RESEARCH ARTICLE

Comparison of Estimation of Gestational Age by Transverse Cerebellar Diameter with Biparietal Diameter in Third Trimester of Pregnancy

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Abstract

Aims and objectives: To determine the accuracy of transverse cerebellar diameter for assessment of gestational age in comparison with biparietal diameter (BPD) in third trimester of pregnancy using the 1st day of the last menstrual period (LMP) for calculation of the actual period of gestation.

Materials and methods: The study was a prospective observational study conducted on 150 antenatal patients between gestational ages 28 weeks and 40 weeks visiting the outpatient department and emergency of Department of Obstetrics and Gynecology, Era's Lucknow Medical College and Hospital, Lucknow. After obtaining detailed history and doing thorough clinical examination, ultrasound of all selected cases was performed; transcerebellar diameter (TCD) and BPD were measured and compared with LMP.

Results: Difference between actual gestational age and gestational age assessed by BPD ranged from −5 to 9 days and by TCD ranged from −6 to 7 days irrespective of gestational age. With respect to mean difference between estimated gestational age by TCD and actual gestational age, it was higher for 28 weeks (1.89 ± 1.32 days) and 34 weeks (1.94 ± 1.53 days) as compared to that at 36 weeks (0.82 ± 0.71 days). Statistically, this difference was significant ($p < 0.001$). For overall assessment as well as assessment at different gestational ages, mean error was higher for BPD as compared to TCD ($p < 0.001$).

Conclusion: In the given scenario, both TCD and BPD were quite useful as observed in the present study; however, in statistical terms, TCD was definitely better as compared to BPD. The applicability and validity of these results in a relaxed sampling frame needs to be validated in further studies.

Keywords: Biparietal diameter, Gestational age estimation, Third trimester of pregnancy, Transcerebellar diameter, Ultrasound.

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Introduction

Gestational age (GA) is the common term used during pregnancy to know the duration of pregnancy. It is measured in weeks, from the 1st day of last menstrual cycle to the current date. A normal pregnancy can range from 37 to 42 weeks. The accurate dating of pregnancy is critically important for pregnancy management from the first trimester to delivery, and it is particularly necessary for determining premature labor and in postdated deliveries. Prior to the widespread use of ultrasound, caregivers relied on a combination of history and physical examination to clinically determine GA. Ultrasound gave clinicians a method to measure the fetus and therefore to estimate GA. Ultrasound biometric measurements determine GA based on the assumption that the size of the embryo or fetus is consistent with its age. Biological variation in size is less during the first trimester than in the third trimester. Ultrasound estimation of GA in the first trimester is therefore more accurate than in late trimesters of pregnancy.

Assessment of GA is important in the management of pregnancy. The most frequently used biometric parameters for the estimation of GA are the fetal biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL). These parameters have few limitations as conditions altering the shape of skull will affect the BPD, which is a well-accepted indicator of GA. So transverse cerebellar diameter (TCD) developed as an alternative parameter to assess fetal brain growth and estimate GA.

The fetal TCD is often measured as an additional fetal biometric parameter. It is measured as the maximal diameter between the cerebellar hemispheres on an axial scan. The value of the TCD in mm is considered roughly equivalent to the GA in week (particularly between 14 weeks and 20 weeks of gestation). The TCD is not thought to be significantly altered by the presence of intrauterine growth restriction (IUGR). The TCD serves as a reliable predictor for assessment of GA of the fetus and is a standard against which aberrations in other fetal parameters can be compared, especially when the GA cannot be determined by the date of the last menstrual period (LMP) or an early pregnancy scan.

Many pregnant women come for their first antenatal checkup in third trimester. They are unsure of dates and do not possess an early dating scan. Management decisions become particularly difficult in conditions where there is growth restriction or growth acceleration. Since the last decade, ultrasound parameter "TCD" is considered a

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reliable predictor for GA in third trimester. Size of the cerebellum is less affected by deviation in fetal growth restriction or growth acceleration. The predicted GA by TCD between 22 weeks and 28 weeks is within 0–2 days, between 29 weeks and 36 weeks is within 5 days, and at 37 weeks is 9 days of actual gestation. Transverse cerebellar diameter normogram predicts GA with accuracy of 94% in the third trimester.

The aim of the study was to determine the accuracy of TCD for assessment of GA in comparison with BPD in the third trimester of pregnancy using the 1st day of LMP for actual period of gestation. For this, we assessed the GA by TCD and BPD at 28, 34, and 36 weeks of pregnancy and compared TCD with BPD for accuracy.

