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Transcerebellar diameter versus biparietal diameter for the measurement of gestational age in third trimester

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gestational age; third trimester; transcerebellar diameter; biparietal diameter

Abstract

Aim: To compare the accuracy of biparietal diameter and transcerebellar diameter in measuring the gestational age during the third trimester of pregnancy. **Material and methods:** In this prospective observational study, 275 pregnant women with singleton pregnancy between 32 and 37 weeks gestational age were recruited from the outpatient clinics of both Helwan University Hospital and Ain Shams University Maternity Hospital, Cairo, Egypt, during the period from February 2021 to August 2021. Transcerebellar and biparietal diameters of the fetus were measured by a radiologist blinded to the women's gestational age, and compared to the gestational age acquired from a reliable date of first day of last menstrual period. **Results:** The gestational age calculated by first day of last menstrual period ranged from 32 to 37 weeks (34.35 ± 1.4), while estimated by transcerebellar and biparietal diameters ranged from 31 to 37 weeks (34.31 ± 1.39) and 31 to 39 weeks (34.32 ± 1.44), respectively. There was a strong positive correlation between gestational age and transcerebellar diameter ($r = 0.98$, $p < 0.001$) as well as biparietal diameter ($r = 0.87$, $p < 0.001$), yet a stronger correlation was with transcerebellar diameter. 93.6% of gestational age assessment by transcerebellar diameter was correct compared to only 79.9% by biparietal diameter. **Conclusions:** Transcerebellar diameter is a reliable single sonographic fetal biometric parameter for the assessment of gestational age in third trimester of pregnancy.

Introduction

Gestational age (GA) estimation is one of the important decisions guiding medical care during pregnancy. It is the basis for the appropriate timing of deliveries and management of complications. Studies have shown that decisions based on inaccurate gestational ages result in higher fetal and maternal morbidity and mortality rates[1].

The traditional method of estimating gestational age, based on the last menstrual period, could be influenced by the regularity of menstrual cycles, especially in the immediate three months pre-conception, and also by prior exposure to hormonal contraception. In women from developing countries, late antenatal booking, absence of accurate menstruation records, and menstrual cycle irregularities are additional challenges[2].

Some consider assessment of gestational age by ultrasonography to be the 'gold standard' in antenatal care, with the first-trimester measurement of crown-rump-length (CRL) recognized as the most reliable index[3]. Following the first trimester, femur length (FL), biparietal diameter (BPD) and abdominal circumference (AC) are the most commonly used fetal biometric parameters[1].

Unfortunately, being dependent on normal fetal growth and regularity of menstrual cycle, some of these parameters are nonspecific; for example, BPD, head circumference (HC), Fl, and AC are adversely affected in fetuses with uteroplacental insufficiency, leading to the redistribution of cardiac output and brain-sparing effect with growth restriction[4]. After 26 weeks of gestation, BPD is not reliable in fetuses with dolichocephaly and brachycephaly[5]; FL is shorter

Fig. 1. *2D gray-scale ultrasound of a pregnant woman at 37 weeks GA showing TCD measuring 52.5 mm corresponding to 37 weeks GA*

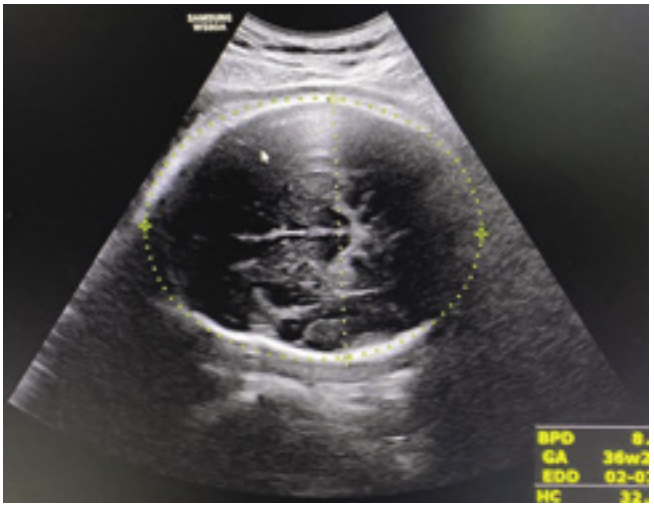

Fig. 2. *2D gray-scale ultrasound of a pregnant woman at 37 weeks GA showing BPD measuring 89.9 mm corresponding to 36 weeks + 2 days GA*

in fetuses with achondroplasia, and abnormalities in the amniotic fluid volume also decrease the accuracy of FL measurement by ultrasound[6].

