester.

Summary and 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 fetal growth parameters i.e. BPD, HC, of every patient were measured serially using real time ultrasonographic examination. The mean of all measurement were tabulated, and were compared individually with western nomograms.

We found that the coefficient of correlation (r) of BPD, varying between (r = 0.96 to 0.98), HC, varying between (r = 0.96 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), showed the difference of ± 2.4 mm in 2nd trimester and ± 2 mm in 3rd trimester.

The mean head circumference on comparing with the western standard (Hadlock F.P 1984) we noted the difference of ± 3.7 mm in 2nd trimester and ± 9 mm in 3rd trimester. (In 16th week there is maximum difference, i.e. of 14 mm.). 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 comparisons concludes that, out of the mean value of all parameters, the minimum discrepancy was found in biparietal diameter, for the prediction of gestational age.

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