Materials and Methods

The study was a prospective observational study conducted over 18 months on 150 antenatal patients in their third trimester of pregnancy (28–40 weeks) visiting the OPD and emergency of the Department of Obstetrics and Gynecology, Era's Lucknow Medical College and Hospital, Lucknow. The study was done after proper informed consent and approval by the Institutional Ethics Committee (Ref No. ELMC/EC/R_Cell/2013/246).

Pregnant women in the third trimester (28, 34, and 36 weeks) with singleton uncomplicated pregnancy and sure of dates (calculated from 1st day of LMP) were included in the study. Patients who were unsure of dates, or with anomalous fetuses, intrauterine death, multiple gestation, or with medical disorders like diabetes, hypertension, etc., were excluded from the study. After obtaining detailed history and doing thorough clinical examination, ultrasound of all selected cases was performed on the Elpro GE Logic 200 ultrasound machine with 3.5-MHz probe sector transducer. Ultrasound measurement of TCD and BPD (BPD) was done and compared with LMP. Biparietal diameter by Hadlock was measured in transverse plane at the level of the thalamus from the outer table of the proximal skull to the inner table of the distal skull corresponding to the leading edge to edge measurement. Transcerebellar diameter by Goldstein was measured by rotating the transducer 300° below the thalamic plane to see a butterfly-like structure in posterior fossa and measuring at outer margin of the cerebellum. Measurements were taken at 28, 34, and 36 weeks of GA.

Sample Size Calculation[1]

$$n = d\frac{\{Z\alpha\sqrt{2p}(1-p)+Z\beta\sqrt{p_1}(1-p_1)+p_2(1-p_2)\}^2}{(p_1-p_2)^2}$$

Where

$$p_1 = 0.917$$
$$p_2 = 0.772$$
$$p = \frac{p_1+p_2}{2}$$

$d = 1.5$; d—design effect
Type 1 error $\alpha = 5\%$
Type 2 error $\beta = 20\%$
Power of study = 80%
Data loss = 10%
Sample size: $n = 150$

Statistical Analysis

The statistical analysis was done using the Statistical Package for Social Sciences (SPSS) Version 21.0 statistical analysis software. The values were represented in number (%) and mean ± SD.
The following statistical formulas were used:

- Chi-square test
- Analysis of variance (ANOVA)

Results

Maximum number of women enrolled in the study were aged 26–30 years (46.0%) followed by those aged 20–25 years (44.7%). Mean age of women was 26.01 ± 3.19 years. Majority of women were from rural areas (57.3%). A total of 64 (42.7%) were from urban areas. Mean BPD was minimum at GA 28 weeks (70.87 ± 0.44 mm) and maximum at GA 36 weeks (89.07 ± 0.44 mm). Mean BPD was 85.03 ± 0.67 mm for GA 34 weeks ($p < 0.001$). Mean TCD was minimum at GA 28 weeks (32.05 ± 1.66 mm) and maximum at GA 36 weeks (47.86 ± 0.95 mm). Mean TCD was 43.77 ± 0.69 mm for GA 34 weeks ($p < 0.001$). Difference between actual GA and GA assessed by BPD ranged from −5 to 9 days irrespective of GA (Table 1). Difference between actual GA and GA assessed by TCD ranged from −6 to 7 days irrespective of GA (Table 2). With respect to mean difference between actual and estimated GA by BPD, with increasing actual GA a significant drop in extent of error in estimated age was observed. For GA at 28 weeks, this error was 2.99 ± 1.60 days; for GA at 34 weeks, it was 2.65 ± 1.77 days; and for GA at 36 weeks, it was 2.20 ± 1.29 days. Statistically, this change in mean error was significant ($p < 0.001$) (Table 3). With respect to mean difference between actual and estimated GA by TCD, it was higher for 28 weeks (1.89 ± 1.32 days) and 34 weeks (1.94 ± 1.53 days) as compared to that at 36 weeks (0.82 ± 0.71 days). Statistically, this difference was significant too ($p < 0.001$) (Table 4). For overall assessment as well as assessment at different GAs, mean error was higher for BPD as compared to TCD ($p < 0.001$) (Table 5).