Ultrasonographically, the cerebellum is easily viewed as a central rectangular echogenic structure (vermix) connecting two oval echolucent structures (hemispheres) after the 14th week of gestation[7]. The size of the cerebellum, visualized as early as in the 10th or 11th week of conception, shows a linear relationship with gestational age[8]. The cerebellum is not affected in fetuses with IUGR owing to the brain-sparing effect[9]. Hence, transcerebellar diameter (TCD) has been described as a reliable single estimator of GA in late pregnancy[8].

The aim of this study is to compare the accuracy of BPD and TCD in measuring the gestational age during the third trimester of pregnancy.

Material and methods

This prospective observational study was conducted at both Helwan University Hospital and Ain Shams University Maternity Hospital, Cairo, Egypt, during the period from February 2021 to August 2021. Approval of the Research Ethics Committee for Human and Animal Research at the Faculty of Medicine, Helwan University (REC-FMHU) was obtained before commencement of the study (decision no.: 12-2021). 275 pregnant women with singleton pregnancy between 32 and 37 weeks gestational age were recruited from the outpatient clinics of both University Hospitals. An informed written consent was obtained from all women before enrollment in the study after explaining the aim and risks associated with the study. All women enrolled were sure of their 1st day of last menstrual period (LMP), had regular menses for the last 6 months preceding pregnancy, and had an early 1st trimester ultrasound which confirmed the gestational age using crown rump length (CRL). Women with multiple pregnancy, intrauterine fetal death (IUFD), intrauterine growth retardation (IUGR), fetal anomalies, fetal macrosomia, and with a history of using any hormonal contraception or hormonal therapy in the last 6 months preceding pregnancy were excluded from the study.

The required sample size was estimated using the Power Analysis and Sample Size software (PASS©) version 11.0.10 (NCSS, LLC. Kaysville, Utah, USA). The primary outcome measure was the proportion of patients with correctly estimated gestational age using the transcerebellar diameter (TCD) or biparietal diameter (BPD), taking gestational age estimated based on the reliable date of the last menstrual period (LMP) as the standard reference. A study reported that the percentage of patients with correctly estimated gestational age using the TCD was approximately 92% versus 77% for the BPD[10]. Assuming that the proportions of correctly assessed patients using the TCD or the BPD would be 0.92 and 0.77, respectively, it was calculated that the proportion of discordant pairs using either assessment tool on the same patient would be 0.27. The proportion of discordant pairs was calculated as follows: $DP = P1 (1 – P2) + P2 (1 – P2)$, where DP is the proportion of discordant pairs, P1 is the proportion of correctly assessed patients using the TCD, and P2 is the proportion of correctly assessed patients using the BPD. Consequently, it was estimated that a sample of 275 patients who were to be subjected to the estimation of gestational age using both the TCD and the BPD would achieve a power 80% with type I error set to 0.01.

All recruited women were subjected to thorough history taking and examination, and ultrasound assessment before enrollment in the study. An ultrasound unit (SAMSUNG MEDISON CO, LTD, Korea MODEL H60 or TOSHIBA Aplio 400, Toshiba medical systems, Japan) with a 3.5–5 MHz convex probe was used to perform all ultrasonographic measurements. Transcerebellar diameter was measured by the

Tab. 1. *Demographic characteristics of study participants*

		Min.	Max.	Mean	SD
Age (years)		18.00	34.00	24.00	3.85
BMI (kg/m²)		21.00	34.00	27.51	3.63
AFI (cm)		9.00	17.00	12.34	2.16
		N		**%**	
Parity	**1**	124		41.5%	
	2	97		32.4%	
	3	56		18.7%	
	4	22		7.4%	
	Total	299		100.0%	

transverse view of fetal intracranial anatomy through the posterior fossa, including visualization of midline thalamus, cerebellar hemisphere, and cisterna magna. Measurements were obtained by placing on screen the calipers of ultrasound units at the outer margins of the cerebellum (Fig. 1).