Table 1: Extent of accuracy of gestational age (GA) estimate by biparietal diameter (BPD)

S. no	*Difference from actual GA*	*No. of observations*	*Percentage*
1	±1 day	145	32.2
2	±2–3 days	156	34.7
3	>±3 days	149	33.1

Mean difference ± SD (range) in days = 1.89 ± 2.42 (−5 to 9)
Difference between actual GA and GA assessed by BPD ranged from −5 to 9 days irrespective of GA

Table 2: Extent of accuracy of gestational age (GA) estimate by transcerebellar diameter (TCD)

S. no	*Difference from actual GA*	*No. of women*	*Percentage*
1	±1 day	270	60.0
2	±2–3 days	137	29.9
3	>±3 days	43	10.1

Mean difference ± SD (range) in days = 0.52 ± 1.98 (−6 to 7)
Difference between actual GA and GA assessed by TCD ranged from −6 to 7 days irrespective of GA

Table 3: Association between actual gestational age (GA) and extent of error between actual and estimated GA by biparietal diameter (BPD)

		Extent of error by BPD							
		±1 day		*±2–3 days*		*>±3 days*			
S. no	*Actual GA*	*No.*	*(%)*	*No.*	*(%)*	*No.*	*(%)*	*Mean*	*SD*
1	28 weeks	28	18.7	55	36.7	67	44.7	2.99	1.60
2	34 weeks	55	36.7	42	28.0	59	39.3	2.65	1.77
3	36 weeks	67	44.7	51	34.0	31	20.7	2.20	1.29

$\chi^2 = 29.063$ (df = 4); $p < 0.001$; $F = 46.698$; $p < 0.001$

With respect to mean difference between actual and estimated GA too, with increasing actual GA a significant drop in extent of error in estimated age was observed. For GA 28 weeks this error was 2.99 ± 1.60 days, for GA 34 weeks it was 2.65 ± 1.77 days, and for GA 36 weeks it was 2.20 ± 1.29 days. Statistically, this change in mean error was significant ($p < 0.001$)

Table 4: Association between actual gestational age (GA) and extent of error between actual and estimated GA by transcerebellar diameter (TCD)

		Extent of error by TCD							
		±1 day		*±2–3 days*		*>±3 days*			
S. no	*Actual GA*	*No.*	*(%)*	*No.*	*(%)*	*No.*	*(%)*	*Mean*	*SD*
1	28 weeks	69	46.0	68	45.3	13	8.7	1.89	1.32
2	34 weeks	72	48.0	48	32.0	30	20.0	1.94	1.53
3	36 weeks	129	86.0	21	14.0	0	0.00	0.82	0.71

$\chi^2 = 81.346$ (df = 4); $p < 0.001$; $F = 120.431$; $p < 0.001$

With respect to mean difference between actual and estimated GA by TCD, it was higher for 28 weeks (1.89 ± 1.32 days) and 34 weeks (1.94 ± 1.53 days) as compared to that at 36 weeks (0.82 ± 0.71 days). Statistically, this difference was significant too ($p < 0.001$)

Table 5: Comparison of extent of error in estimation by biparietal diameter (BPD) and transcerebellar diameter (TCD)

		BPD		*TCD*		*Statistical significance*	
S. no	*Actual GA*	*Mean*	*SD*	*Mean*	*SD*	*t*	*p*
1	Overall	2.62	1.60	1.55	1.34	10.876	<0.001
2	28 weeks	2.99	1.60	1.89	1.32	6.495	<0.001
3	34 weeks	2.65	1.77	1.94	1.53	3.717	<0.001
4	36 weeks	2.20	1.29	0.82	0.71	11.478	<0.001

For overall assessment as well as assessment at different GAs, mean error was higher for BPD as compared to TCD ($p < 0.001$)

Discussion

In utero estimation of fetal age in consonance with GA is one of the methods that help in estimation of fetal growth restriction and fetal well-being as well as for the purpose of management of a planned delivery. Mean BPD showed an incremental trend with increasing GA. An average growth of 2.58 mm/week during 28–34 weeks and 2.02 mm/week during 34–36 weeks. In a study by Jaiswal et al.,[2] the biparietal growth rate during 27–34 weeks of pregnancy was 2.46 mm/week, which is close to that obtained in the present study. Fetal BPD generally increases rapidly during the second trimester with average growth rate of 3.1–3.36 mm/week during 13–28 weeks. However, in third trimester this growth rate is decelerated to some extent and is minimum at near term. In the present study, 28–29 weeks' mean BPD values were found to be 70.87 ± 0.44 mm, which is close to a mean value of 70.60 mm as obtained by Babuta et al.[3] However, 34 and 36 weeks' measurements in the present study (85.03 and 89.07 mm) were much higher than that reported by Babuta et al. who reported these values to be 82.08 and 87.07 mm, respectively.