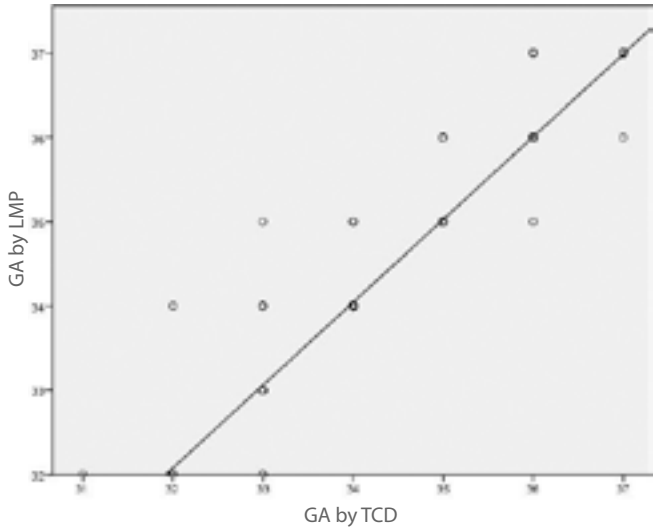

Fig. 3. *Plot showing a strong positive correlation between GA measured by LMP and GA measured by TCD*

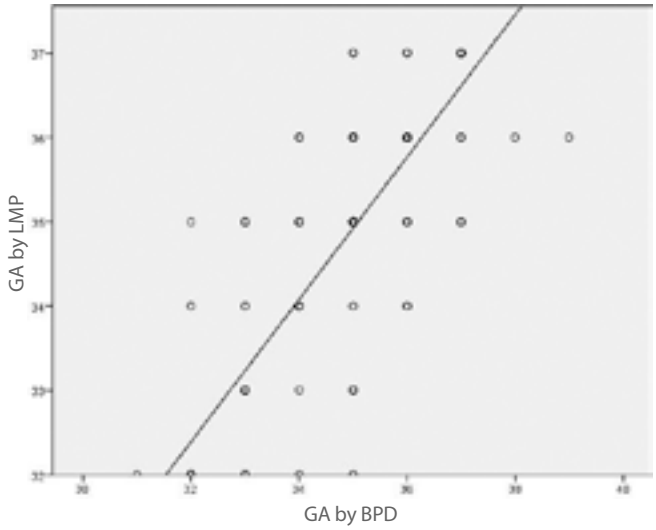

Fig. 4. *Plot showing a strong positive correlation between GA measured by LMP and GA measured by BPD*

Tab. 2. *Comparison between TCD and BPD regarding correct assessment of GA (accuracy of GA assessment)*

		N	%	*P* value*
Correct assessment of GA by TCD	**Yes**	280	93.6%	<0.001 HS
	No	19	6.4%	
Correct assessment of GA by BPD	**Yes**	239	79.9%	
	No	60	20.1%	

The biparietal diameter was measured in the transverse plane at the level of thalami from the outer table of proximal skull to the inner table of distal skull corresponding to the leading edge to edge measurement (Fig. 2). History taking and calculation of gestational age were done by a physician who was blinded from the ultrasound measurements; similarly, the sonographer was blinded from the GA estimated using the first day of LMP. Both types of data were not revealed until after statistical analysis.

Statistical analysis was performed on a personal computer using IBM© SPSS© Statistics version 21 (IBM© Corp., Armonk, NY, USA). Data were collected, tabulated, and then analyzed using appropriate statistical tests. The D'Agostino-Pearson test was used to test the normality of numerical data distribution. Numerical data were presented as means and standard deviations (if normally distributed) or as medians and interquartile ranges (if skewed). Categorical data were presented as numbers and percentages, or as ratios. The McNemar test was used to compare the difference between the TCD and the BPD as regards the proportion of patients with correctly estimated gestational age. $P < 0.05$ was considered statistically significant. Intra-class correlation coefficient (ICC) was used to measure agreement between GA measured by TCD and BPD with that measured by LMP, and it was interpreted as follows: 0–0.2 indicated poor agreement; 0.3–0.4 indicated fair agreement; 0.5–0.6 indicated moderate agreement; 0.7–0.8 indicated strong agreement; and >0.8 indicated almost perfect agreement.

Results

275 pregnant women with singleton pregnancy between 32 and 37 weeks gestational age were recruited in the study. Their demographic characteristics are shown in Tab. 1. The gestational age calculated by LMP ranged from 32 to 37 weeks (34.35 ± 1.4), while that estimated by TCD and BPD ranged from 31 to 37 weeks (34.31±1.39) and 31 to 39 weeks (34.32 ± 1.44), respectively. There was a strong positive correlation between GA determined by LMP and TCD ($r = 0.98$, $p < 0.001$) as well as between LMP and BPD ($r = 0.87$, $p < 0.001$), yet a positive correlation of GA determined by LMP with TCD is stronger than that with GA by BPD (Fig. 3, Fig. 4). 93.6% of GA assessments by TCD were correct, compared to only 79.9% of GA assessments based on BPD (Tab. 2). Still, intra-class correlation coefficient for agreement between GA measured by both TCD and BPD and GA measured by LMP showed perfect agreement for both as a reliable method to measure GA (Tab. 3, Tab. 4).