In the present study, variation in estimates of BPD as compared to standards was lower and hence the errors in estimates of GA were of lower order. These results showed that BPD was capable of estimating the GA within ±3 days in more than two-third (66.9%) cases. Contrary to the findings of the present study, few studies have found the possibility of errors in GA estimations to be above 3 weeks while using the BPD as a basis for estimate. Previous studies prove BPD to be a less reliable tool for GA estimation in third trimester because of biological variability and because of an increased probability of distortion of cranial shape due to fetal position and other clinical circumstances.

In the present study, for BPD, with increasing actual GA, a decline in the extent of estimate error was observed. This is a controversial finding as most of the studies have indicated that with the progression of pregnancy, the reliability of BPD measurements decreases. A number of factors may contribute to variation or inaccuracy in the BPD measurement. It has been seen that accuracy of BPD measurements is dependent on the head shape too. To determine whether head shape is appropriate, Hadlock and coworkers[4] compared the BPD and the front occipital diameter. The ratio of these diameters is called the cephalic index (CI). In the fetus with an abnormal cephalic index, estimated dates might show error. In the present study, no such abnormalities were detected and hence the BPD measurements could be considered more appropriate. In the absence of these abnormalities, with the progression of pregnancy, the anatomic localization was much easier and hence contributed to a greater extent of accuracy.

Transcerebellar diameter is considered to be a valuable marker for assessment of GA of fetus. Although the present study was limited only to measurements in third trimester of pregnancy, yet the order of changes observed in the present study endorsed the incremental trend with increasing GA. In the present study, with increasing actual GA, proportion of women with an error >1 day for estimated GA by TCD showed a declining trend. It also showed TCD to be highly accurate and this pattern of accuracy sustained throughout the assessment, with mean error higher for BPD estimates as compared to TCD estimates. Several authors working on TCD have correlated it well with GA, even in the presence of growth retardation, and found it as a better marker for GA estimation as compared to other clinical and biometric parameters. In the present study, the accuracy levels were far superior and may be attributed to the fact that the present study was carried out in a relatively growth-restriction risk-free case. However, usefulness of TCD estimations in fetal growth restriction has also been reported in the literature.

The results in the present study are similar to those reported by Naseem et al.[1] who found that in the third trimester, TCD measurements provide more accurate estimates of GA as compared to BPD. The relatively better usefulness and accuracy of TCD as compared to BPD can also be justified owing to its practical application in cases where it is difficult or impossible to measure BPD or in cases where it is unsuitable because of the molding of the head. However, Akl et al.[5] found TCD seems to be as accurate as BPD in both term and preterm late pregnancies. Nonetheless, they also endorsed the high accuracy of TCD. Like our study, Ravindernath et al.[6] found good correlation between TCD and other assessed values in pregnancies between 15 weeks and 40 weeks, with TCD being a more reliable parameter for assessment of GA compared to BPD and FL. He also ascertained that the TCD measurements were not affected by instances that affected the BPD. Pavithra et al.[7] also concluded that the value of TCD increased with advancing GA. The data of this study suggested that measurement of fetal TCD was a reliable predictive biometric parameter for estimation of the accurate GA. Similar results were found by Bansal et al.[8] They also concluded that in IUGR fetuses, the TCD values were comparatively less than in normal growth fetuses but the difference was within normal limits suggesting significant association between TCD and GA in both fetuses.

Gameraddin et al.[9] concluded that evaluation of GA with BPD and femoral length joined together was more accurate than when these parameters were used separately. Mahmoud et al.[10] concluded that fetal TCD by ultrasound could be a predictive biometric parameter of GA in the last two trimesters of pregnancy.

Sharma et al.,[11] by their study, suggested that TCD could be used as an independent parameter in estimation of GA and can reliably estimate the GA in IUGR cases. Satish Prasad and Likhitha[12] concluded that TCD was the better parameter for GA assessment than BPD and FL as it was not fraught with the problems in the measurements commonly encountered in BPD and FL and also it is an added advantage in cases of IUGR pregnancies and also could be used as a single growth parameter to predict the GA using various obtained formulas and nomograms both in normal and IUGR pregnancies.

Conclusion

In the present study, the level of accuracy was much higher and the relative differences between BPD and TCD were nominal and did not account for a qualitative difference as far as accuracy level of ±1 week was concerned.

In the given scenario, both TCD and BPD were quite useful as observed in the present study; however, in statistical terms, TCD was definitely better as compared to BPD. The applicability and validity of these results in a relaxed sampling frame needs to be validated in further studies.

Compliance with Ethical Requirements

Informed Consent in Studies with Human Subjects

For studies with human subjects: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). Informed consent was obtained from all patients for being included in the study

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