Tab. 3. *Intra-class correlation coefficient for agreement between GA measured by TCD and GA measured by LMP*

	Intra-class correlation (ICC)	95% confidence interval		F test with true value 0	
		Lower bound	Upper bound	Value	Sig
Single measures	0.978	0.973	0.983	91.849	<0.001 HS
Average measures	0.989	0.986	0.991	91.849	<0.001 HS

Tab. 4. *Intra-class correlation coefficient for agreement between GA measured by BPD and GA measured by LMP*

	Intra-class correlation (ICC)	95% confidence interval		F test with true value 0	
		Lower bound	Upper bound	Value	Sig
Single measures	0.870	0.839	0.895	14.378	<0.001 HS
Average measures	0.930	0.913	0.945	14.378	<0.001 HS

Tab. 5. *Accuracy of TCD for GA estimation in the 3rd trimester compared to the results of other studies*

Study	Pearson correlation	*P*-value
This study	0.98	<0.001
Chavez *et al.*[15]	0.95	0.001
Reddy *et al.*[12]	0.982	0.0004
George *et al.*[14]	0.995	<0.001
Bavini *et al.*[11]	0.971	<0.0001

Discussion

In developing countries, many women do not have access to regular antenatal care. Accordingly, a number of pregnant women attend hospitals in the 3rd trimester of pregnancy without any records that can be used to determine their gestational age. Doctors are faced with the dilemma of how to estimate the correct gestational age in these women to allow proper management of pregnancy. Ultrasound assessment is sometimes the only available tool that can be used to assess GA in instances when women are confused about the menstrual history. Still, calculation of GA using some ultrasonographic parameters in the 3rd trimester, such as BPD, abdominal circumference (AC), or head circumference (HC), has been reported to show discrepancies of up to 3 weeks[11].

TCD has been studied over the last few years with very promising results, showing a very strong correlation with GA, especially in the last trimester of pregnancy[10–14]. The fetal cerebellum is located in the posterior fossa between the occipital and petrous bones. Its growth shows a linear correlation with advancing GA, and does not vary with changes in the fetal skull, and remains unaffected by fetal growth even in IUGR[11]. These features allowed many authors to consider TCD as one of the most reliable sonographic parameters for the estimation of GA. Some of them noted that it was even more reliable than other parameters in IUGR cases[12,13].

This study showed a very high accuracy of TCD in predicting GA, with a strong positive correlation with GA measured by LMP. The correlation was nearly similar to most studies investigating the accuracy of TCD in measuring GA in the 3rd trimester, Tab. 5 shows the correlation of some of these studies compared to the findings of this study[11,12,14,15]. Chavez *et al*. 2007, suggested even high accuracy of TCD in correctly estimating GA in both IUGR and large fetuses[16]. On the other hand, despite an overall strong correlation between TCD and GA, one author found this correlation to be very mild after 32 weeks gestation. However, the author did not offer a possible explanation for this weak correlation[13].

TCD is not routinely measured by the majority of physicians during fetal biometry, and most ultrasound systems are not routinely setup with GA measurement by TCD. This study confirms, based on the results of several studies, that TCD could be used as a reliable ultrasound parameter for GA estimation in the 3rd trimester of pregnancy, and encourages its routine use during fetal biometry. The relatively adequate sample size together with the prospective nature of the study and the blinding of both the physician and the sonographer until after the statistical analysis of data contribute towards the reliability of the results and support the claim that TCD can be used as a single sonographic parameter for GA measurement in the 3rd trimester. Still, combining TCD with other biometric parameters might lead to a more accurate assessment of GA, especially that several studies have claimed a declining accuracy when using TCD alone in the 3rd trimester[12,13]. More studies are still needed to find the best combination of biometric parameters.

One of the strong points of this study is the elimination of inter-observer variation, as all the ultrasounds were performed by the same radiologist. Still, excluding both large and small GA fetuses limited the clinical application and importance of the study. Knowing the accurate GA in these two categories, especially IUGR, seems to be of greater clinical significance and, therefore, more studies are needed to validate the value of using TCD in these categories of patients. Also, limiting the comparison between TCD and BPD decreased the reproducibility of results.

Conclusion

While TCD seems to be a reliable single biometric parameter for GA estimation in the 3rd trimester of pregnancy, more studies are needed to validate its accuracy in determining GA in IUGR and large fetuses. It is highly likely that a combination of sonographically measured TCD with other fetal biometric parameters would yield more accurate estimates of GA.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organizations which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

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